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NUCLEAR RESEARCH AND TEST ESTABLISHMENT DECOMMISSIONING LICENCE

WHITESHELL LABORATORIES

I) LICENCE NUMBER: **NRTEDL-W5-8.00/2024**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act*, this licence is issued to

Canadian Nuclear Laboratories Ltd
Laboratoires Nucléaires Canadiens Ltée
286 Plant Road
Chalk River, Ontario
K0J 1J0

III) LICENCE PERIOD: This licence is valid from January 1, 2020 and remains in effect until December 31, 2024 unless otherwise suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

a) operate and decommission the Whiteshell Laboratories (hereinafter “WL”) located in Pinawa, Province of Manitoba as further described in the Whiteshell Laboratories *Licence Conditions Handbook* (LCH) ,

b) produce, possess, process, refine, transfer, use, package, manage, and store the nuclear substances that are required for, associated with or arise from the activities described in a),

c) possess, use, produce and transfer prescribed equipment that is required for, associated with, or arises from the activities described in a),

d) possess, use and transfer prescribed information that is required for, associated with, or arises from the activities described in a),

e) carry out the site preparation, construction or construction modification or undertaking that is required for, associated with or arise from the activities described in a).

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Whiteshell Laboratories Licence Conditions Handbook (LCH) provides compliance verification criteria used to verify compliance with the conditions set out in this licence, including information regarding delegation of authority and applicable versions of documents and a process for version control of codes, standards or other documents that are used as compliance verification criteria.

VI) CONDITIONS:

G GENERAL

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations;

(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence; and

(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

G.4 The licensee shall implement and maintain a public information and disclosure program.

1 MANAGEMENT SYSTEM

1.1 The licensee shall implement and maintain a management system.

2 HUMAN PERFORMANCE MANAGEMENT

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain a training program.

3 OPERATING PERFORMANCE

3.1 The licensee shall implement and maintain an operating program, which includes a set of operating limits.

3.2 The licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission.

4 SAFETY ANALYSIS

4.1 The licensee shall implement and maintain a safety analysis program.

4.2 The licensee shall implement and maintain a nuclear criticality safety program.

5 PHYSICAL DESIGN

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program.

6 FITNESS FOR SERVICE

6.1 The licensee shall implement and maintain a fitness for service program.

7 RADIATION PROTECTION

7.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

8 CONVENTIONAL HEALTH AND SAFETY

8.1 The licensee shall implement and maintain a conventional health and safety program.

9 ENVIRONMENTAL PROTECTION

9.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

10 EMERGENCY MANAGEMENT AND FIRE PROTECTION

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11 WASTE MANAGEMENT

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall implement and maintain a decommissioning plan.

12 SECURITY

12.1 The licensee shall implement and maintain a security program.

12.2 The licensee shall complete the implementation of all security arrangements as outlined in the corrective action plan: *Implementation Plan: Tiered Response Force (TRF)* 119-508710-PLA-010, no later than May 1, 2020

13 SAFEGUARDS AND NON-PROLIFERATION

13.1 The licensee shall implement and maintain a safeguards program.

14 PACKAGING AND TRANSPORT

14.1 The licensee shall implement and maintain a packaging and transport program.

SIGNED at OTTAWA, DEC 1 9 2019.

Rumina Velshi, President
on behalf of the Canadian Nuclear Safety Commission

CANADA

CONSOLIDATION

Canadian Environmental Assessment Act, 2012

[Repealed, 2019, c. 28, s. 9]

NOTE

[Enacted by section 52 of chapter 19 of the Statutes of Canada, 2012, in force July 6, 2012, *see* SI/2012-56.]

Current to June 19, 2024

Last amended on August 28, 2019

Published by the Minister of Justice at the following address:
http://laws-lois.justice.gc.ca

CODIFICATION

Loi canadienne sur l’évaluation environnementale (2012)

[Abrogée, 2019, ch. 28, art. 9]

NOTE

[Édictée par l’article 52 du chapitre 19 des Lois du Canada (2012), en vigueur le 6 juillet 2012, *voir* TR/2012-56.]

À jour au 19 juin 2024

Dernière modification le 28 août 2019

Publié par le ministre de la Justice à l’adresse suivante :
http://lois-laws.justice.gc.ca

OFFICIAL STATUS OF CONSOLIDATIONS

Subsections 31(1) and (2) of the *Legislation Revision and Consolidation Act*, in force on June 1, 2009, provide as follows:

Published consolidation is evidence

31 (1) Every copy of a consolidated statute or consolidated regulation published by the Minister under this Act in either print or electronic form is evidence of that statute or regulation and of its contents and every copy purporting to be published by the Minister is deemed to be so published, unless the contrary is shown.

Inconsistencies in Acts

(2) In the event of an inconsistency between a consolidated statute published by the Minister under this Act and the original statute or a subsequent amendment as certified by the Clerk of the Parliaments under the *Publication of Statutes Act*, the original statute or amendment prevails to the extent of the inconsistency.

CARACTÈRE OFFICIEL DES CODIFICATIONS

Les paragraphes 31(1) et (2) de la *Loi sur la révision et la codification des textes législatifs*, en vigueur le 1er juin 2009, prévoient ce qui suit :

Codifications comme élément de preuve

31 (1) Tout exemplaire d'une loi codifiée ou d'un règlement codifié, publié par le ministre en vertu de la présente loi sur support papier ou sur support électronique, fait foi de cette loi ou de ce règlement et de son contenu. Tout exemplaire donné comme publié par le ministre est réputé avoir été ainsi publié, sauf preuve contraire.

Incompatibilité — lois

(2) Les dispositions de la loi d'origine avec ses modifications subséquentes par le greffier des Parlements en vertu de la *Loi sur la publication des lois* l'emportent sur les dispositions incompatibles de la loi codifiée publiée par le ministre en vertu de la présente loi.

LAYOUT

The notes that appeared in the left or right margins are now in boldface text directly above the provisions to which they relate. They form no part of the enactment, but are inserted for convenience of reference only.

MISE EN PAGE

Les notes apparaissant auparavant dans les marges de droite ou de gauche se retrouvent maintenant en caractères gras juste au-dessus de la disposition à laquelle elles se rattachent. Elles ne font pas partie du texte, n'y figurant qu'à titre de repère ou d'information.

NOTE

This consolidation is current to June 19, 2024. The last amendments came into force on August 28, 2019. Any amendments that were not in force as of June 19, 2024 are set out at the end of this document under the heading "Amendments Not in Force".

NOTE

Cette codification est à jour au 19 juin 2024. Les dernières modifications sont entrées en vigueur le 28 août 2019. Toutes modifications qui n'étaient pas en vigueur au 19 juin 2024 sont énoncées à la fin de ce document sous le titre « Modifications non en vigueur ».

TABLE OF PROVISIONS

TABLE ANALYTIQUE

An Act respecting the environmental assessment of certain activities and the prevention of significant adverse environmental effects

Loi concernant l’évaluation environnementale de certaines activités et visant à prévenir les effets environnementaux négatifs importants

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 12-M47

Date signed/Signé le : AUGUST 28, 2012

Atomic Energy of Canada Limited

Énergie atomique du Canada Limitée

Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories

Rapport de mi-parcours sur l'état d'avancement des activités de déclassement réalisées aux Laboratoires de Whiteshell

Public Meeting

Réunion publique

Scheduled for :

13 September 2012

Prévue pour :

Le 13 septembre 2012

Information Regarding:

Interim Status Report

Information au sujet de ce qui suit :

Rapport de mi-parcours

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

E-DOCS-#: 3884369 (WORD)
E-DOCS-#: 3990749 (PDF)

Summary

Atomic Energy of Canada Limited (AECL) is in the process of decommissioning the Whiteshell Laboratories (WL) facility in accordance with Nuclear Research and Test Establishment Licence no. NRTEDL-08.01/2018, issued by the Commission for a ten-year term valid from January 1, 2009 to December 31, 2018.

CNSC staff are updating the Commission, as requested, with respect to AECL's performance and compliance with CNSC regulatory requirements. This report covers the period from January 1, 2009 to December 31, 2011.

CNSC staff's assessment concludes that AECL is decommissioning and operating the licensed facility in compliance with CNSC regulatory requirements, and the continued decommissioning and operation of the facility does not pose unreasonable risks to the health and safety of persons, the environment, and national security.

This CMD is for information only. No action is requested from the Commission in this regard.

Résumé

Énergie atomique du Canada limitée (EACL) est en train de déclasser l'installation des Laboratoires de Whiteshell conformément au permis d'exploitation d'établissement de recherche et d'essais nucléaires n° NRTEDL-08.01/2018, délivré par la Commission pour une période de dix ans, soit du 1er janvier 2009 au 31 décembre 2018.

Le personnel de la CCSN tient au courant la Commission, à la demande de celle-ci, en ce qui concerne le rendement d'EACL et de sa conformité aux exigences réglementaires de la CCSN. Le présent rapport couvre la période du 1er janvier 2009 au 31 décembre 2011.

L'évaluation effectuée par le personnel de la CCSN permet de conclure qu'EACL déclasse et exploite l'installation autorisée conformément aux exigences réglementaires de la CCSN et que la poursuite du déclassement et de l'exploitation de l'installation ne présente aucun risque inacceptable pour la santé et la sécurité des personnes et de l'environnement ainsi que pour la sécurité nationale

Ce CMD est fourni à titre d'information seulement. Aucune mesure n'est demandée par la Commission dans ce dossier.

Signed/Signé le

August 28, 2012

Don Howard

Director General Acting

Directorate of Nuclear Cycle and Facilities Regulation

Directeur général par intérim de la

Direction de la réglementation du cycle et des installations nucléaires

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EXECUTIVE SUMMARY

Atomic Energy of Canada Limited (AECL) operates the Whiteshell Laboratories, a Class IB nuclear facility under a research and test establishment decommissioning licence located near the town of Pinawa, Manitoba, licence no. NRTEDL-08.01/2018 [1]. The licence was issued for a ten-year period commencing on January 1, 2009 to December 31, 2018.

As per the Commission's request [2], CNSC staff and the licensee are required to submit two interim status reports at the three and seven-year points in the licensing period reviewing the performance of the licensee with regard to decommissioning activities. This report summarizes AECL's performance with regard to key Safety and Control Areas (SCAs) since the licence was issued.

A separate CMD (CMD 12-M47.A), which is confidential, includes information on AECL's performance related to security.

The summary table below lists the rating for the AECL performance in the applicable Safety and Control Areas.

Functional Areas	Safety and Control Areas	Rating
1. Management	1.1 Management System	SA
	1.2 Human Performance Management	SA
	1.3 Operating Performance	SA
2. Facility and Equipment	2.1 Safety Analysis	SA
	2.2 Physical Design	SA
	2.3 Fitness for Service	SA
3. Core Processes	3.1 Radiation Protection	SA
	3.2 Conventional Health and Safety	SA
	3.3 Environmental Protection	SA
	3.4 Emergency Management and Fire Protection	SA
	3.5 Waste Management	SA
	3.6 Security	FS
	3.7 Safeguards	SA
	3.8 Packaging and Transport	SA

Note: SA = Satisfactory, FS = Fully Satisfactory (For definitions of ratings refer to Addendum E)

CNSC staff concludes that AECL continues to decommission WL in compliance with its licence, the *Nuclear Safety and Control Act*, and the *Regulations* made under the *Act*.

1 OVERVIEW

1.1 Background

The facility operated for about 40 years as a nuclear research and test establishment, first under operating licences issued by the Atomic Energy Control Board (AECB), and since coming into force of the NSCA under operating licenses issued by the CNSC. Based on its decision to discontinue operations at WL, AECL applied for a licence to decommission the facility in 2002.

The Commission issued Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-02.00/2008 to AECL in December 2002, following a two-day Public Hearing. The six-year licence was valid from January 1, 2003 to December 31, 2008.

Following a one-day Public Hearing, the Commission renewed AECL's Nuclear Research and Test Establishment Decommissioning Licence, NRTEDL-08.00/2018, in December 2008 for a ten-year licensing period.

This CMD reviews the period from January 1, 2009 to December 31, 2011, with the inclusion of some additional information occurring in 2012.

1.2 Facility Overview

Atomic Energy of Canada Limited (AECL) owns and manages Whiteshell Laboratories (WL). The nuclear research and test establishment is located on the east bank of the Winnipeg River, about 100 km northeast of Winnipeg, and about 10 km west of the town of Pinawa. The WL site encompasses an area of 4,375 hectares. The facility is comprised of a number of nuclear and non-nuclear facilities and activities, including the Whiteshell Reactor (WR-1), the Shielded Facilities (SF), the liquid and solid radioactive waste management facilities, and various research laboratories. Aerial views of the facility are illustrated in Figures 1 and 2.

1.2.1 Decommissioning Status

In 2006, WL became a part of the Nuclear Legacy Liabilities Program (NLLP), which is part of the Federal Government's long-term strategy to deal with the nuclear legacy liabilities at AECL sites. Through this program, an accelerated approach to decommissioning was introduced. Addendum A provides a decommissioning long-term timeline and a comparison table (Addendum B) of the decommissioning status for buildings at WL facility at three time points: the beginning of the licence (January 1, 2009), the current status and the end of the licensing period (December 31, 2018).

During the review period, AECL's decommissioning activities included the demolition of redundant non-nuclear buildings; continued decommissioning of Building 300 (Research & Development Complex); and the construction of enabling facilities and remediation of existing buildings, such as the construction of the Shielded Modular Above Ground Storage (SMAGS) building and the remediation of Shielded Facilities (SF) area to support decommissioning activities. Additionally, AECL is currently replacing the central oil-fired heating system with an electrical heating system.

Of the major facilities that were operated on the site, the Van de Graff Accelerator and the Neutron Generator were fully decommissioned during the previous licensing period. The WR-1 reactor at WL is permanently shutdown, de-fuelled and partially decommissioned. The facility continues to be monitored and maintained by AECL staff. Decommissioning of the WR-1 reactor is currently scheduled in 2024 (See Addendum A)

The SF includes the Hot Cell Facility and the Immobilized Fuel Test Facility (IFTF). With the decommissioning and removal of the warm cells, the additional floor space within the SF was re-designated for the waste handling area to support the newly constructed SMAGS.

Building 300, the Research and Development Complex, housed more than 170 labs and approximately 400 office spaces, mechanical rooms, and a high bay area for large-scale engineering projects. This facility is being decommissioned and demolished in seven stages reflecting how the facility was constructed. The process for decommissioning Building 300 is following seven main steps: operational shutdown, active drain system removal, dismantlement and decontamination, active ventilation system removal, release survey, demolition and site remediation. While five of the seven stages of Building 300 will be operational at the end of the licensing period, decommissioning and demolition of stages 4 and 7 is planned to be completed (See Addendum B).

All eight redundant Non-nuclear Buildings at WL have been decommissioned and demolished during the current licensing period. The remaining buildings are still operational and will be decommissioned following the WR-1 Reactor decommissioning (See Addendum B).

As part of the enabling facilities at WL, AECL has constructed the SMAGS building in the Waste Management Area (WMA). AECL commenced operation of the SMAGS with the acceptance of its first waste package on April 24, 2012. Additionally, within the WMA, AECL has constructed a Soil Storage Compound for the increased volumes of low-level contaminated soil generated from decommissioning the WL site. The current layout of the WMA is illustrated in Figure 3, with the exception of the Soil Storage Compound, which is located across from Building 431.

As previously mentioned, to improve the efficiency of the heating system for the non-redundant buildings at WL, AECL reconfigured the heating system from oil to electricity. Approximately 60% of the central oil-fired heating system has been converted to stand-alone electric heating systems. The transition from oil to electricity allows for advanced decommissioning of the central oil-fired heating plant, which includes boilers, storage tanks and distribution piping.

1.3 Licensing Status

The Commission issued a 10-year licence [1] to AECL, valid from January 1, 2009 to December 31, 2018, following a one day Public Hearing on November 5, 2008 [3]. To date, one licence amendment has been made, occurring in April 2010. CNSC staff plan to change the format of the WL licence and introduce a Licence Condition Handbook at the next major amendment.

In April 2010, the licence was amended [4] to:

1. change the submission dates for the annual reports to align with the AECL Chalk River Laboratories (CRL) operating licence, and;
2. correct two errata in the appendices of the licence, as they were outdated and not representative of the facility and its conduct of operations.

These changes were considered administrative in nature, and amendments were made through an abridged hearing resulting in the current licence, NRTEDL-08.01/2018. To date, AECL has applied for additional licence amendments. This is currently in the process for an abridged hearing.

1.4 Follow-up from November 2008 Renewal

At the renewal hearing, CNSC staff reported the quality assurance program developed over the licence period met requirements, but the implementation of the program was below expectations. Subsequent to CNSC staff review of AECL's corrective action plan and verification of activities during the 2009 inspection follow-up, CNSC staff provided status updates [5][6] to the Commission in March and May of 2010 with the conclusion that AECL progressed in the implementation of the corrective actions, and the rating was satisfactory. The rating of the Management System SCA remains satisfactory (See Section 3.1).

2 MATTERS FOR CONSIDERATION

2.1 CNSC Compliance plan

The compliance plan consists of compliance inspections, review of operations reports, review of reportable events and other occurrences that are reported to CNSC staff outside of any formal reporting requirements.

Based on a facility's relative risk, CNSC staff has established baseline compliance activity plans for all nuclear facilities. These plans include the minimum number of compliance inspections to be conducted by CNSC staff at each facility. In accordance with this plan, CNSC staff conduct routine inspections at WL on a semi-annual basis. Safeguards and security inspections are also conducted at the facility to verify compliance with applicable regulatory requirements. Additionally, an audit follow-up of the quality assurance program and implementation for WL was conducted in 2009. The results of the inspections conducted during the review period are provided in the applicable Safety and Control Areas, in Section 3.0 of this CMD.

2.2 Relevant Safety and Control Areas

As part of the CNSC continuous improvements in its regulatory processes, this CMD incorporates the new Safety and Control Areas (SCA). There are now fourteen SCAs. Each SCA is comprised of a specific area of regulatory interest. However the detailed requirements associated with each SCA vary between facility types. Addendum C, "Safety and Control Framework", contains further information about SCAs. Addendum D maps the new SCAs framework compared to the Safety Areas framework that was applied in previous CMDs for AECL-WL.

2.3 Other Matters of Regulatory Interest

The following table identifies other matters of regulatory interest and their relevance to this CMD. Relevant areas are further discussed in Section 4.0 of this document.

Other Matters of Regulatory Interest	
Area	**Relevance to this CMD**
Environmental Assessment	No
CNSC Consultation - Aboriginal	Yes
CNSC Consultation - Other	No
Cost Recovery	Yes
Financial Guarantees	Yes
Improvement Plans and Significant Future Activities	No
Nuclear Liability Insurance	No
Licensee's Public Information Program	Yes

3 GENERAL ASSESSMENT OF SCA'S

In previous licensing CMDs for this facility, CNSC staff rated both the licensee's program and the continuing implementation. In this CMD, CNSC staff rate performance of the programs which were approved at the last licensing hearing. The current rating is based on information from all compliance activities including reviews of annual reports, compliance inspections, and reviews and assessments of other licensee submissions. Addendum E, Rating Levels, provides a definition for the rating levels used by the CNSC.

The rating for 2012 has not been included in each of the 14 SCA trending tables. However, the licensee continues to demonstrate performance in 2012 that is consistent with the 2011 ratings provided.

3.1 Management System

The following table indicates the overall performance for Management System over the review period. This area was addressed at the licence renewal under SCA Quality Management. The current rating level is SATISFACTORY (SA).

Management System				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	BE	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

Subsequent to the licence renewal in 2008, the Commission requested CNSC staff to provide an update on the status of the Quality Assurance (QA) program and implementation following CNSC staff's review in 2009. This was to address the deficiencies resulting from the QA Audit, and the Below Expectations rating of the Decommissioning Quality Assurance (QA) Program implementation.

In June 2010, CNSC staff concluded, through documentation review and an inspection follow-up, that AECL had made progress in the implementation of the accepted Corrective Action Plan (CAP) to ensure an improved safety performance at AECL WL. The rating of the program implementation improved to Satisfactory.

All directives and action notices relating to the 2008 QA Audit at WL have been closed. CNSC staff concluded that the licensee has established and effectively implemented a record control process, for all records associated with decommissioning activities that complies with the QA requirements of the CSA Standard N286.6-98: *Decommissioning Quality Assurance for Nuclear Power Plants.*

In May 2011, AECL revised the Facility Authorization (FA) documents and submitted these to CNSC staff. CNSC staff reviewed the documentation and determined that the functional responsibilities defined were not clearly and completely documented in the revised documents for all positions pertaining to the licensee's organization, a requirement of the CSA N286.6-98 standard. These are minor in nature and do not introduce any elevated risk or reduce the integrity of the QA program. CNSC staff instructed AECL to address the review findings in the next revision of the FA documents.

Conclusion

Based on the information presented above, CNSC staff conclude that the AECL's Decommissioning QA program, as established and implemented, continues to meet CNSC requirements.

3.2 Human Performance Management

The overall compliance performance with regard to Human Performance Management is shown in the table below. This area was not addressed as a stand-alone area at the licence renewal, but was considered satisfactory under Quality Management and Radiation Protection. The current rating is SATISFACTORY (SA).

Human Performance Management				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

During the October 2011 Type II Compliance Inspection at WL, CNSC staff reviewed the training procedures and records relating to the AECL Corporate Training Plan for new employees in Decommissioning and Waste Management. The review of training records indicated that WL has an established training program and process to ensure that new WL staff or contractors are trained prior to conducting work at WL.

AECL has in place a corporate wide Human Performance Program (HPP) which is followed at WL. During compliance inspections, CNSC staff have confirmed that the appropriate program elements are being followed.

Improvements

AECL has implemented a fire fighter physical fitness program for the evaluation of fire fighters as part of overall fitness for duty.

Conclusion

Overall, CNSC staff are satisfied with the Human Performance Program and its implementation at WL.

3.3 Operating Performance

The following table indicates the overall performance for Operating Performance over the review period. This area was addressed at the licence renewal under SCA Decommissioning Performance. The current rating level is SATISFACTORY (SA).

Operating Performance				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

As previously mentioned, CNSC staff conducted semi-annual inspections under its baseline compliance program. The CNSC inspections confirmed programs, procedures, and work plans for the decommissioning and operations at WL remain in place. No issues relating to safety related systems were identified during the inspections. However, weaknesses in overall housekeeping were noted and subsequently corrected to the satisfaction of CNSC staff.

CNSC staff had reviewed the WL Annual Safety Reports for the review period. AECL has satisfactorily addressed all of CNSC staffs comments and recommendations relating to the 2009 ASR. CNSC staff continue to check that future versions of the annual report reflect staff comments.

All AECL facilities have transitioned to the use of the Improvement Action (ImpAct) process for internal reporting of issues since 2007. Reporting culture improved with the implementation of this process and provided AECL an opportunity for trending and continuous improvement in operations. Hence, over the reporting period, there was an increase in reportable events to CNSC, as depicted in the following table. Along with the improved reporting culture, contributing to the increase in 2010 were around the security alarm system, maintenance, and the aging fire protection systems hardware, as noted in Section 3.10 of this report.

Table 1: Reportable Events at WL 2009 - 2011

Year	Number of Reportable Events
2009	6
2010	24
2011	10

CNSC staff has reviewed the reportable events and the associated corrective action plans. All of which are closed to CNSC staffs satisfaction, and at no time was there an impact to the health and safety of the public, workers or the environment.

Decommissioning performance as assessed by radiation dose to workers (Section 3.7), and effluent releases and environmental monitoring (Section 3.9), indicates that decommissioning programs and controls are adequate and being implemented.

Conclusion

AECL had adequately addressed CNSC staffs concerns resulting from the baseline compliance inspections and review of annual compliance reports. CNSC staff are satisfied with AECL’s operating performance during the review period.

Further, CNSC staff conclude that AECL has operated the Whiteshell Laboratories facility safely, in accordance with the Act, regulations and the licence, while meeting the requirements of their program and procedures.

3.4 Safety Analysis

The overall compliance performance with regard to Safety Analysis is shown in the table below. This area was not addressed as a stand-alone area at the licence renewal, but was considered satisfactory under Fire Protection and Nuclear Criticality Safety. The current rating is SATISFACTORY (SA).

Safety Analysis				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

Fire Hazard Assessment

At the renewal hearing, CNSC staff reported the licensee's Fire Hazard Assessment (FHA) for Building 300 (B300) met regulatory requirements, subject to the completion of AECL's CAP. AECL has since completed the actions identified in the CAP. CNSC staff conclude they have met the regulatory requirements.

Safety Analysis Reports

In April 2012, AECL began operation of the SMAGS Building for the storage of low and intermediate level waste (L&ILW). As required in the licence for the operation of a newly constructed nuclear facility, AECL submitted the Safety Assessment Report (SAR): Safety and Hazard Assessment for the SMAGS Facility at WL. Following CNSC staff's review, the licensee was notified to have met the requirements of the licence, and the operation of the SMAGS facility provided adequate protection to the health and safety of persons, workers and the environment.

Following the events at the Fukushima site in Japan CNSC requested all Class I nuclear facilities review the lessons learned and re-examine the safety case. AECL identified no significant gaps for the WL facility, thus adequately addressing the request from CNSC. However, AECL identified areas for improvement to update the WL safety case documentation to current standards. Following this, AECL reported to have scheduled the revision of all AECL SAR`s based on a priority ranking system. During the review period, AECL began the revision of the SF SAR and the WMA SAR, with the submission of these documents to CNSC staff in 2013.

Nuclear Criticality Safety

As reported at the licence renewal, there remains no activities associated with fissionable material at WL, other than storage of used fuel in the Concrete Canister Storage Facility (CCSF), which AECL and CNSC staff consider to be low-risk and low priority. In October 2010, AECL reported the removal of all fissionable material from *Building 418: Fissionable Materials Storage*. This action reassigned the function of the building from a Nuclear Criticality Controlled Area to a non-nuclear building, as currently in the licence amendment application. CNSC staff confirmed the removal of this material as part of the baseline compliance inspections at WL in October 2011.

The Nuclear Criticality Safety (NCS) Program at AECL is a corporate-wide program, and is the process used at WL and CRL. As reported at the renewal and through AECL's NCS Program schedule for revising the current Criticality Safety Documents (CSD), AECL has provided CNSC staff with temporary limits to be used as the Upper Sub-critical Limits (USL) until all CSDs are revised to include explicit USLs. CNSC staff has reviewed the temporary USLs and concluded they are consistent with CNSC regulatory requirements.

Improvements

As mentioned, AECL has developed a corporate-wide *Nuclear Criticality Safety Program* set of documents in accordance with the Regulatory Commitments. Further, AECL has completed the initial stage of implementation, to establish the requirements of the NCS Program.

Outstanding Actions and Future Plans

Based on AECL's risk-graded approach, the licensee continued to progress with the NCS Program requirements. Semi-annual updates are provided to the CNSC on the NCS Program progress and target dates.

Conclusions

Through desktop review, CNSC staff conclude that AECL has satisfactorily addressed the CAP for the B300 FHA.

With respect to nuclear criticality safety, CNSC staff conclude that AECL's update of the CSDs will lead to a consistent and gradual implementation of the nuclear criticality requirements at WL, which are based on modern national and international standards.

3.5 Physical Design

The overall compliance performance with regard to Physical Design is shown in the table below. This area was not addressed as a stand-alone area at the licence renewal, but was considered satisfactory under decommissioning performance and quality management. The current rating is SATISFACTORY (SA).

Physical Design				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The discussion and conclusion for this SCA are provided in the following subsections.

Discussion

As reported to CNSC staff through the annual safety report, changes to the WL facility are controlled as per the *Engineering Change Control* procedure, which has been adopted from the CRL process.

Shielded Modular Above-Ground Storage (SMAGS) Building

The WL SMAGS building is a new storage building, which was designed based on the *2005 National Building Code of Canada (NBC)*. The SMAGS building consists of precast concrete walls on a slab-on-grade foundation, designed for low-level radiation shielding with specific design requirements for assuring waste containment of solid low-level radioactive waste material at the WL site.

AECL has provided a systematic examination of failure modes for the SMAGS facility systems, concluding there are no credible accidents that may result in serious radiological consequences. Further, the safety related systems have been analyzed, designed and implemented into the SMAGS building, which includes the building structure, comprised of a geomembrane/sub-base system, sump collection tanks, the building envelope and the fire detection system.

These systems ensure the protection of the health and safety of people and the environment from any radiological hazards associated with the SMAGS.

Pressure Boundaries

In May 2011, CNSC staff requested that AECL submit information relating to the pressure boundary systems at WL. CNSC staff has reviewed the information submitted by AECL, and concludes the pressure boundary systems at WL meet regulatory requirements.

Improvements

The current decommissioning licence is in the process for being updated to include the new standards for pressure boundaries. With this amendment, CSA Standards N285.0-2008 and B51-03 (R2007) will replace outdated standards to comply with CNSC regulatory requirements.

Outstanding Actions and Future Plans

AECL has submitted a preliminary code classification list for all pressure boundary systems at WL and will submit the final code classification for all systems to the CNSC by March 2013.

Conclusion

CNSC staff conclude that the licensee is in compliance with the regulatory requirements, and that AECL performed satisfactorily with respect to Physical Design.

3.6 Fitness for Service

The overall compliance performance with regard to Fitness for Service is shown in the table below. This area was not addressed as a stand-alone area at the licence renewal, but was considered satisfactory under decommissioning performance and Protection of the Environment and Public. The current rating is SATISFACTORY (SA).

Fitness for Service				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

In 2009, the Periodic Inspection Plan, meeting the requirements of CSA N291-08 for the WMA storage structures, was developed following a 2008 fitness-for-service evaluation. This plan was implemented at WL to ensure continued facility fitness for service.

CNSC staff reviewed the inspection and maintenance related information provided in AECL's Annual Safety Reports, which confirmed that all safety-related inspection and maintenance activities have been effectively conducted and no significant issues were identified during the review period. Additionally, CNSC staff has reviewed the Safety and Hazard Analysis Report (SAR) and the Commissioning Report of the new SMAGS building, and concluded the proposed SMAGS maintenance program is appropriate.

In 2009, AECL provided a technical basis to demonstrate that the Standpipe structures will be fit for service, in which AECL stated that there was considerable planning on developing testing and monitoring methods for Standpipe structures. Field work to complete the inspection and monitoring activities for the Standpipe continued in 2012 with adequate controls in place to address potential safety concerns.

AECL reported one unplanned event during the review period relating to civil structures fitness for service. In May 2011, AECL discovered radiologically contaminated soil between in ground Medium Level Waste (MLW) bunkers 1 and 2, located in the Waste Management Area. The contamination was restricted to an area adjacent to the bunker of 1.0 × 0.5 meters, approximately 0.7 meters deep. AECL's investigation concluded the source of contamination was water ingress and subsequent leakage out of the bunker's adjoining roof slab and wall seam. Soil samples taken indicated the activity concentrations to be below the exemption quantities provided in the *Nuclear Substances and Radiological Devices Regulations*. The contaminated soil was recovered and remediated. AECL developed a CAP which included the prevention further water ingress, an interior monitoring system and the implementation of this system in similar MLW Bunkers. CNSC staff will continue to monitor the completion of the corrective actions committed to by AECL. CNSC staff conclude there remains adequate protection to the health and safety of persons and the environment.

Improvements

The areas which need improvement are house keeping, acceleration of complete implementation of the computerized maintenance management system and acceleration of completion of the field work for the inspection and monitoring of the Standpipes.

Conclusions

In general, CNSC staff is satisfied with the progress made by AECL in the areas of periodic inspection of the MLW and Low-Level Waste (LLW) concrete storage bunker structures at Whiteshell Laboratories. In addition, inspection activities and remediation actions, where appropriate, for the concrete storage bunker structures have been effectively conducted.

3.7 Radiation Protection

The following table indicates the overall performance for radiation protection over the current licensing period. The current rating is SATISFACTORY (SA).

Radiation Protection				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

The SCA 'Radiation Protection' covers the licensee's implementation of its radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that radiation doses to persons and contamination are monitored and controlled as low as reasonable achievable (ALARA), where social and economic factors are taken into account. This is achieved by management control over work practices; personnel qualification and training; and control of occupational and public exposure to radiation.

Estimated Dose to the Public

AECL is required to determine the doses to the most exposed members (critical group) of the public from both airborne and liquid effluents from Whiteshell Laboratories, and then verify that they are below the annual dose limit for members of the public in the Regulations made pursuant to the *Nuclear Safety and Control Act*. CNSC staff concluded the results shown between 2009 and 2011 for the total estimated dose to a member of the public is below the regulatory limit of 1 mSv/year.

Table 2: Estimated Dose to the Public				
Dose	**2009**	**2010**	**2011**	**Regulatory Limit**
Airborne Effluent (mSv)	0.000005	0.000006	0.000005	1 mSv/yr
Liquid Effluent (mSv)	0.00017	0.0018	0.00062	
Airborne (% of regulatory dose limit)	0.0005	0.0006	0.0005	N/A
Liquid (% of regulatory dose limit)	0.017	0.18	0.062	N/A

Worker Dose Control

CNSC staff reviewed dose data from 2009 to 2011, as shown below in Tables 3 and 4[1]. These indicate that radiation doses to personnel are being adequately controlled to levels well below the regulatory limits. During the review period, the maximum individual effective annual dose for a Nuclear Energy Worker (NEW) was 1.3 mSv, or 2.6% of the annual regulatory limit of 50 mSv. The maximum dose to a non-NEW worker was 0.07 mSv, well below the regulatory limit of 1 mSv/year.

Table 3: Effective Dose Statistics for NEWs at WL

Dose Statistics	2009	2010	2011	Regulatory Limit
Total Persons Monitored	781	798	771	N/A
Average Effective Dose (mSv/year)	0.06	0.03	0.03	
Maximum Individual Effective Dose (mSv/year)	1.35	0.89	1.12	50 mSv/year
Maximum Individual Effective Dose over 5 years (mSv)	4.01 (2006-2010)			100 mSv/5 years

Table 4: Effective Dose Statistics for non-NEWs at WL

Dose Statistics	2009	2010	2011	Regulatory Limit
Total Persons Monitored	603	570	559	N/A
Average Effective Dose (mSv/year)	0.00	0.00	0.00	
Maximum Individual Effective Dose (mSv/year)	0.07	0.04	0.02	1 mSv/year

AECL also measured internal doses to staff at WL that are at risk of internal intake of radioactive material. The workers participated in a routine bioassay program, which involves urine analysis and/or whole-body counting. During the review period, all internal doses due to tritium and non-tritium sources have been zero.

Action Levels

Action levels (ALs) have been established as performance indicators or early warnings that a potential loss of control within a certain aspect of the radiation protection program may have occurred. There have been no action level exceedances at WL facility for the 2009-2011 reporting period.

Historically, AECL has used the Corporate AECL action levels for WL, as stipulated in their Radiation Protection manual. The effective dose action levels are 6 mSv/monitoring period and 20 mSv/year. CNSC staff had deemed these action levels inappropriate as, historically, the average annual doses to workers at WL have been far below the doses typically seen at other AECL sites.

[1] All reported average doses in tables 3 and 4 include zero dose values.

Following a number of communications between CNSC and AECL, AECL developed a set of new ALs for WL that CNSC staff found acceptable. The new action levels, found in Table 5 below, have been in place at WL since 2010. This change will be formally implemented into the framework of the amended licence.

Table 5: List of new action levels for NEWs at WL

Category	Previous AL - 2010		Revised AL - 2012	
	mSv/monitoring period	mSv/year	mSv/monitoring period	mSv/year
Effective Dose	6	20	2	6
Equivalent Dose to skin	100	200	20	60
Equivalent Dose to extremities	100	-	100	-

Contamination Control

AECL continued to maintain and implement a surface contamination monitoring program at WL to effectively control contamination at its facility.

Based on CNSC staff's assessment through inspection observations and record review, contamination monitoring continued to be effectively performed at WL.

Personnel Dosimetry

AECL continued to utilize its own internal dosimetry service at WL, licensed by the CNSC to ascertain whole-body dose, extremity beta/gamma dose, and internal dose. Neutron whole-body dose is monitored using CR-39 dosimeters supplied by Health Canada's National Dosimetry Services, which is licensed by the CNSC. For immediate monitoring of individual gamma doses, direct reading electronic dosimeters are used.

AECL continued to effectively implement and maintain a personnel dosimetry program to monitor and record worker doses at WL.

Application of ALARA

AECL continued to strive to maintain doses to staff ALARA. An example of which was the development and implementation of WL-508770-GL-190-01, "Job Scope and Safety Analysis", which provides an all hazards integrated approach to planning and executing decommissioning work packages and non-routine nuclear facility activities. Through this process, AECL are maintaining exposures and potential for unplanned exposure ALARA at WL through the application of "remove the hazard", "guard the hazard" and "guard the worker" hazard controls and safety measures. The focus has been on defining clear limiting conditions for work and applying aggressive safe back-out points for early detection of unexpected or abnormal hazards.

As a result of this process, AECL-WL have executed many radiological work packages in the 2009 to 2011 period with minimal dose consequence, no internal intakes and no significant contamination or exposure events. Examples of this include the Building 300 plutonium laboratory glove box removal, the Hot Cell Facility windows refurbishment, and the Warm Cells active drain line and ventilation duct removal.

Conclusion

CNSC staff conclude that AECL is effectively maintaining and implementing their radiation protection program to adequately control radiation exposures and doses to workers. Therefore, the Radiation Protection SCA is rated as ‘Satisfactory (SA)’ – meeting requirements.

3.8 Conventional Health and Safety

The overall compliance performance with regard to Conventional Health and Safety is shown in the table below. In the 2008 renewal CMD, this SCA was not provided with a rating; however, CNSC staff did assess this SCA through compliance performance and concluded that AECL has provisions for conventional hazards at WL and was considered satisfactory.

Operating Performance				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	--	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

AECL is required to comply with the *Canada Labour Code Part II* and the associated regulations, such as the *Regulations Respecting Occupational Health and Safety* and the *Safety and Health Committees and Representatives Regulations*; the *Nuclear Safety and Control Act* and its regulations; and the decommissioning licence for WL.

The licensee followed the AECL corporate-wide Occupational Safety and Health (OSH) Program. The OSH Program provides a management framework and processes that, together with active employee involvement, and is designed to ensure the health and safety of people involved in all aspects of AECL’s activities. The AECL OSH Program is applicable to all AECL organizational units, facilities, and projects.

The framework for the OSH Program is established though AECL’s current *Occupational Safety and Health Program Manual*. Further documentation includes processes, procedures, supporting documents, records, forms and training packages to be used in achieving the objectives of the OSH Program. These allow for site-specific and project-specific needs, while still ensuring consistent application of the OSH Program requirements. In addition, AECL schedules monthly site Safety and Health Committee meetings, whereby the minutes, safety advisories, and other important OSH bulletins are posted and made fully accessible to workers.

During routine compliance inspections, CNSC staff noted some non-compliances relating to health and safety, mainly housekeeping issues of low significance. CNSC staff continued to monitor housekeeping at WL and in this regard, there have been no other observations by CNSC staff in the area of conventional health and safety.

As reported annually, AECL provides information relating to loss-time accidents at the WL facility. During the review period, the frequency of such accidents has increased slightly, from five loss-time accidents in 2008 to nine in 2011. The majority of these accidents are related to strain injuries, struck by/struck against, and slips, trips and falls. In order for AECL to prevent any future occurrences, an educational awareness effort for employees and line management has been initiated. The aim is to raise awareness of the statistics and the roles and responsibilities of staff in support of reducing hazards with emphasis on hazard recognition, early reporting and resolution. CNSC staff is satisfied with AECL's efforts to reduce loss-time accidents and increase the occupational health and safety of WL employees.

Conclusion

Based on the review above, CNSC staff conclude that AECL's performance in the SCA of Conventional Health and Safety is satisfactory, and that appropriate provisions are made by AECL for conventional hazards at WL.

3.9 Environmental Protection

The following table indicates the overall performance for environmental protection over the review period. The current rating level is SATISFACTORY (SA).

Environmental Protection				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

Performance levels for the Environmental Protection Safety and Control Area (SCA) have remained stable between 2009 and 2011 at the Whiteshell Laboratories site. This review is based upon both radioactive and non-radioactive emissions, compliance with Derived Release Limits (DRLs) for radioactive emissions, compliance with AECL effluent guidelines for non-radioactive emissions, environmental monitoring and the estimated dose to the public.

Effluents and Emissions (releases)

Airborne Radiological Emissions

The main sources of airborne radiological emissions from Whiteshell Laboratories are the Hot Cells Facility, Immobilized Fuel Test Facility, Reactor Building, Active Liquid Waste Treatment Centre and the Incinerator and Compactor/Baler in the Waste Management Area. The airborne radiological emissions from Whiteshell Laboratories between 2009 and 2011 remain below the DRLs. Table 6 shows the airborne radiological releases from the site between 2009 and 2011 are similar to previous years, displaying a consistent, low site release.

Table 6: Total Airborne Radiological Emissions at WL Facility

Release as a % of DRL	2009	2010	2011
Site Total Airborne Release	0.00532	0.00559	0.000521

Airborne Releases of Hazardous Substances

The largest hazardous (non-radiological) gaseous emissions from the Whiteshell Laboratories site are related to fuel combustion for building heating and steam generation purposes, and inadvertent losses of halocarbons used in research, cooling and fire suppression applications.

The main source of fuel combustion releases is the combustion of #2 fuel oil and propane gas to generate heat. The fuel consumption data is used to estimate the air emissions for Criteria Air Contaminants. Those that exceed the National Pollutant Release Inventory (NPRI) threshold for reporting are then reported under the NPRI. Estimated emissions between 2009 and 2011 remained low and fall below the NPRI reporting thresholds.

AECL reports semi-annually to Environment Canada under the *Federal Halocarbon Regulations* on releases in excess of 10 kg from halocarbon (Ozone Depleting Substances {ODS}) systems at all AECL facilities, including WL. AECL maintains an inventory of ODS for the WL site and make any reports as required. During the review period there was one reportable event for the fire suppressant loss of Halon (11.4 kg in the Control Room of the RD-14M). This event was reported to Environment Canada and the CNSC, as per the regulations and AECL procedures, respectively. Notwithstanding this was a reportable release, CNSC staff are satisfied this is a low significance event and that the hazardous substance emissions do not pose risks to the public or the environment. Additionally, as a remedial action and to continue with the phase-out of applicable ODS, AECL performed an evaluation that indicated the halon fire suppression system in that area was no longer required, and it has since been removed.

Liquid Radiological Emissions

The main source of liquid radiological emissions from Whiteshell Laboratories is the process water outfall, which discharges on a regular basis to the Winnipeg River. Secondary sources of liquid effluent are the Sewage Lagoon and the Waste Management Area’s two drainage ditches. The liquid radiological emissions from the site between 2009 and 2011 remain below the DRLs. The liquid radiological releases between 2009 and 2011 are similar to previous years.

Table 7: Total Liquid Radiological Emissions at WL Facility			
Release as a % of DRL	**2009**	**2010**	**2011**
Site Total Liquid Release	0.0113	0.00896	0.00687

Liquid Releases of Hazardous Substances

The Whiteshell Laboratories site routinely discharged, in various liquid effluents, many hazardous substances to the environment (the Winnipeg River) via the sewage lagoon, process sewer outfall, drainage ditches and internal liquid discharges. In total, AECL routinely monitors nine different monitoring points for hazardous substances such as metals, organic and phosphorous.

AECL's *Environmental Management System for AECL Sites in Canada* established monthly guidelines against which it assesses Whiteshell's performance. AECL's reports on the discharges between 2009 and 2011 show overall satisfactory performance in comparison to the guidelines; however, there were certain problem areas such as Total Suspended Solids (TSS), iron, mercury, oil and grease exceedences against AECL's internal guidelines in the Active Liquid Waste Treatment Centre discharges. In addition, there were TSS, iron and mercury exceedences in the discharges from the drainage ditches. AECL has on-going actions to lessen guideline exceedences through initiatives such as improving wastewater quality and managing decontamination effluent. CNSC staff is tracking these exceedences through the review of the annual safety reports.

Environmental Monitoring Program

The Whiteshell Laboratories Environmental Monitoring Program consists of radiological and non-radiological monitoring of several environmental media at various locations at the site and the surrounding communities. Its purpose is to confirm that radiation doses caused by releases of radioactive material in site effluents remain below the annual dose limit for members of the public.

Radiological monitoring results between 2009 and 2011 confirmed that the levels of radiation and radioactive contamination in the environment outside the Whiteshell Laboratories site due to operations at the site, as well as the resulting radiation doses to members of the public, were below the regulatory limit of 1 mSv/year. Monitoring of atmospheric radiological effluent exposure pathways did not indicate any measurable dose concentrations from the site in excess of natural background levels.

Monitoring of liquid radiological exposure pathways indicate small but measurable contributions from Whiteshell Laboratories operational and decommissioning activities. Radioactivity in the Winnipeg River is a small fraction of the allowable levels defined in the Canadian Drinking Water Standard.

Overall, the environmental monitoring results of Whiteshell Laboratories operations indicate that the risk is low for human health and the environment. Also, the trending indicates stable performance with no cases of widespread degrading conditions.

EA Follow-up Monitoring Program

AECL submitted the Annual Status Reports on Environmental Assessment Follow-Up Actions at Whiteshell Laboratories for 2009 through 2011. The reports summarized the activities related to nine individual work packages from the EA of the Whiteshell Laboratories Decommissioning Project which were performed during each reporting period.

Environmental Risk Assessment

Based on CNSC staffs assessment of the WL Monitoring Program for radiological, no-radiological and groundwater component, risk to humans and the environment is expected to be low.

Action Levels

The CNSC requires Class I licensees to establish action levels for controlled releases from licensed facilities. The purpose of these action levels is to give warning to the licensee and the CNSC of potential loss of control of a process or facility. During the review period there were no releases exceeding AECL's action levels from 2009 to 2011.

Outstanding Actions and Future Plans

In 2010, AECL assessed the Whiteshell Laboratories Environmental Monitoring System against CSA N288.4-10 *Environmental Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* for the purpose of updating the EM Program with the CSA Standard. AECL documented any identified gaps and will address them, within a reasonable timeline, to improve the future performance of Whiteshell Laboratories' Environmental Monitoring Program.

Conclusion

Whiteshell Laboratories performance in its environmental programs (effluent monitoring, environmental monitoring and EA follow-up) indicates that Whiteshell Laboratories' Environmental Management System is adequately implemented.

CNSC staff conclude that AECL's performance in the area of Environmental Protection meets regulatory requirements and CNSC staff expectations. Overall, the risk for human health and the environmental is considered low. Therefore, the Environmental Protection SCA is rated as 'Satisfactory (SA)' – meeting requirements.

3.10 Emergency Management and Fire Protection

The following table indicates the overall performance for emergency management and fire protection over the review period. The current rating level is SATISFACTORY (SA).

Emergency Management and Fire Protection				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

At the 2008 renewal, emergency management and fire protection were rated separately. Both the AECL WL emergency management and fire protection programs and implementation were rated as satisfactory.

Emergency Management

The AECL Whiteshell Site Emergency Plan and related site-specific emergency procedures, as part of the AECL WL emergency preparedness program requirements, was reviewed by CNSC staff and determined that the Whiteshell Site Emergency Plan is consistent with the requirements of CNSC Regulatory Guide, G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*. The AECL WL emergency preparedness documentation is appropriate for the anticipated degree of emergencies at the WL site.

During the review period, AECL reported two minor issues pertaining to the site alerting system (sirens) which encountered some operational problems due to extreme cold weather. In both cases, WL management and staff took appropriate action to implement temporary measures and satisfactory solutions until the problem with the sirens could be corrected. Appropriate corrective actions were initiated and completed to resolve the problem with the sirens.

Overall, CNSC staff conclude that AECL has adequately demonstrated its ability to effectively respond to and manage an emergency at the WL site, and to provide for the protection of the environment and the health and safety of persons.

Improvements

As a result of CNSC staff reviews and comments relating to the 2010 ASR, repairs and improvements were made to the site-wide Public Address (PA) system to ensure its functionality. However, further improvements are required to ensure broader coverage and audibility for staff working at the WL site.

With respect to fire response status and capability, AECL WL has recently implemented a fire fighter physical fitness program, and to date approximately ninety percent of the fire fighters have successfully completed the fitness evaluation. The remainder of the fire fighters are receiving additional fitness coaching and opportunities to meet the fitness requirements.

Fire fighter training has been enhanced with the addition of two new fire training facilities, one to practice their search and rescue skills and the other to allow live fire response training. In addition, enhancements are under development to provide computer based training for on-site fire fighters to gain site-specific knowledge designed to inform and evaluate fire fighter knowledge. Plans to implement a new fire command and communications protocol are scheduled to begin in 2012 September.

Fire Protection

The Fire Protection Program (FPP) has been established to comply with the requirements of the *National Building Code (2005)*, the *National Fire Code (2005)*, and *National Fire Protection Association, NFPA-801(2008).* During the review period, AECL submitted the revised WL Fire Protection Program. The FPP identifies the procedures, processes and supporting analyses necessary to demonstrate a planned, coordinated and controlled approach to fire protection at the facility. The continued implementation and maintenance of the WL FPP will continue to be monitored through routine regulatory oversight and future fire protection inspections.

Biennially, AECL submits a Third Party Review (TPR) of fire protection features at the facility which includes inspection, testing and maintenance (ITM) activities as required by the operating licence [1]. The TPR confirmed that the ITM activities relating to fire safety systems and equipment meet the intent of the NFCC. CNSC staff has reviewed the TPR, and the AECL corrective action plan to address the recommendation of the TPR, and concludes it is acceptable. CNSC staff is tracking the remaining four open items, of which AECL has made a commitment to provide an update to CNSC staff by July 29, 2012. There remains adequate protection to persons and the environment. AECL-WL also continues to submit third party reviews of any proposed modifications of the WL with the potential to impact protection from fire.

AECL has reported the completion of all the corrective actions relating to the focused Fire Protection Type II Compliance Inspection, with the exception of replacing an aging fire alarm system due to the complexity of the system and the decommissioning activities. AECL provided a status update regarding the outstanding action plan to replace the aging fire alarm system it was indicated that the design work has been completed and a supplier will be chosen by May 2012. CNSC staff will be verifying the completion of the closed actions and status of the remaining action items during the CNSC compliance inspection in the fall of this year.

During the reporting period, WL reported six unplanned events related to the failure of the Fire Alarm Monitoring System at WL. WL staff took the appropriate actions following the events and notified the CNSC as required. There remained adequate protection to persons and the environment.

Outstanding Actions and Future Plans

Relating to the PA system repairs, AECL has initiated an investigation to incorporate the site emergency tone through the PA system more evenly. In addition, AECL WL has committed to investigating methods of maximizing the emergency notification process and reporting the results of that investigation to CNSC staff by 2012 September 30.

Conclusion

Based on the review of AECL WL emergency preparedness documentation, CNSC staff has concluded that the emergency preparedness program meets the regulatory requirements, and it has been demonstrated through the implementation of that program that they are adequately prepared to effectively respond to and manage an on-site emergency, and provide for the protection of the environment and the health and safety of persons.

Further, CNSC staff conclude that AECL continued to maintain its Fire Protection Program and the licensee is in compliance with regulatory requirements. Therefore, AECL Whiteshell Laboratories performed satisfactorily with respect to this SCA.

3.11 Waste Management

The overall compliance performance with regard to Waste Management is shown in the table below. This area was not addressed as a stand-alone area at the licence renewal, but was considered satisfactory under Decommissioning Performance, Radiation Protection and Protection of the Environment and Public. The current rating level is SATISFACTORY (SA).

Waste Management				
Overall Compliance Ratings				
Year	2008	2009	2010	2011
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

As AECL decommissions the WL facility, waste volumes continued to increase, which has required the need for additional LLW storage space. To address this need, AECL constructed the SMAGS building which is based on the CRL design, currently stores LLW radioactive solid waste from the decommissioning of B300, B100, B200 and B411. The SMAGS has a storage capacity of approximately 4000 m^3 of waste, and is anticipated to meet the need for retrievable LLW storage over the next 5-6 years.

Some of the other waste management enabling facilities at WL include the waste handling area (WHA) located in Building 300, the waste clearance facility (WCF) or Building 304, and the new Soil Storage Compound located in the WMA. The WHA comprises of compaction and waste assay scanning equipment for the purpose of minimizing radiologically contaminated waste volumes. The WCF is used to verify uncontaminated waste for uncontrolled clearance.

Decommissioning and demolition waste are radiologically screened and segregated at the source as either “Likely Clean” or “Presumed Active”. “Likely Clean” waste is monitored for clearance either at the source or at the WCF. Cleared materials are segregated and characterized as recyclable, reusable, landfill, or hazardous materials. Materials identified as contaminated during clearance monitoring are sent to the WHA for processing.

“Presumed Active” materials are inventoried and sent to the WHA for decontamination, volume reduction, packaging, and radiological characterization. Decontaminated materials are sent to the WCF for clearance monitoring. Contaminated materials are sent to the WMA for storage.

The WMA provides storage facilities for radioactive wastes and small volumes of hazardous industrial waste. It consists of an organic incinerator, the new SMAGS building, bunkers and Quonset storage buildings used to store low-level waste (LLW) and medium-level waste (MLW) generated from WL decommissioning.

Waste generated during decommissioning activities is characterized, segregated, packaged and sent either for disposal or storage in the WL Waste Management Area (WMA). Clean waste that can be re-used or recycled is sent off-site; clean waste that is non-reusable is placed in the on-site landfill. All contaminated materials are safely removed and stored in the on-site WMA.

Table 8 provides information on the percentage of space in the waste storage building that is filled and the estimate number of years of storage space remaining. There are also two empty standpipes in the WMA.

Table 8: Partially-filled Waste Storage Buildings in the WMA (December 31, 2011)

Building No.	% Full	Years of Storage Space Remaining
LLW B5	99	I month
LLW B6	60	1
MLW B4	70	2-3
MLW B6*	60	2-3
MLW B7	85	2-5
431 (LLW Storage Building)	60	3
433 (LLW Storage Building)	80	2
SMAGS Building #1	2	5-6
Soil Storage Compound**	0	6-8

* MLW B6 is currently not accepting waste due to water ingress issues
** Currently in the approval process for operation

The Concrete Canister Storage Facility (CCSF) is located adjacent to the WMA and has stored irradiated fuel since 1975. During the licensing period, only one change was made to the CCSF; the concrete base beneath each canister was built up above the surrounding ground to ensure there is no accumulation of surface waters around the base of the canister.

Active liquid waste from Buildings 100 (WR-1), 300 and 400 (Decontamination Centre) is routinely transferred via underground pipes to the ALWTC where the liquids are stored in two separate holding tanks, based on their radioactivity levels. Low-level liquid waste is then processed, sampled and discharged into the Winnipeg River once the release criteria are met.

To help reduce waste at the WL landfill, AECL set up “Recycling Stations” throughout the facility to encourage recycling and redirect waste.

Outstanding Actions and Future Plans

Construction of the Soil Storage Compound was completed in 2011 and is expected to be operational in 2012 for the purpose of storing contaminated soils associated with WL decommissioning activities. This 30m by 40m engineered compound is capable of containing 2000 m^3 of soil, and was designed to Canadian Council of Ministers of the Environment (CCME) hazardous waste landfill specifications.

Conclusion

Based on the above review, CNSC staff conclude that AECL’s performance in the area of Waste Management meets regulatory requirements and CNSC staff’s expectations.

3.12 Security

The following table indicates the overall performance for Security over the review period. The current rating level is FULLY SATISFACTORY (FS).

Security				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	FS

The rating trend, discussion and conclusion for this SCA are provided in the following subsections and CMD 12-M47.A.

Discussion

Previously, security ratings were treated as prescribed information. These are now being publicly released, but the information supporting the performance rating will remain classified and will be presented to the Commission in a separate classified document (CMD 12-M47.A).

AECL continues to perform satisfactorily in the prevention of loss, theft or sabotage of nuclear material or sabotage at the Concrete Canister Storage Facility (CCSF) and the Standpipes, located in the Waste Management Area.

AECL has a security program for the CCSF and the Standpipes in accordance with CNSC requirements. Although the CNSC is actively overseeing the licensee's security program, the related security inspection and assessment information is confidential and is not publicly available. As a result, a separate security protected CMD (CMD 12-M47.A) has been produced to address AECL security program at the WL facility.

Conclusion

Based on the information assessed and described in CMD 12-M47.A, CNSC staff conclude that the implementation of the security program at the Whiteshell Laboratories facility is adequate and meets all regulatory requirements.

3.13 Safeguards

The following table indicates the overall performance for Safeguards over the review period. The current rating level is SATISFACTORY (SA).

Safeguards				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

Performance levels for this SCA have been consistent over the licensing period at the WL site. At the 2008 renewal hearing, a rating level of B (equivalent to meets requirements - SA) was assigned for the safeguards program and its implementation at WL. The safeguards SCA covers the programs required for the implementation of the obligations arising from the Canada/IAEA safeguards agreements.

AECL maintains a safeguards program to comply with the requirements set out in the operating licence for the WL facility. Compliance activities include the timely provision of reports on the movement and location of all nuclear materials, the provision of access and assistance to IAEA inspectors for verification activities, and the submission of annual operational information as well as accurate design information on plant processes and procedures.

During the review period, WL provided the CNSC and IAEA with all reports and information necessary to comply with the safeguards regulatory requirements, including those related to nuclear material accounting and reporting. During this period the IAEA performed a number of activities, including three inspections, one Physical Inventory

Verification (PIV), three Design Information Verifications (DIV), and one Complementary Access (CA) visit. In addition, the CNSC performed an evaluation of the licensee's preparedness for PIV in 2009 and 2011, when WL was not selected by the IAEA for a PIV. In all cases the licensee provided the IAEA and CNSC with the necessary access and assistance to perform their activities, and fully complied with all regulatory requirements.

Improvements

Prior to October 2010, the WL facility maintained a nuclear material inventory system. Since then, WL has implemented a new nuclear material accounting system that is compliant with RD-336, *Accounting and Reporting of Nuclear Material*, and which provides more efficient reporting.

Conclusion

CNSC staff is satisfied that the safeguards program and its implementation at WL meets regulatory requirements and provides the measures required to implement the international obligations to which Canada has agreed.

3.14 Packaging and Transport

The overall compliance performance with regard to Packaging and Transport is shown in the table below. This area was not address as a stand-alone area at the licence renewal, but was considered satisfactory under decommissioning performance. The current rating level is SATISFACTORY (SA)

Packaging and Transport				
Overall Compliance Ratings				
Year	**2008**	**2009**	**2010**	**2011**
AECL-WL	SA	SA	SA	SA

The rating trend, discussion and conclusion for this SCA are provided in the following subsections.

Discussion

The SCA ‘Packaging and Transport’ covers the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility. The specific areas that comprise this SCA at AECL’s Whiteshell Laboratories include AECL’s radioactive material transportation program and CNSC staff inspection results.

AECL must adhere to the CNSC *Packaging and Transport of Nuclear Substances Regulations* and Transport Canada’s *Transportation of Dangerous Goods Regulations* for all shipments leaving the site. The *Packaging and Transport of Nuclear Substances Regulations* apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage and unloading of packages.

AECL is required to have appropriate training for personnel involved in the handling, offering for transport and transport of dangerous goods, and is required to issue a training certificate to those workers in accordance with the *Transportation of Dangerous Goods Regulations*.

AECL has developed and implemented a Radioactive Material Transportation Program for activities at all AECL's Canadian sites. CNSC staff conducted a compliance inspection of AECL's program in April 2009, and concluded that it meets the regulatory requirements and the requirements of the licence.

In July 2007, AECL received CNSC recovered radioactive sources from the Enviropac issue and provided secure, temporary storage at the Whiteshell facility. AECL staff characterized the sources prior to its shipment to the CRL in March 2012 for long-term storage.

Conclusion

Based on the information that was assessed CNSC staff conclude that AECL carried out packaging and transport of nuclear substances in compliance with the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations* at the WL facility.

4 OTHER MATTERS OF REGULATORY INFORMATION

4.1 Cost Recovery

AECL remains in compliance with the CNSC *Cost Recovery Fee Regulations*

4.2 Financial Guarantee

As per condition 12.1 in the licence, AECL submitted an updated cost estimate for the WL decommissioning plan, of approximately $1.5 billion for 2009 to 2064 in 2009 dollars. The revised cost estimate was accepted by CNSC staff in 2011 [7]. The implementation of the Detailed Decommissioning Plan is funded through the NLLP.

AECL has maintained a detailed decommissioning plan and financial guarantee as per condition 12.2 in the licence. The financial guarantee is in the form of an expressed commitment from the federal government[2]. This guarantee was accepted by the Commission in its Record of Proceedings published on October 2004 for the Hearing that took place in September, 2004 [8].

Conclusion

CNSC staff is satisfied with the AECL's revised cost estimate. The financial guarantee for WL, as accepted by the Commission in 2004, remained valid and in effect.

[2] *Honourable H. Dhaliwal, P.C., M.P., Minister of Natural Resources Canada, Letter to L. Keen, President and Chief Executive Officer, Canadian Nuclear Safety Commission, 2003 December 11.*

4.3 Public Information Program

During the review period, AECL continued to conduct Public Liaison Committee (PLC) Meetings. Formed in 2003, the PLC consists of local municipal officials, provincial government officials and on-site business tenants. These biannual meetings set out to discuss regulatory developments, the status of WL decommissioning activities and other issues, relating to the PLC Terms of Reference. CNSC staff has attended several meetings of the PLC, and will continue to attend these meetings.

In addition, AECL provided three requested site tours to members of the public during the review period: Manitoba Hydro regional staff (managers and supervisors), Ear Falls (Ontario) Town Council (looking at hosting a nuclear waste disposal facility), and Beausejour Town Council.

Improvements

Several initiatives have been undertaken to improve communication with the public through public postings on the AECL website, including the WL environmental performance reports. The Nuclear Legacy Liabilities Program launched a public website that includes information on decommissioning activities at Whiteshell Laboratories. AECL has developed and distributed a newsletter to mailboxes throughout the local WL communities.

Outstanding Actions and Future Plans

AECL has an action plan in place for the development of a Public Information Program and Public Disclosure Protocol to align with the new CNSC regulatory document, *RD/GD-99.3, Public Information and Disclosure*. CNSC staff will review the program and protocol against the regulatory document prior to the implementation at WL.

Conclusion

Overall, the licensee's public information activities conducted for the review period are acceptable and satisfactory.

4.4 Aboriginal Consultation

The common law duty to consult with Aboriginal groups applies when the Crown contemplates actions that may adversely affect established or potential Aboriginal or treaty rights. The CNSC, as an agent of the Crown, and as Canada's nuclear regulator recognizes and understands the importance of consulting and building relationships with Canada's Aboriginal peoples. The CNSC ensures that all its licensing decisions under the *Nuclear Safety and Control Act* (NSCA) uphold the honour of the Crown and consider Aboriginal peoples' potential or established Aboriginal or treaty rights pursuant to section 35 of the *Constitution Act*, 1982.

Background

The Comprehensive Study level environmental assessment (EA) for the Whiteshell Decommissioning project began before a formalized Aboriginal consultation process was established by the Crown. Nevertheless, at the outset of the project, efforts were made as part of the WL public consultation program to ensure that Aboriginal issues and concerns related to the project were identified and addressed.

In 2002, the EA concluded that the project was “not likely to cause significant adverse environmental effects taking into account the mitigation measures recommended in the report; that there were not likely to be any cumulative effects associated with the project; and that public concerns raised about the project, were adequately addressed”, including those brought forth by First Nations. With a view to establishing and maintaining long-term relationships with interested parties beyond the project’s EA phase and throughout the entire decommissioning program, the WL public consultation program was designed. The public consultation program is still actively used as a means of engaging communities located close to the project site.

Discussion

The Whiteshell Laboratory property is located within the western boundary of Treaty #3 and slightly east of the Treaty #1 boundary.

Since the beginning of the project, the Sagkeeng First Nation (signatory to Treaty #1, also known as Fort Alexander First Nation and located 75 kilometers downstream from the facility), has demonstrated a sustained interest in the project and to this effect established a communications protocol with AECL-Whiteshell in 1999.

During the present licensing period, the Sagkeeng First Nation has communicated directly with the CNSC requesting that they be kept informed of the activities occurring on-site. CNSC staff has worked to support its information-sharing relationship with the leadership of the Sagkeeng First Nation. Specifically, the CNSC has provided to the Sagkeeng First Nation written information about the CNSC’s regulatory role and processes, site information, waste management, CNSC hiring practices, licence amendment updates and notification of this mid-term meeting.

Conclusion

CNSC staff will continue to provide Sagkeeng First Nation with information updates on activities occurring at the AECL-Whiteshell site. CNSC staff will also ensure that the Sagkeeng First Nation and other Aboriginal groups who might express an interest in the decommissioning project are informed of future regulatory decisions that the Commission may take in relation to this licence and will encourage them to participate in the review process.

As the information provided in this report is for information purposes and whereas the Commission is not expected to make a licensing decision, this activity does not trigger a specific duty to consult.

5 OVERALL CONCLUSION

In summary, CNSC staff is satisfied with the licensee's overall performance and that the licensee continues to comply with all regulatory requirements in an acceptable manner. CNSC staff conclude that AECL is qualified to continue decommissioning at the Whiteshell Laboratories.

Further, the licensee, in carrying on the licensed activities, has made adequate provisions for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations with which Canada has agreed.

REFERENCES

[1] AECL-Whiteshell Laboratories CNSC, NRTEDL-08.01/2018; e-Doc 3535981.

[2] Record of Proceedings, Including Reason for Decision In the Matter of Atomic Energy of Canada Limited, Application to Renew the Nuclear Research and Test Establishment Decommissioning Licence for the Whiteshell Laboratories, Hearing Date November 5, 2008; e-Doc 3316267.

[3] CMD 08-H24: Application by Atomic Energy of Canada Limited for the Renewal of Nuclear Research and Test Establishment Decommissioning Licence for Whiteshell Laboratories, November 5, 2008; e-Doc 3284667.

[4] CMD 10-H109: Licence Amendment of the Whiteshell Laboratories Decommissioning Licence, April 26, 2010; e-Doc 3525213.

[5] CMD 10-M22: Status Update to the Commission on AECL Whiteshell Laboratories' Decommissioning Quality Assurance Program and Implementation, March 16, 2010; e-Doc 3515673.

[6] CMD 10-M36: AECL-Whiteshell Laboratories' Corrective Action Plan for Implementation of the Decommissioning QA Program, May 31, 2010; e-Doc 3533664.

[7] David, Claude, Letter to Needham, S., *CNSC Review of AECL Submission – Financial Guarantee Cost Estimate for AECL – Whiteshell Laboratories*, July 19, 2011; e-Doc 3754644.

[8] Record of Proceedings, Including Reason for Decision In the Matter of Atomic Energy of Canada Limited, Financial Guarantee for Decommissioning AECL's Whiteshell Laboratories Site, Hearing Date September 16, 2004; e-Doc 3009372.

GLOSSARY

AECL	Atomic Energy of Canada Limited
AECB	Atomic Energy Control Board
AL	Action Level
ALARA	As Low as Reasonable Achievable
ASR	Annual Safety Report
B300	Building 300
CA	Complementary Access
CAP	Corrective Actions Plan
CCME	Canadian Council of Ministers of the Environment
CCSF	Concrete Canister Storage Facility
CMD	Commission Member Document
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSD	Criticality Safety Document
DIV	Design Information Verifications
DRL	Derived Release Limit
FA	Facility Authorization
FHA	Fire Hazard Assessment
FPP	Fire Protection Program
IAEA	International Atomic Energy Agency
IFTF	Irradiated Fuel Test Facility
ImpAct	Improvement Action
ITM	Inspection, Testing and Maintenance
L&ILW	Low & Intermediate Level Waste
LCH	Licence Condition Handbook
LLW	Low Level Waste
MLW	Medium Level Waste

NBC	*National Building Code of Canada*
NCS	Nuclear Criticality Safety
NEW	Nuclear Energy Worker
NFCC	*National Fire Code of Canada*
NLLP	Nuclear Legacy Liabilities Program
NPRI	National Pollutant Release Inventory
NSCA	*Nuclear Safety and Control Act*
ODS	Ozone Depleting Substances
OSH	Occupational Safety and Health
PA	Public Address
PIV	Physical Inventory Verification
PLC	Public Liaison Committee
QA	Quality Assurance
SAR	Safety Analysis Report
SCA	Safety and Control Area
SF	Shielded Facilities
SMAGS	Shielded Modular Above-Ground Storage
TPR	Third Party Review
TSS	Total Suspended Solids
USL	Upper Subcritical Level
WHA	Waste Handling Area
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactor-1

FIGURES

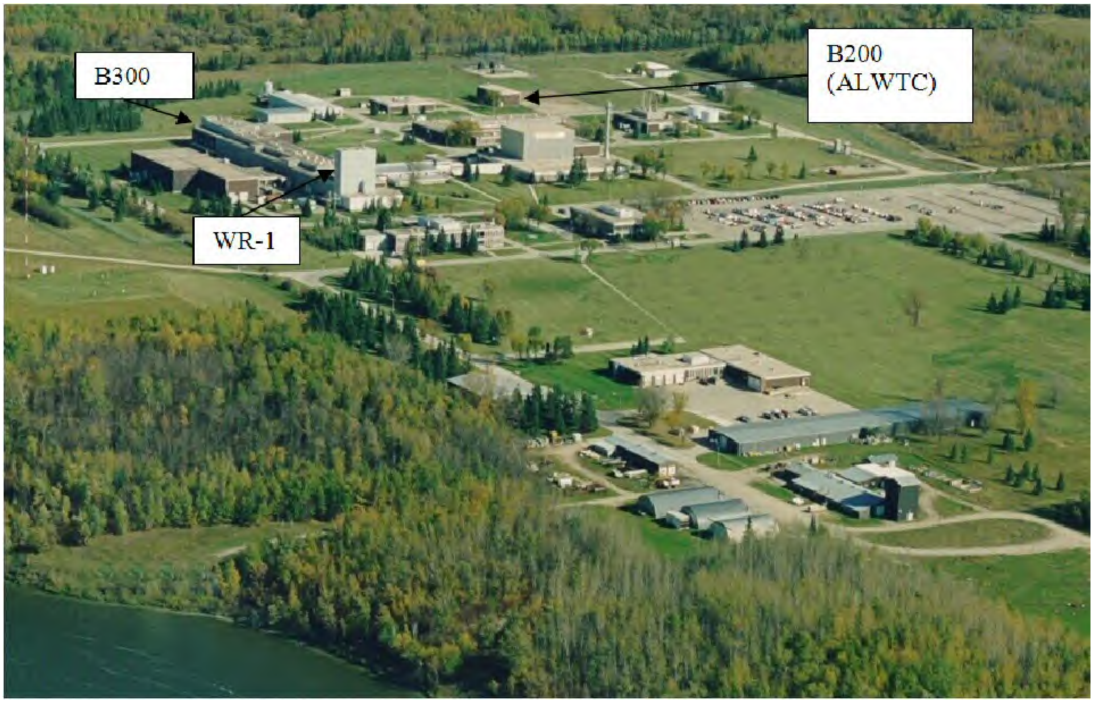


Figure 1: Aerial view of AECL Whiteshell Laboratories

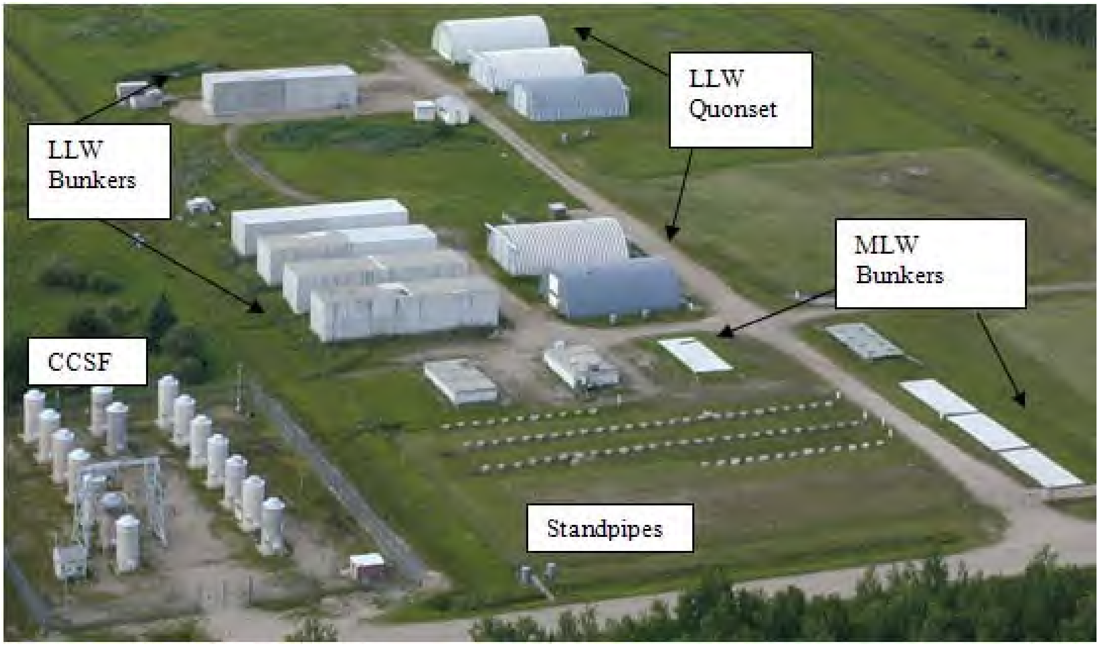


Figure 2: Aerial view of the AECL WL Waste Management Area

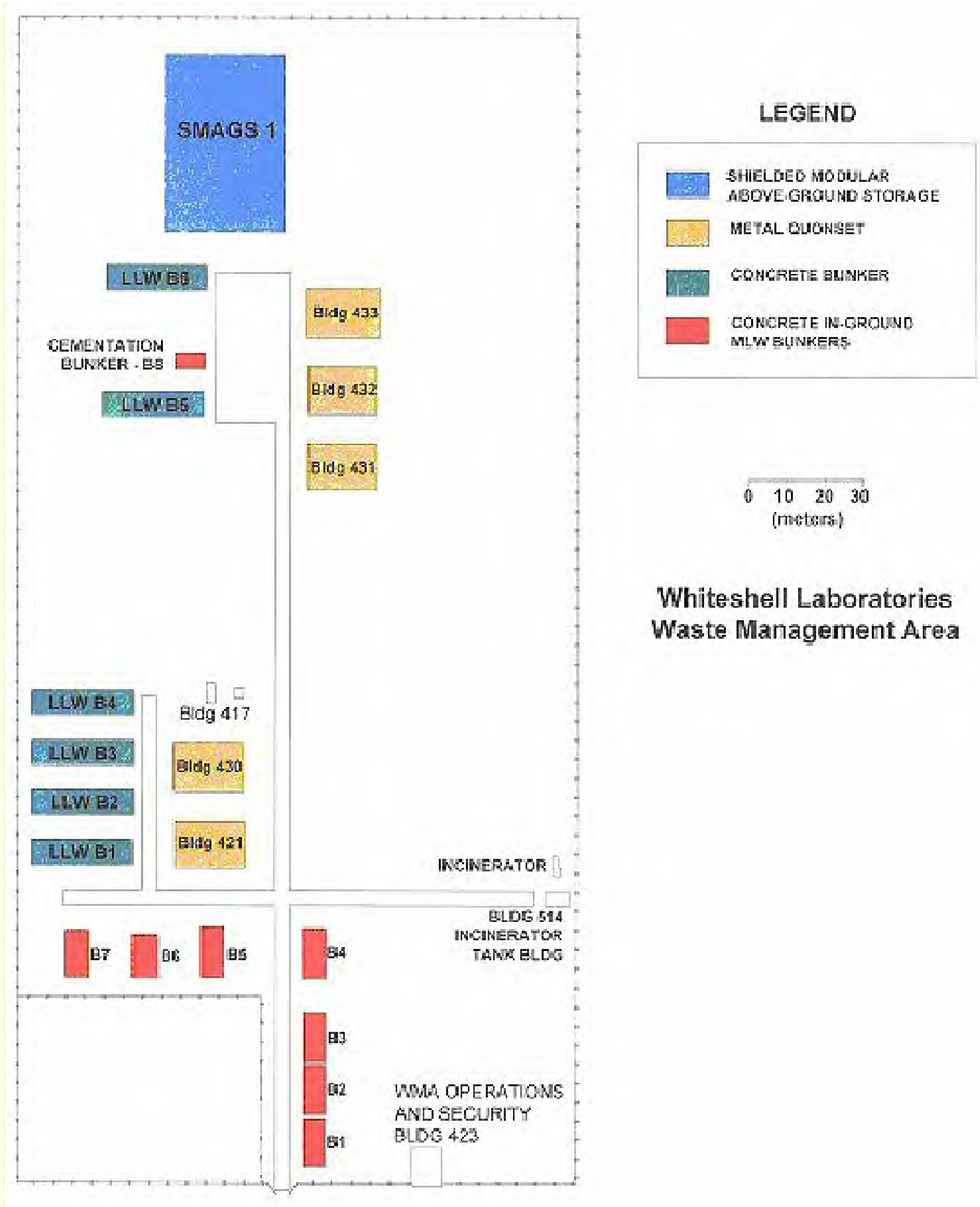
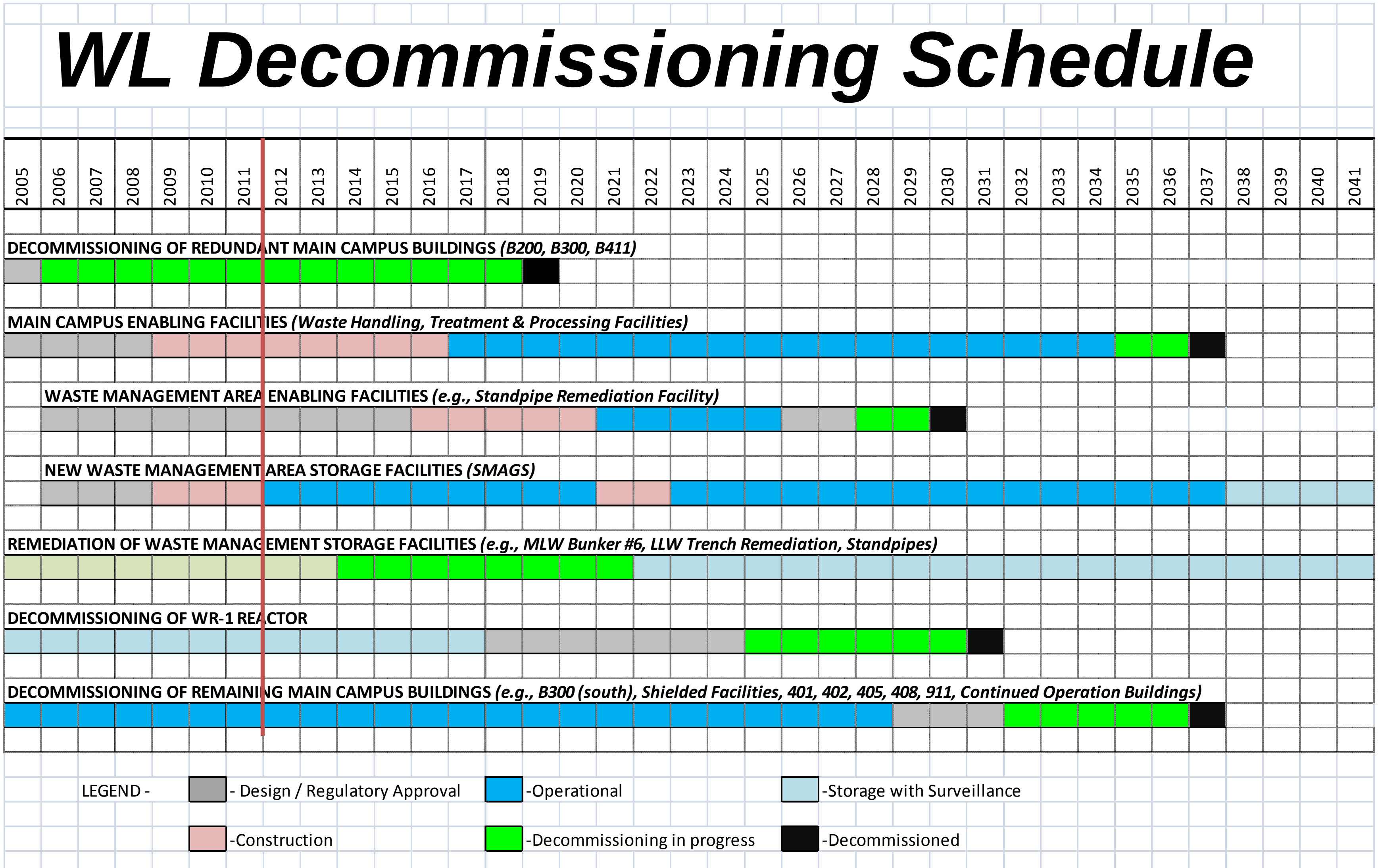


Figure 3: WL Waste Management Area

ADDENDUM A – FACILITY DECOMMISSIONING SCHEDULE



ADDENDUM B – FACILITY DECOMMISSIONING STATUS

Facility Information		Decommissioning Status		
Area	Building/Facility	2009 January 01	Current	2018 December 31 (scheduled)
Nuclear Facilities (site licence Appendices B & C)	CCSF	Operational	Operational	Operational
	B200 - ALWTC	Operational	Operational	Decommissioning in progress
	Shielded Facilities[3]	Operational (some areas decommissioned)	Operational (some areas decommissioned)	Operational (some areas decommissioned)
	WMA	Operational	Operational	Operational
	B411 – Decontamination Centre	Operational	Operational	Decommissioning in progress
	B300 – R&D[4] South (Stages 1, 3, 6)	Operational (some areas decommissioned)	Operational (some areas decommissioned)	Operational
	B300 – R&D[2] North (Stages 4 and 7)	Operational (some areas decommissioned)	Operational (some areas decommissioned)	Decommissioned (Stages 4 and 7 demolished)
	B402 – Health & Safety	Operational	Operational	Operational
	WR-1 Reactor (B100)	Storage with Surveillance	Storage with Surveillance, decommissioning planning resumed	Decommissioning in progress5

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3 Current status of Shielded Facilities decommissioning:
- Six of the twelve Hot Cells (Cells 6-11) partially decommissioned (manipulators, services (air, distilled and process water, electrical), and equipment have been disconnected/removed, and the cells have been partially decontaminated and are presently in a defined interim end-state as they share active drain and ventilation systems with operating Hot Cells 1-5). Associated experimental equipment such as a Scanning Electron Microscope and Hot Cell 12 (which contained a Metallographic Microscope) were dismantled and removed.
- The HCF storage blocks have been decontaminated and are presently in a defined interim end-state.
- Seven canisters in the Irradiated Fuel Test Facility (IFTF) were fully decommissioned (dismantled and removed).
- The IFTF's Warm Cells 14-18 and Main Floor Operating Area facilities were fully decommissioned (dismantled and removed).

4 Current status of B300 decommissioning:
- All active drain lines removed, all active ventilation devices and systems removed from the High Bay area (Stage 3), all redundant office, laboratory and experimental equipment and furnishings removed from all stages except Stage 7, all ventilation devices removed from Stages 1 and 4 (over 100 fumehoods removed), initiated removal of office and laboratory equipment and furnishings in Stage 7. Building 300 is a 17000 m^2 structure.

5 This does not coincide with the bar chart as the timelines for WR-1 decommissioning are being revised.

Facility Information		Decommissioning Status		
Area	Building/Facility	2009 January 01	Current	2018 December 31 (scheduled)
Non-Nuclear Facilities (site licence Appendix E)	B302 - ZEUS Control	Decommissioned	Decommissioned	Decommissioned
	B303 - Containment Test Facility	Operational	Operational	Operational
	B304 - Waste Clearance Facility	Operational	Operational	Operational
	B306 - Gas Dynamics Equipment Storage	Operational	Operational	Operational
	B307 - Diffusion Flame Facility	Operational	Decommissioned	Decommissioned
	B308 - Large Scale Vented Combustion Test Facility	Operational	Operational	Operational
	B309 - LSVCTF-Local Services	Operational	Operational	Operational
	B310 - LSVCTF-Remote Control	Operational	Operational	Operational
	B311 - LSVCTF-Hydrogen Storage	Operational	Operational	Operational
	B312 - Steam Generator Storage	Operational	Decommissioned	Decommissioned
	B400 - Engineering and Administration	Decommissioned	Decommissioned	Decommissioned
	B401 - Security and Reception	Operational	Operational	Operational
	B403 - Vehicle Gate House	Operational	Operational	Operational
	B404 - Meteorological Tower	Operational	Operational	Decommissioned
	B405 - Technical Information Centre	Operational	Operational	Operational
	B406 - Cafeteria	Decommissioned	Decommissioned	Decommissioned

Facility Information		**Decommissioning Status**		
Area	Building/Facility	2009 January 01	Current	2018 December 31 (scheduled)
	B408 - Material Handling	Operational	Operational	Operational
	B409 - Active Area Storage	Operational	Operational	Operational
	B410 - Cafeteria Garbage Storage	Decommissioned	Decommissioned	Decommissioned
	B412 - Machine Shop and Maintenance	Operational	Operational	Operational
	B413 - Waste Chemical Storage	Operational	Operational	Operational
	B414 - Controlled Area 2 Entrance	Operational	Operational	Operational
	B415 - Material Warehouse	Operational	Operational	Operational
	B416 - Storage	Operational	Operational	Operational
	B418 - Fissionable Material Storage	Operational	Operational	Operational
	B420 - Mobile Equipment Storage	Operational	Operational	Operational
	B422 - Outfall Monitoring Station	Operational	Operational	Operational
	B424 - WR-1 Organic Monitoring Building	Operational	Operational	Operational
	B426 - Civil Storage #1	Operational	Operational	Operational
	B427 - Mechanical Shop Storage #1	Operational	Operational	Operational
	B428 - Mechanical Shop Storage #2	Operational	Operational	Operational
	B429 - Civil Storage #2	Operational	Operational	Operational
	B500 - Internal Friction Laboratory	Decommissioned	Decommissioned	Decommissioned

Facility Information		Decommissioning Status		
Area	Building/Facility	2009 January 01	Current	2018 December 31 (scheduled)
	B501 - Aquatic Toxicology Laboratory	Decommissioned	Decommissioned	Decommissioned
	B503 - Ecology Lab	Operational	Decommissioned	Decommissioned
	B504 - Engineering Development and Test	Operational	Decommissioned	Decommissioned
	B505 - Soils Research Laboratory	Operational	Operational	Operational
	B509 - Civil Utility Building	Operational	Decommissioned	Decommissioned
	B511-1 - Active Waste Storage #1	Operational	Shutdown	Shutdown
	B511-2 - Active Waste Storage #2	Operational	Shutdown	Shutdown
	B511-3 - Active Waste Storage #3	Operational	Shutdown	Shutdown
	B511-4 - Active Waste Storage #4	Operational	Shutdown	Shutdown
	B511-5 - Active Waste Storage #5	Operational	Operational	Operational
	B515 - Drill Site Office	Operational	Decommissioned	Decommissioned
	B518 - Building 300 Coffee Room	Decommissioned	Decommissioned	Decommissioned
	B523 - Controlled Environment Building	Decommissioned	Decommissioned	Decommissioned
	B525 - Meteorology Trailer #2	Operational	Decommissioned	Decommissioned
	B526 - Borehole Instrumentation Test Facility	Operational	Decommissioned	Decommissioned
	B527 - Inflammable Liquid Storage Building	Operational	Shutdown	Shutdown

Facility Information		Decommissioning Status		
Area	Building/Facility	2009 January 01	Current	2018 December 31 (scheduled)
	B530 - Internal Friction Laboratory Annex	Decommissioned	Decommissioned	Decommissioned
	B531 - PCB Storage	Operational	Operational	Operational
	B570 - Hazardous Chemical Storage Building	Did not exist	Operational	Operational
	B902 - Pump House	Operational	Operational	Operational
	B903 - Water Filtration Plant	Operational	Operational	Operational
	B904 - Fire Protection Water System	Operational	Operational	Operational
	B905 - Process Water System	Operational	Operational	Operational
	B906 - Storm Drainage System	Operational	Operational	Operational
	B907 - Sewage Lift Station and Lagoons	Operational	Operational	Operational
	B911 - Power House	Operational	Operational	Operational (note: boilers will be decommissioned)
	B913 - Main Substation	Operational	Operational	Operational
	B914 - Main Power Distribution	Operational	Operational	Operational
	B916 - Communications System	Operational	Operational	Operational
	B917 - Supervisory Control and Alarm	Operational	Operational	Operational
	B918 - Clarified Water System	Operational	Operational	Operational
	B921 - Pedestrian Links Between Buildings	Operational	Operational	Operational

ADDENDUM C – SAFETY AND CONTROL AREA FRAMEWORK

SAFETY AND CONTROL AREA FRAMEWORK			
Functional Area	**Safety and Control Area**	**Definition**	**Specific Areas (may include, but are not limited to)**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.	▪ Management System (including Safety Management/Quality Management Oversight) ▪ Organizational structure, roles and responsibilities, resource management, leadership ▪ Organizational/Management change ▪ Internal Communications ▪ Safety Culture
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee staff are sufficient in number in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.	▪ Personnel Training ▪ Human Performance Programs (procedural adherence, identification of error) ▪ Awareness, Safety Meetings, Review Topics ▪ Work Organization and Job Design (minimum shift complement, hours of work limitation) ▪ Fitness for Duty
	Operating Performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	▪ Conduct of licensed activity ▪ Adequacy of Procedures ▪ Operating Experience (OPEX) (Corrective Actions Programs, Root Cause Analysis, Effectiveness Review) ▪ Reporting and Trending

SAFETY AND CONTROL AREA FRAMEWORK			
Functional Area	**Safety and Control Area**	**Definition**	**Specific Areas (may include, but are not limited to)**
Facility and Equipment	Safety Analysis	Maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.	▪ Hazard Analysis (internal and external) including: fire, flood, seismic ▪ Safe Operating Envelope ▪ Job hazard analysis process ▪ Change management ▪ Criticality Safety
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.	▪ System Classification ▪ Site Characterization ▪ Engineering Change Control ▪ Equipment Qualification ▪ Pressure Boundary Design ▪ Process and Control Systems ▪ Waste Management Systems ▪ Package Certification ▪ Structure and Storage Container Design
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	▪ Equipment Fitness for Service/Equipment Performance (e.g. System Health Report) ▪ Maintenance ▪ Structural Integrity ▪ Aging Management

SAFETY AND CONTROL AREA FRAMEWORK			
Functional Area	**Safety and Control Area**	**Definition**	**Specific Areas (may include, but are not limited to)**
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled	▪ Application of ALARA ▪ Dosimetry Services ▪ Worker Dose Control ▪ Contamination Control
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.	▪ Compliance with the applicable Labour Code (regulations and Programs) ▪ House Keeping (fire, chemical, tripping hazard, etc.) ▪ Safety statistics ▪ Safety awareness
	Environmental Protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities	▪ Effluent and Emissions (releases) ▪ Environmental Monitoring ▪ Estimated Dose to Public ▪ Environmental Risk Assessment ▪ Environmental Management System (EMS)
	Emergency Management and Fire Protection.	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.	▪ Nuclear Emergency Management ▪ Fire Protection and Response ▪ Conventional Emergency Response ▪ Business continuity
	Waste Management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning	▪ Waste minimization, segregation and characterization ▪ Waste storage and processing ▪ Preliminary Decommissioning Plans

SAFETY AND CONTROL AREA FRAMEWORK			
Functional Area	**Safety and Control Area**	**Definition**	**Specific Areas (may include, but are not limited to)**
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in their license, in orders, or in expectations for their facility or activity.	▪ Facility and Equipment ▪ Access Control Site Security Drills and Exercises ▪ Response Force
	Safeguards	Covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement.	▪ Nuclear Material Accountancy and Control ▪ Access and Assistance to the IAEA ▪ Operational and Design Information ▪ Safeguards Equipment, Containment and Surveillance
	Packaging and Transport	Programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.	▪ Adherence to CNSC, TC and International Regulations on packaging and transport

ADDENDUM D – SAFETY AND CONTROL AREA COMPARISON

Comparison of Safety and Control Areas	
New SCA Framework	**Previous WL SCAs**
Management System	Quality Management Decommissioning Performance
Human Performance Management	Quality Management Radiation Protection Decommissioning Performance
Operating Performance	Quality Management Decommissioning Performance
Safety Analysis	Nuclear Criticality Safety Fire Protection
Physical Design	Protection of the Environment and Public
Fitness for Service	Protection of the Environment and Public Decommissioning Performance
Radiation Protection	Radiation Protection
Conventional Health and Safety	Conventional Health and Safety
Environmental Protection	Protection of the Environment and Public
Emergency Management and Fire Protection	Emergency Preparedness and Response Fire Protection
Waste Management	Radiation Protection Decommissioning Performance
Security	Nuclear Security
Safeguards	IAEA Safeguards
Packaging and Transport	Decommissioning Performance

ADDENDUM E – RATING LEVELS

The following rating levels reflect a recent transition in the rating terminology used by the CNSC.

Fully Satisfactory (FS)

Compliance with regulatory requirements is fully satisfactory. Compliance within the area exceeds requirements and CNSC expectations. Compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant has taken, or is taking appropriate corrective action.

Unacceptable (UA)

Compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 14-M79

Date signed/Signé le : October 10, 2014

Annual Report | Rapport annuel

Annual Performance Report AECL's Nuclear Sites and Projects: 2013

Rapport annuel sur le rendement des sites et des projets nucléaires d'EACL : 2013.

Public Meeting | Réunion publique

Scheduled for: | Prévue pour :
December 17-18, 2014 | Le 17 et 18 décembre 2014

Submitted by: | Soumise par :
CNSC Staff | Le personnel de la CCSN

e-Doc 4442810 (WORD)
e-Doc 4528291 (PDF)

Canada

Summary

- This CMD presents *CNSC Staff's Assessment of AECL's Nuclear Sites and Projects: 2013.*

There are no actions requested of the Commission. This CMD is for information only.

The following item is attached:

- *Annual Performance Report AECL's Nuclear Sites and Projects: 2013.*

Résumé

- Ce CMD présente l'*Évaluation du personnel de la CCSN des sites et des projets nucléaires d'EACL : 2013.*

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

La pièce suivante est jointe :

- *Rapport annuel sur le rendement des sites et des projets nucléaires d'EACL : 2013.*

Signed/Signé le

October 10, 2014

D. Newland

Director General (Acting)

Directorate of Nuclear Cycle and Facilities Regulation

Directeur général (Intérimaire) de la

Direction de la réglementation du cycle et des installations nucléaires

Attachment: *Annual Performance Report AECL's Nuclear Sites and Projects: 2013*

e-Doc 4316116 (WORD)
e-Doc 4518159 (PDF)

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EXECUTIVE SUMMARY

Each year, the Canadian Nuclear Safety Commission (CNSC) produces a report on the performance of Atomic Energy of Canada Limited (AECL) Chalk River Laboratories. This year, the scope has been expanded to include an assessment of AECL's Nuclear Sites and Projects. The report, entitled *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* summarizes CNSC staff's assessment of the safety performance of:

- Chalk River Laboratories (CRL)
- Whiteshell Laboratories (WL)
- Port Hope Area Initiative (PHAI); includes the Port Hope project and the Port Granby project

Through inspections, reviews and assessments, CNSC staff conclude that AECL has operated all facilities and activities safely during 2013. The evaluations of all findings for the safety and control areas show that, overall, AECL made adequate provision for the security, the protection of health and safety of persons and the environment from the use of nuclear energy, and took the measures required to implement Canada's international obligations.

The following observations support the conclusion of safe operation:

- No member of the public received a radiation dose that exceeded the regulatory limit
- No worker at any AECL site received a radiation dose that exceeded the regulatory limits
- The frequency and severity of non-radiological injuries to workers was minimal
- No radiological releases to the environment from the sites/projects exceeded the regulatory limits
- AECL complied with their licence conditions concerning Canada's international obligations

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1 INTRODUCTION

As part of the assessment, CNSC staff evaluated how well AECL is meeting regulatory requirements and expectations for the performance of programs in 14 safety and control areas (SCAs). The report makes comparisons and shows trends, where possible, and it highlights emerging regulatory issues pertaining to AECL's nuclear sites and projects.

2 OVERVIEW

The review of each nuclear site or project's safety performance in the SCA framework confirms that AECL has made adequate provisions for the protection of the health and safety of Canadians and the environment, as well as to ensure that Canada continued to meet its international obligations on the peaceful use of nuclear energy.

Ratings for CRL for the year 2013 ranged from "below expectations" to "satisfactory". A notable rating change was issued for the SCA Management System previously reported as "below expectations" in CMD 13-M14: *Report for the Performance of Atomic Energy of Canada Limited Chalk River Laboratories* and now rated as "satisfactory". As indicated, this SCA was in an improving trend. Since, AECL has completed several improvements which have resulted in the satisfactory rating. For SCA Fitness for Service, CNSC staff continue to rate this as "below expectations" due to the aging and legacy issues of systems, structures and components at CRL, particularly the National Research Universal (NRU) reactor.

For WL, ratings for 2013 were deemed "satisfactory" or "fully satisfactory" for the reporting period which remains unchanged from reports previously made to the Commission in CMD 12-M47: *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories*.

Unchanged ratings were also noted for AECL's projects (Port Hope and Port Granby), as previously reported in CMD 11-H10: *Application by Atomic Energy of Canada Limited for a Waste Nuclear Substance Licence for the Port Granby Long-Term Low-Level Radioactive Waste Management Project* and CMD 12-H10: *Application by Atomic Energy of Canada Limited for Amendment of Waste Nuclear Substance Licence for the Port Hope Long-Term Low-Level Radioactive Waste Management Project*. All SCAs for these two projects continue to be rated as "satisfactory" for the year 2013.

3 CONSULTATION

A draft version of the report was posted on the CNSC Web site, in both official languages, for consultation from October 15, 2014 to November 17, 2014. The public was invited to comment, in writing, on this report. Written submissions will be filed with the Secretariat of the Commission. It is noted that all submissions will be available to the public upon request to the Secretariat.

CNSC staff will review each comment, and would be pleased to provide feedback to the Commission.

4 OVERALL CONCLUSIONS

Following this meeting, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* will be published on the CNSC Web site and made available to licensees and stakeholders.

Canada's Nuclear Regulator

Annual Performance Report
AECL's Nuclear Sites and Projects: 2013

October 2014

DRAFT

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

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This document can be viewed on the CNSC Web site at nuclearsafety.gc.ca or to request a copy of the document in English or French, please contact:

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YouTube: youtube.com/cnscccsn

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From left to right: Photos: Aerial Chalk River Laboratories, Whiteshell Laboratories, Port Hope Landscape

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EXECUTIVE SUMMARY

Each year, the Canadian Nuclear Safety Commission (CNSC) produces a report on the performance of Atomic Energy of Canada Limited (AECL) Chalk River Laboratories. This year the scope of the report has been expanded to include an assessment of AECL’s Nuclear Sites and Projects. The report, entitled *Annual Performance Report AECL’s Nuclear Sites and Projects: 2013* summarizes CNSC staff’s assessment of the safety performance of AECL sites and projects where physical operations occurred in 2013:

- Chalk River Laboratories (CRL)
- Whiteshell Laboratories (WL)
- Port Hope Area Initiative (PHAI), which includes the Port Hope Project and the Port Granby Project

The report highlights the regulatory requirements and expectations in selected areas, and discusses significant events, licence changes, major developments and overall performance. It provides performance data on all 14 of the safety and control areas (SCAs) where applicable.

The report is organized by nuclear site and project and covers CRL, WL, the Port Hope Project and the Port Granby Project. The information presented covers the complete 2013 calendar year and, when applicable, compares information to previous years. The report also provides recent updates on key issues up to June 30, 2014.

Overall performance highlights

CNSC staff efforts during the reporting period for AECL’s nuclear sites and projects focused on desktop reviews, performance analyses, and site compliance inspection activities. Inspections conducted in 2013 covered various aspects of many SCAs, commensurate with the risk associated with the facilities. In 2013, a total of 28 inspections were conducted by CNSC staff, 22 at CRL, three at WL, three for the PHAI (1 at Port Hope and 2 at Port Granby). Through these inspections and additional reviews and assessments, CNSC staff conclude that AECL operated all facilities and activities safely during 2013. Overall, AECL made adequate provisions for security, the protection of health and safety of persons and the environment and took the measures required to implement Canada’s international obligations.

The following observations support the conclusion of safe operation:

- No member of the public received a radiation dose that exceeded the regulatory limit
- No worker at any AECL site received a radiation dose that exceeded the regulatory limits
- The frequency and severity of non-radiological injuries to workers were minimal
- No radiological releases to the environment from the sites/projects exceeded the licence limits
- AECL complied with its licence conditions concerning Canada’s international obligations

Tables 1, 5, 10 and 12 summarize the 2013 ratings for AECL's nuclear sites and projects. These tables present the SCAs for each site/project, along with the ratings that gauge the overall safety performance. The rating categories are "fully satisfactory" (FS), "satisfactory" (SA), "below expectations" (BE) and "unacceptable" (UA). A rating of "satisfactory" indicates the licensee's safety and control measures are effective while a "fully satisfactory" indicates they are highly effective. An SCA rating of "below expectations" indicates the safety and control measures are marginally ineffective, while "unacceptable" indicates the safety and control measures are significantly ineffective.

Ratings for CRL for the year 2013 ranged from "below expectations" to "satisfactory". A notable rating change was issued for the SCA "management system" previously reported as "below expectations" in Commission Member Document (CMD) 13-M14: *Report for the Performance of Atomic Energy of Canada Limited Chalk River Laboratories* and now rated as "satisfactory". As indicated in the CMD, this SCA was in an improving trend. Since that report, AECL has completed several improvements that have resulted in the satisfactory rating. Regarding the SCA "fitness for service", CNSC staff continue to rate this SCA as "below expectations" due to the aging and legacy issues of structures, systems and components at CRL, particularly the National Research Universal (NRU) reactor.

For WL, the 2013 ratings were deemed "satisfactory" or "fully satisfactory" for the reporting period which remains unchanged from reports previously made to the Commission in CMD 12-M47: *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories*.

Unchanged ratings were also noted for AECL's projects (Port Hope and Port Granby), as previously reported in CMD 11-H10: *Application by Atomic Energy of Canada Limited for a Waste Nuclear Substance Licence for the Port Granby Long-Term Low-Level Radioactive Waste Management Project* and in CMD 12-H10: *Application by Atomic Energy of Canada Limited for Amendment of Waste Nuclear Substance Licence for the Port Hope Long-Term Low-Level Radioactive Waste Management Project.* All SCAs for these two projects continue to be rated as "satisfactory" for the year 2013.

During the review period for the CRL site, CNSC staff have focused and continue to focus oversight efforts on the implementation of the Integrated Implementation Plan (IIP). CNSC staff have been monitoring the progress of the IIP actions throughout the review period. An assessment was performed by CNSC staff in February 2014 to evaluate the implementation of IIP. Overall, CNSC staff conclude that most of the actions reported by AECL as closed have been completed as scheduled (with supporting documented evidence); however, there are many instances where closure of some actions may be delayed. AECL continues to emphasize that the delayed actions have no adverse effect on safety, stating that the overall progress supports ongoing confidence in the safety of the NRU reactor. CNSC staff are following up on these delayed actions with AECL. For more details regarding this assessment, see the related SCA within this report.

Addressing the lessons learned from the nuclear accident at the Fukushima Daiichi nuclear power plant in Japan continues to be a focus area for CNSC staff in 2013 for both the CRL and WL sites. AECL reviewed its existing safety cases and emergency management program against the ability to withstand extreme external events. By reviewing AECL's reports, CNSC staff concur that the underlying defence-in-depth provisions are in place to deal with natural disasters. AECL has identified a number of improvements for CRL and included them in the IIP.

CNSC staff's evaluations conducted throughout the review period identified that AECL has operated the nuclear sites and projects safely. This conclusion is based on CNSC staff's assessment activities which included: site inspections, desktop reviews, event review, follow-up and general communication and exchange of information with the licensee. CNSC staff continue to plan compliance activities over the next year to confirm the effective implementation of AECL's planned activities.

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Annual Performance Report of AECL’s Nuclear Sites and Projects: 2013

1 OVERVIEW

1.1 Background

This report on the annual performance of AECL’s nuclear sites and projects: 2013 summarizes CNSC staff’s assessment for the safety performance of AECL sites where physical operations occurred in 2013:

- Chalk River Laboratories (CRL)
- Whiteshell Laboratories (WL)
- Port Hope Area Initiative (PHAI), which includes the Port Hope Project and the Port Granby Project

The report highlights AECL’s performance against the regulatory requirements and expectations, discussing significant events, licence changes, and major developments. It provides performance data on all 14 of the SCAs, where applicable.

The report is organized by nuclear site and project, covering CRL, WL, Port Hope and Port Granby. The information presented covers the complete 2013 calendar year and, when applicable, compares information to previous years. The report also provides recent updates on key issues up to June 30, 2014.

This report has 10 appendices:

- Appendix A: Safety and Control Area Framework
- Appendix B: Rating Methodology and Definitions
- Appendix C: Trend in Safety and Control Area Ratings
- Appendix D: Financial Guarantees
- Appendix E: Worker Dose Data
- Appendix F: Environmental Data
- Appendix G: Status of Fukushima Actions
- Appendix H: Changes to Licence(s) and Licence Conditions Handbook(s)
- Appendix I: Links to Licensee Websites
- Appendix J: Acronyms

1.2 AECL's restructuring

On February 28, 2013, the Minister of Natural Resources announced that Canada would undertake a competitive procurement for a contractor to manage the operations of AECL's nuclear laboratories using a government-owned, contractor-operated model. Similar models are used in the management of nuclear operations in other jurisdictions, such as in the United States and the United Kingdom. Going forward, the nuclear laboratories will focus on three key areas: (i) managing radioactive waste and decommissioning responsibilities; (ii) performing science and technology activities to meet core federal responsibilities; and (iii) supporting Canada's nuclear industry through access to science and technology facilities and expertise on a commercial basis.

The federal government is undergoing a procurement process to obtain the services of a contractor to manage the Canadian Nuclear Laboratories Limited (CNL). The CNL was created in June 2014 as a wholly owned subsidiary of AECL. The plan is that this company will become operational in the fall of 2014; it is anticipated to then become the employer of the majority of AECL's employees. The CNL will perform most of the functions and operations that AECL currently performs, including the management of operations of AECL's nuclear laboratories, dependent upon the attainment of the necessary regulatory approvals. The CNL will hold all necessary licences, permits and other regulatory approvals required to operate AECL's properties and assets. Because the CNL will be a wholly owned subsidiary of AECL, it will retain its overall governance and executive structure and will not fundamentally change.

AECL has applied to transfer (in July 2014) from the AECL parent body to the CNL: (i) CNSC licences (Commission issued, and Designated Officer issued); and (ii) exemptions from *Class II Nuclear Facilities and Prescribed Equipment Regulations* and *Cost Recovery Fees*. CNSC staff are currently drafting a CMD for the transfer of Commission-issued licences and the regulations exemptions that will be presented at an abridged hearing in October. AECL has requested that the effective date of the transfer be coincident with the stand-up (i.e., bringing into operation) of the CNL, which is expected to occur on November 3, 2014. The amendments made to the Commission-issued licences and the issuance of exemptions to the regulations is strictly administrative in nature; the requirements of the licences and the licensing periods will remain the same. The transfer of licences issued by Designated Officers will be processed separately. CNSC staff are monitoring the situation to understand the implications of AECL's restructuring for licensing and compliance activities for its sites.

In late 2015, it is anticipated that the federal government will complete its procurement of a contractor to manage all AECL laboratories and sites. At that time, the ownership of the CNL will be transferred to the contractor, and the contractor will own the CNL for the term of the contract and any subsequent extension. It is anticipated that the CNL will have a new executive team provided by the contractor. It is also expected that the contractor will institute changes in the CNL to bring about business efficiencies. In this regard, CNSC staff have been confirming that the necessary change management requirements are in place and that they will remain in place throughout the transition.

1.3 CNSC's regulatory efforts

The CNSC regulates Canada's nuclear research and testing establishments and waste nuclear substances in order to protect the health and safety of persons, to protect the environment, and to ensure that Canada continues to implement its international obligations on the peaceful use of nuclear energy. The CNSC achieves this mission by ensuring compliance through verification, enforcement and reporting.

CNSC staff establish compliance plans for each licensed facility based on the relative risks of the facility's activities in order to identify appropriate levels of regulatory monitoring and control. Modifications to the compliance plans are made on an ongoing basis in response to events, facility modifications and changes in licensee performance.

CNSC staff efforts during the reporting period for AECL's nuclear sites and projects focused on desktop reviews, performance analyses, and site compliance inspection activities. Inspections conducted in 2013 covered various aspects of many SCAs, commensurate with the risk associated with the facilities. For CRL, WL, and the PHAI, CNSC staff's assessments and inspections confirmed that:

- no member of the public received a radiation dose that exceeded the regulatory limit
- no worker received a radiation dose that exceeded the regulatory limits
- the frequency and severity of injuries/accidents involving workers were minimal
- no radiological releases exceeded the regulatory limits
- AECL complied with its licence conditions

CNSC staff also verified compliance through desktop reviews of reports, applications and licensee programs which are supplemented with meetings, presentations, and facility visits.

In 2013, CNSC staff efforts continued to focus on the lessons learned from the nuclear accident at the Fukushima Daiichi nuclear power plant in Japan. For each of the facilities covered by this report, AECL reviewed existing safety cases and emergency management programs against its sites' abilities to withstand extreme external events. CNSC staff reviewed and verified the licensee reports and findings. CNSC staff conclude that the underlying defence-in-depth controls are in place to deal with natural disasters, confirming that the facilities continue to be operated safely. AECL continues to make improvements identified in the Fukushima action plan.

CNSC staff previously updated the Commission regarding CNSC's Fukushima action plans. These updates were presented in October 2012 and August 2013, as referenced below:

- CMD 12-M56 Status Update on the CNSC Action Plan: Lessons Learned from the Fukushima Accident, October 2012; and

- CMD 13-M34 Status Update on the CNSC Integrated Action Plan: Lessons Learned from the Fukushima Accident, August 2013.

The current status of the Fukushima actions for CRL and WL can be viewed in appendix G. There are no Fukushima actions for the PHAI.

1.4 Public information and disclosure

Licensees have an important responsibility to inform the public about their respective nuclear facilities and activities. To ensure Class I licensees (such as CRL and WL) provide open and transparent information to the public, in 2012, the CNSC published new regulatory requirements in RD/GD-99.3, *Public Information and Disclosure*.

These regulatory requirements include:

- The identification of clear and measurable objectives
- The identification of target audiences
- The tracking of public comments and concerns related to licensee activities
- The development of strategies for open and transparent communication of information
- The establishment and implementation of rules for the public disclosure of information
- The review and evaluation of the public information and disclosure programs to determine their effectiveness and the identification of improvements
- The documentation of records to demonstrate that public information and disclosure requirements are met

Since 2011, AECL has made significant progress in developing its Corporate Public Information Program (PIP) and disclosure protocol and incorporating its activities among its various sites which meets the requirements of RD/GD-99.3. A challenge remains, however, in balancing the level of public interest, involvement and information disclosure commensurate with the public perception of risk for each site/project in one corporate program. Although the varied risk levels of each site are recognized, this challenge needs to be articulated within the PIP to provide the context and scope for individual evaluations. AECL is addressing this as part of the regular updates to its PIP as required by RD/GD-99.3.

Further information on the performance of specific site/project PIPs can be found in corresponding sections of this report.

1.5 Nuclear Legacy Liabilities Program

The Nuclear Legacy Liabilities Program (NLLP) was established by the Government of Canada in 2006 to manage Canada's nuclear legacy liabilities at AECL sites (other than the PHAI). The main objective of the NLLP is to safely and cost-effectively reduce the nuclear legacy liabilities on AECL's sites and the associated risks based on sound waste management and environmental principles. The NLLP includes projects to design, construct and operate waste processing and storage facilities; to identify viable long-term management, waste acceptance criteria, and interim end state criteria; to develop decommissioning strategies; and to remediate contaminated lands and areas arising from past practices and legacy wastes.

Canada's nuclear legacy liabilities comprise aging nuclear facilities and associated infrastructure, a wide variety of buried and stored waste, and contaminated lands, all the result of nuclear research and development, medical isotope production and the production of heavy water for use in nuclear power reactors. The earliest liabilities were generated in 1944 by the National Research Council, as part of the national Second World War effort, and since 1952 by AECL, the federal Crown Corporation established to exploit the peaceful applications of the atom. The nuclear legacy liabilities are associated with a number of sites (figure 1), as follows:

- Chalk River Laboratories in Chalk River, Ontario
- Whiteshell Laboratories in Pinawa, Manitoba and the nearby Underground Research Laboratory
- The partially decommissioned Douglas Point prototype power reactor in Kincardine, Ontario
- The partially decommissioned Nuclear Power Demonstration (NPD) prototype power reactor in Rolphton, Ontario
- The partially decommissioned Gentilly-l prototype power reactor located near Bécancour, Quebec
- The site of the former heavy water plant in Laprade, Quebec (near the Gentilly-l reactor)

Currently, Douglas Point, NPD, and Gentilly-1 are each in a safe storage state with no operational activities taking place during 2013.

In addition to the NLLP, the PHAI is funded separately. In a news release from January 13, 2012, Canada's Minister of Natural Resources announced that the Government of Canada is investing $1.28 billion over 10 years to clean up low-level radioactive waste in the Port Hope area.

Figure 1: AECL sites associated with the Nuclear Legacy Liabilities Program

The CRL and WL sites contain the majority of the nuclear legacy liabilities. At these sites, the inventory of legacy wastes includes used nuclear fuel, and intermediate-level and low-level solid and liquid radioactive waste, as well as contaminated lands, buildings, structures, and tanks. It also includes waste from site clean-up work performed across Canada (e.g., contaminated soils) and radioactive waste received from Canadian hospitals, research facilities, and universities. Prior to the NLLP, most of the legacy waste was in an unconditioned form, and limited characterization information was available for the waste generated in the past. Efforts are currently being made by AECL to both re-package and characterize these wastes as part of the NLLP.

In January 2014, AECL and CNSC staff agreed to a series of meetings to discuss strategic initiatives associated with the NLLP activities. The objective of the meetings was to ensure a better informed approach and alignment with international best practice in the development of waste solutions, executing selected projects and developing an acceptable disposal strategy that includes in-situ disposal, all to be considered in the context of the NLLP.

The NLLP projects and associated actions/milestones are also subject to the CNSC compliance activities. AECL submits semi-annual progress updates on key NLLP projects and matters of interest. Compliance findings for the projects executed under the NLLP are listed within this report under the SCA "waste management" for CRL and WL.

PART I: NUCLEAR SITES

2 OVERVIEW

The Chalk River Laboratories (CRL) are located in the province of Ontario, 160 kilometres northwest of Canada's national capital, Ottawa, and represent the largest single complex within Canada's science and technology infrastructure. The site contains several nuclear facilities, including the National Research Universal (NRU) reactor, Molybdenum Production Facility, waste management areas, and many other facilities and laboratories.

The Whiteshell Laboratories (WL), located 100 kilometres northeast of Winnipeg, Manitoba, operated from 1961 to 1997. This is where AECL pioneered the development of dry storage containment facilities for used nuclear fuel, a technology that is now in use throughout the world. The site is no longer operating and is currently being decommissioned.

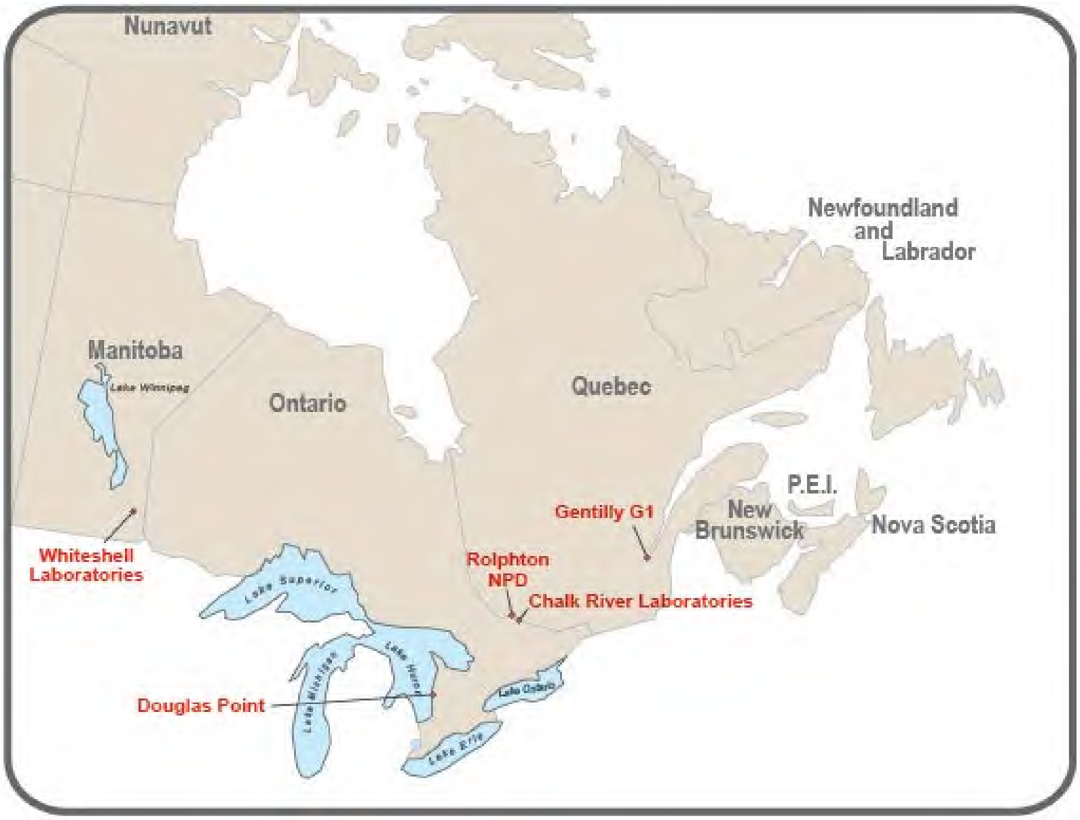
In addition to these two sites, AECL also maintains a number of nuclear reactor facilities that include Douglas Point, Nuclear Power Demonstration, and Gentilly-l. At the time of writing of this report, these sites were transitioning to modern licences and were therefore not included in the report. An abridged hearing was held on June 30, 2014, where an update on these sites was given via CMD 14-H107: *Application by Atomic Energy of Canada Limited to Replace the AECL Prototype Waste Management Facility Licences*.

Part I of this report focuses on two of AECL nuclear sites in Canada. These sites are:

- AECL's Chalk River Laboratories
- AECL's Whiteshell Laboratories

The locations of AECL's nuclear sites in Canada are shown in figure 2.

Figure 2: Location of AECL's nuclear sites



2.1 Chalk River Laboratories

2.1.1 Overview

Figure 2-1: Chalk River Laboratories as seen from above

(Source: AECL)

Located on the south shore of the Ottawa River, 160 kilometres northwest of Ottawa, CRL is one of the most complex nuclear facilities in Canada. The CRL site is occupied by 159 buildings. Outside the built-up area, there are several waste management areas for handling and storage of both nuclear and non-nuclear waste. AECL employs approximately 3000 people at the CRL site. The site is expected to continue operating for many years, although some facilities will undergo decommissioning activities. For planning purposes, the remaining operational life of the site is assumed to be approximately 85 years.

The CRL site provides for the production of medical isotopes, the delivery of various nuclear services and the conduct of a wide variety of research and development programs. The site includes 12 Class I nuclear facilities in an operational state and six either in extended shutdown or in storage with surveillance, including research reactors, processing facilities, fuel manufacturing facilities, and hot cells. The site also includes 13 different waste management areas, five in operation and eight in long-term monitoring, three Class II nuclear facilities such as accelerators and irradiators, and more than 50 radioisotope laboratories, support facilities and offices.

After a two-day public hearing held on June 8, 2011 and October 4, 2011, the CNSC issued a five-year operating licence to AECL for the operation of the CRL site, valid from November 1, 2011 to October 31, 2016 [2]. To support licence renewal, AECL conducted an Integrated Safety Review of the NRU reactor which resulted in a list of actions referred to as the Integrated Implementation Plan (IIP). The IIP drives improvements related to the NRU reactor for the current licensing period (expiring 2016), and provides an overview of additional action plans for the period of 2016 to 2021. CNSC staff have been monitoring the progress of IIP actions throughout the review period. Details of the compliance activities related to oversight of IIP implementation are provided in the relevant SCA.

CNSC staff continue to verify implementation of AECL's programs at CRL and assess them against the performance objectives and compliance verification criteria defined in the regulations, the licence [1] and the Licence Conditions Handbook (LCH) [2, 3]. Verification includes desktop reviews and site inspections. Program documents referenced in the LCH are revised by AECL as needed; these are subject to desktop review by CNSC staff, as appropriate. Many inspections have been carried out during the review period; details of these are provided in the related SCAs within the report.

An update on the performance of CRL operations by SCA follows. For 2013, the ratings concerning each SCA are based on CNSC staff assessment for the review period. The review period for CRL is the complete 2013 calendar year and, when applicable, compares information to previous years. The report also provides recent updates on key issues through June 30, 2014.

2.1.2 Public information and disclosure

As previously stated, licensees are required to have a robust public information program and public disclosure protocol as a fundamental element in accordance with RD/GD-99.3, *Public Information and Disclosure*. As a component, where the public has indicated an interest to be informed, the program shall include a protocol for ongoing, timely communication of information related to the licensed facility during the course of the licence period.

AECL has met the requirement of RD/GD-99.3 when it comes to keeping the public informed of and disclosing activities at CRL, including for example, any environmental releases, emergency preparedness drills/exercises, and the posting of reports. AECL is aware of its role in the community and is also aware of sensitivities, which AECL regularly brings to its Environmental Stewardship Council.

When dealing specifically with Aboriginal communities interested in CRL, AECL conducts engagement activities targeted to them, including ensuring there is representation from Aboriginal groups on the Environmental Stewardship Council. During the review period, CNSC staff have been satisfied with AECL's engagement activities and deem them appropriate to keep interested Aboriginal groups informed.

2.1.3 Safety and control areas

Table 1 presents the ratings for CRL for the year 2013. All SCA ratings ranged from "below expectations" to "satisfactory" for this reporting period. A notable rating change was issued for the SCA "management system" previously reported as "below expectations" in CMD 13-M14 [4] and now rated as "satisfactory". As indicated in [4], this SCA has been exhibiting an improving trend. Since the last CNSC staff report, AECL has completed several improvements that have resulted in the satisfactory rating. Regarding the SCA "fitness for service", CNSC staff continue to rate this SCA as "below expectations" due to the aging and legacy issues of structures, systems and components (SSCs) at CRL, particularly the NRU reactor. More details on this SCA and the performance of all SCAs are contained within the particular sections below.

Table 1: Performance ratings for Chalk River Laboratories

Safety and control area	Rating
Management system	**SA**
Human performance management	**SA**
Operating performance	**SA**
Safety analysis	**SA**
Physical design	**SA**
Fitness for service	**BE**
Radiation protection	**SA**
Conventional health and safety	**SA**
Environmental protection	**SA**
Emergency management and fire protection	**SA**
Waste management	**SA**
Security	**SA**
Safeguards and non-proliferation	**SA**
Packaging and transport	**SA**

Notes:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in the subsection of the report.
- The information presented below is site specific; general trends are not identified.

Management system

RATINGS FOR MANAGEMENT SYSTEM		
Overall Performance Ratings		
2011	2012	2013
BE	BE	SA
For the review period, CNSC staff rate the "management system" SCA at CRL as "satisfactory" primarily based on progress related to AECL's transition to the CSA (Canadian Standards Association, now called the CSA Group), standard N286-05, *Management System Requirements for Nuclear Power Plants*, improvements made in safety culture and further implementation of the Operating Experience (OPEX) program.		

The "management system" SCA covers the framework establishing the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

For CRL, this SCA encompasses the following specific areas:

- Management system
- Organization (see section 1.2 on AECL restructuring)
- Performance assessment, improvement and management review (no significant observations to report)
- Operating experience
- Change management
- Safety culture
- Records management (no significant observations to report)
- Management of contractors (no significant observations to report)
- Business continuity (no significant observations to report)

Management system

<u>Transition towards compliance with CSA N286-05</u>

At licence renewal in 2011, CNSC staff indicated that AECL was transitioning to a management system for CRL, that met the requirements of CSA N286-05, *Management System Requirements for Nuclear Power Plants*. AECL's transition plan to CSA N286-05, including the timelines, is listed in the LCH.

In the last review [4], CNSC staff noted that AECL was taking steps to implement the transition in accordance with its Project Execution Plan [6], identifying the actions and timelines to meet the requirements of the standard.

In July 2013, AECL reported that the transition activities included in Phase I of the Project Execution Plan were completed and concluded that "AECL's Management System substantially complies with the requirements of CSA N286-05", addressing over 80 percent of the previously identified gaps. CNSC staff observed that AECL had recognized the need to execute additional transition activities for gaps associated with the following elements of the standard:

- Operating procedures
- Changes are controlled
- Safety analysis
- Verification of work
- Preparation and distribution of documents are controlled
- Identification and labelling of systems and components
- Surveillance testing

AECL submitted the revised version of the Project Execution Plan, including in it, revised due dates for actions and additional transition activities (identified at the completion of Phase I) required for AECL's management system to become fully compliant with the standard. AECL progress against Phase II, ending June 30, 2015, is currently on track. CNSC staff recognize that this transition is a very lengthy process and that a cautious approach is required. The complete transition to CSA N286-05 is scheduled for June 2016.

As stated in CMD 13-M14 [4], acknowledging that AECL is taking appropriate steps to complete the transition to a management system fully compliant with the requirements of the standard, CNSC staff are conducting compliance verification activities of AECL's management system. Thus, CNSC staff are currently reviewing a sample of AECL's programmatic documents that have been revised as part of Phase I transition to CSA N286-05. Also, CNSC staff have conducted an inspection to assess AECL's implementation of its revised processes. These verification activities have focussed on key AECL processes, such as procurement, construction, installation, commissioning and turnover processes. Improvements are needed in the conduct of commissioning and completion assurance. AECL has submitted its proposed actions to address these elements which CNSC staff are reviewing.

Management System Manual

As previously reported [4], CNSC staff reviewed revision 2 of AECL's *Management System Manual* and identified opportunities for improvement related to consistent definitions of roles and responsibilities, and clarification of interfaces.

AECL recently revised its *Management System Manual* which documents the framework through which all work is managed and executed. CNSC staff are in the process of reviewing this manual, including several subsidiary documents to which it refers.

Operating experience

The OPEX program at AECL comprises the processes that ensure the organization uses the experience both from within the organization and from industry peers to improve the safety of operations, improve operational performance, and reduce the significance and the occurrence of unplanned events. OPEX provides the process for the identification and investigation of unplanned events, the apparent cause analysis and root cause analysis, determination of corrective actions, notification of stakeholders, trending and information sharing internally and between industry peers.

The OPEX program has matured significantly since licence renewal in 2011, when many recently introduced processes were still in early development. Such processes include AECL's Improvement Action process which is the vehicle used for reporting adverse conditions, with a specific focus on events with potential consequences on health, safety, security and the environment.

The OPEX program was one of the areas identified as needing improvement under AECL's Voyageur Phase-II improvement plan, including the strengthening of the cause analysis processes, corrective action, trending and ensuring the broad use of lessons learned by AECL personnel to improve safety, reliability, time at risk and overall performance. All actions from the Voyageur Phase-II were completed, including those on OPEX processes. More details on the Voyageur Phase-II can be found in the safety culture section below.

Other processes under the OPEX program, such as trending, internal and external sharing of safety issues, communication of safety information and benchmarking appear to be effective and satisfactory. CNSC staff will continue to confirm this during an assessment of components of the OPEX program in 2015. The OPEX program has increased its presence at AECL, and its overall contribution to safety, by way of integration into processes, procedures, plans and operations has been beneficial.

Change management

In September 2012, CNSC staff conducted an inspection of the organizational change control process, implemented at CRL in March 2011 within the 'Operations' Division. CNSC staff found that AECL followed this process for the reorganization; however, CNSC staff identified that AECL did not perform a post-reorganization assessment to evaluate the impact of the change as required by its processes. Consequently, CNSC staff requested AECL to conduct a post-reorganization self-assessment. AECL communicated the results of its self-assessment which was reviewed and accepted by CNSC staff. Further inspections of AECL's organizational change control process will be conducted to verify all elements of the process are being performed.

CNSC staff also identified the need for AECL to conduct self-assessments during the inspections of the NRU extended outage in 2012 and the system health program in 2013 (see the specific area "outage management performance" in the SCA "operating performance"). In both instances, AECL has committed to conducting self-assessments of these newly established processes to identify opportunities for improvement.

In conclusion, CNSC staff have observed that AECL would benefit from periodic reviews and self-assessments of important initiatives to confirm that they (1) meet requirements, (2) bring about the goals of the organization, and (3) identify opportunities for improvement. CNSC staff will continue to monitor AECL's performance of assessments during the remainder of the licence period.

Safety culture

Safety culture at AECL has been the object of important strides for improvement, especially since the 2009 vessel leak event [5], which highlighted some shortcomings in the areas of safety culture and human performance. In response to this event, AECL undertook a significant effort to improve a wide range of programs and elements of safety culture and human performance. AECL built upon the Voyageur theme introduced in 2006 and revitalized this improvement plan as the Voyageur Phase-II. The Voyageur Phase-II included 98 actions linked to each of the contributing factors of the vessel leak event, many of which were in the area of safety culture. CNSC staff have closely followed the implementation of this plan, ensuring that AECL carries out the actions as committed in the Voyageur Phase-II. During the review period, CNSC staff verified that all actions under the Voyageur Phase-II were completed.

Changes in safety culture within AECL have been noticeable in a wide range of activities. CNSC staff observed the use of event free tools (questioning attitude, pre-job-briefings, procedure adherence, three-way communication, Stop-Think-Act-Review) in daily operations. Observation and coaching is also carried out broadly, contributing to improvements in safe practices.

Human performance management

RATINGS FOR HUMAN PERFORMANCE MANAGEMENT		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continued to rate the "human performance management" SCA at CRL as "satisfactory". Significant improvements were made during the review period including the completion of the Voyageur Phase-II, the creation of a formal Human Performance program, a program based on the Systematic Approach to Training and the development of the Practical Learning Facility.		

The "human performance management" SCA covers the activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

For CRL, this SCA encompasses the following specific areas:

- Human performance program
- Personnel training
- Personnel certification
- Work organization and job design (no significant observations to report)
- Fitness for duty (no significant observations to report)

AECL employees participating in an on-the-job training session

Human performance program

AECL has made significant efforts to develop and improve human performance in all operations at CRL during the review period, particularly via the Voyageur Phase-II program. AECL has also implemented a Practical Learning Facility. The facility includes the following practice stations: Lock-Out Tag Out, use of harnesses, three-way communication simulator, including a rig with pumps circulating water with different controls and actuators, foreign material exclusion, fire response, and radiation protection.

In February 2013, during a controlled shut down of the NRU reactor, a potential loss-of-flow event occurred when inadvertent closure of the main heavy water pump outlet isolation valves was manually initiated. This event was reported to the Commission via an Event Initial Report (EIR) in May 2013 [6]. AECL completed a root cause analysis that identified causal factors and corrective actions, with a focus on training and the use of event free tools, to prevent recurrence of this event. AECL also performed a technical assessment of the potential consequences had the error not been discovered and the valves not been re-opened. CNSC staff continue to follow-up with AECL on this event and AECL's subsequent assessment of the potential impacts of a loss-of-flow event on the safety of the NRU reactor. As a corrective measure stemming from this event, all NRU direct operational personnel are required to complete Operator Fundamentals training in the Practical Learning Facility. CNSC staff note this facility and the mandatory training are significant developments in promotion of better human performance.

Personnel training

In 2013, CNSC staff conducted an inspection of AECL's Radiation Protection training program. The objective of the inspection was to verify compliance with AECL's Systematic Approach to Training (SAT), as required by section 3.2 of the LCH for the Chalk River Laboratories.

This inspection concluded that, although AECL has established training processes and procedures in accordance with SAT, AECL's Radiation Protection training program is not fully compliant with the processes and procedures under AECL's SAT-based training system. AECL subsequently developed an action plan to address the inspection findings which was found acceptable by CNSC staff. Completion of actions is targeted for April 2016. CNSC staff are monitoring the progress to completion of these actions.

Personnel certification

AECL is required to maintain a sufficient number of certified senior reactor shift engineers and NRU health physicists to support NRU operations. During the review period, AECL successfully certified four senior reactor shift engineers and one health physicist. CNSC staff are confident that all certified staff at CRL are competent to perform the duties of their respective positions.

The current complement of reactor engineers is deemed sufficient; however, CNSC staff have expressed concerns with the current complement of certified health physicists. Frequently, during the review period, NRU operations was reliant on one certified health physicist due to the unavailability of the other certified health physicist. The reliance upon one certified health physicist resulted in AECL requesting time limited changes from the LCH to allow a former certified health physicist to cover for periods of rest and vacations. This interim measure was accepted by CNSC staff with the commitment from AECL to develop a plan that will ensure sustainability of this position for future NRU operations. CNSC staff are tracking this plan closely.

Operating performance

RATINGS FOR OPERATING PERFORMANCE		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
The rating for the "operating performance" SCA over the review period is "satisfactory". Overall, AECL operated CRL safely and in compliance with the *Nuclear Safety and Control Act* (NSCA), regulations, conditions of the licence and the Licence Conditions Handbook, and in accordance with the licensing basis.		

The "operating performance" SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

For CRL, this SCA encompasses the following specific areas:

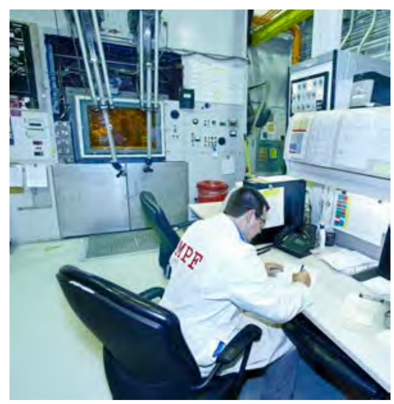
- Conduct of licensed activity
- Procedures
- Reporting and trending
- Outage management performance (NRU reactor)

Conduct of licensed activity

Facilities at CRL are governed by AECL's *Facility Authorization* and *Conduct of Operations* documents, which indicate the operational limits and conditions for the various facilities. Facilities in storage with surveillance or undergoing active decommissioning are governed by storage-with-surveillance plans or decommissioning plans.

These governing documents prescribe how each facility are operated and maintained to ensure nuclear safety and keep the risk to the public acceptably low. As such, they are referenced in the CRL operating licence and listed in the LCH.

CNSC staff assessments conclude that AECL has conducted its activities at CRL in compliance with regulatory requirements and the licensing basis for CRL.



Molybdenum-99 production technician

Procedures

AECL maintains a comprehensive suite of procedures across all programs and facilities at the CRL site. During the review period, facility-specific procedures relating to operations, maintenance, and emergency response were reviewed and updated as required. There were no significant changes to operating documentation that could have affected the safe operation of facilities at CRL.

As part of the IIP, AECL is prepared to update operating manuals for the NRU reactor and issue the revised manuals for use. AECL has developed the framework by which the manuals will be revised, updated and validated to meet best practice. AECL continues to work toward the target end date of March 31, 2016, for this project.

Reporting and trending

The requirements for reporting unplanned situations or events at CRL to the CNSC are prescribed in appendix H of the CRL's LCH. AECL has complied with the requirements for submission of these reports during the review period.

AECL categorizes reportable events by Significance Level as follows:

- Significance Level 1: Highly significant problem
- Significance Level 2: Significant problem
- Significance Level 3: Problem
- Significance Level 4: Minor problem/improvement

Events reported to the CNSC by Significance Level category are presented in table 2:

Table 2: Reportable events for CRL (2011-2013)

	2011	2012	2013
Level 1	-	-	1
Level 2	17	24	14
Level 3	162	95	110
Level 4	44	34	41
Total	**223**	**153**	**166**

The Level 1 event was reported to the Commission via an EIR [6] and is discussed in the human performance management SCA. CNSC staff's review of the other reports did not identify significant regulatory concerns, thus those were not subject to EIRs or otherwise reportings to the Commission.

AECL also submits annual reports on compliance monitoring and operational performance of facilities at CRL, as required by condition 4.16 of the CRL operating licence. No significant regulatory issues were identified during CNSC staff's review of these reports.

Outage management performance (NRU reactor)

Continued operation of the NRU reactor has historically relied upon periodic outages to conduct maintenance that cannot be performed with the reactor at power. AECL operates the NRU reactor for two to three weeks and then shuts it down for planned five-day maintenance outages.

Condition 16.1 of the CRL operating licence additionally requires AECL to implement extended outages for the NRU reactor in order to perform maintenance, inspection, repair and replacement activities that cannot be completed during the regular monthly maintenance outages, including hardware improvements required by the IIP.

CNSC staff closely monitored the 2011, 2012, and 2013 extended outages. AECL's performance in the planning and preparation of these outages has improved over time. Further monitoring will be conducted in order to assess AECL's management and implementation of activities.

Safety analysis

RATINGS FOR SAFETY ANALYSIS		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "safety analysis" SCA at CRL as "satisfactory" based on the information assessed. CNSC staff conclude that the implementation of the safety analyses at CRL meets applicable regulatory requirements.		

The "safety analysis" SCA covers maintenance of the safety analysis that supports the overall safety case for CRL facilities. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.

For CRL, this SCA encompasses the following specific areas:

- Deterministic safety analysis
- Hazard analysis
- Probabilistic safety analysis
- Criticality safety
- Severe accident analysis
- Environmental risk assessment

Deterministic safety analysis

The safety analyses for CRL facilities are mostly deterministic complemented in cases by probabilistic safety analysis (PSA) and hazard analysis.

A formal Safety Analysis Report (SAR) is required under the *Class I Nuclear Facilities Regulations* for Class I nuclear facilities. In addition, AECL has performed safety analyses for its Class II nuclear facilities, radioisotope laboratories and other locations at CRL where nuclear materials are used. There are currently 33 safety analyses documented for Class I and Class II nuclear facilities. AECL has updated five SARs (for Recycle Fuel Fabrication Laboratories, Tritium Facility, Health Physics Neutron Generator, Fuel and Materials Cells Facilities, and the Van de Graaff Accelerator) and produced a SAR for the new Fuel Packaging and Storage facility. The safety analyses demonstrate that, for operation of the nuclear facilities, operational limits are not exceeded, radiological doses to workers and members of the public are within the prescribed limits, and releases of radioactive materials into the environment are within the limits allowed by the licence.

AECL has committed to completing the revision of the NRU reactor SAR by March 30, 2016, through the IIP. The revised SAR will incorporate and integrate results of previously submitted deterministic safety analyses, PSA, hazard analyses, criticality safety, and severe accident analyses. During an assessment, CNSC staff confirmed that AECL has taken some measures to expedite the initiation and execution of work by a contractor to recover delays in the project under IIP.

Hazard analysis

Various hazard analysis techniques are used to determine internal and external events to be considered for the design basis of new nuclear facilities at CRL. The major techniques used are Preliminary Hazard Analysis, Hazard and Operability Study, Failure Modes and Effects Analysis and "What If" Analysis. In addition, systematic review of hazards from similar facilities is performed. The extensive use of these hazard identification methods by AECL gives confidence that all major hazards are identified and have produced a clear design basis.

Fire protection

AECL has a robust fire protection program in place for the CRL site which complies with the current licence and associated LCH, the *National Building Code*, the *National Fire Code*, and NFPA-801: *Fire Protection for Facilities Handling Radioactive Material*. During the review period, CNSC and AECL fire protection staff held regular meetings to discuss the progress of projects and any other programmatic matters or subjects of interest.

Probabilistic safety analysis

The probabilistic safety analysis is used where methods and data are available to complement the deterministic safety analysis in support of safety case for CRL facilities, and to evaluate and optimize facility design.

AECL has conducted Level 1 and Level 2 PSA for the NRU reactor according to REGDOC-2.4.2, *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants*. CNSC staff have reviewed AECL's Level 1 and Level 2 PSA and deemed them acceptable.

Criticality safety

This specific area addresses operations with fissionable materials outside nuclear reactors and prevention of nuclear criticality events.

CNSC requirements for the prevention of criticality accidents in operations with fissionable materials are documented in RD-327, *Nuclear Criticality Safety*. The associated GD-327, *Guidance for Nuclear Criticality Safety*, provides information on how to meet those requirements.

The CRL site operating licence requires AECL to implement and maintain a nuclear criticality safety program compliant with RD-327, *Nuclear Criticality Safety*. AECL has developed a suite of nuclear criticality safety program documents acceptable to CNSC staff. AECL has made significant progress in the implementation of the program through revisions and updates to the nuclear criticality safety documents.

There are currently 46 criticality safety documents for CRL. Due to the nature of the work changing since 2011, AECL has revised and updated 11 of these documents. AECL continues to conduct updates as needed.

Severe accident analysis

Regulatory document: REGDOC-2.3.2, *Severe Accident Management Program for Nuclear Reactors*, issued in September 2013, describes CNSC's expectation that AECL develops and implements measures to:

- prevent the escalation of a reactor accident into an event involving severe damage to the reactor core
- mitigate the consequences of an accident involving severe damage to the reactor core
- achieve a safe, stable state of the reactor and plant over the long term

Related to this specific area, AECL continues to implement the Fukushima action items established to address the recommendations of the CNSC Fukushima Task Force through the NRU's IIP. The progress of these actions can be viewed in appendix G of this report.

AECL has performed a severe accident analysis for the NRU reactor and developed a framework for development and implementation of an NRU severe accident management program (SAMP). The completion of SAMP implementation is targeted for September 30, 2015. CNSC staff confirmed through an assessment that AECL's project management tools and practices are helping AECL toward the successful completion of the SAMP project.

Environmental risk assessment

AECL has performed an environmental risk assessment for the CRL site based on the CSA standard N288.6, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills*. The assessment has predicted acceptably low risk and adequate provision for the protection of the environment and public.

On December 16, 2013, a Memorandum of Understanding (MOU) was signed between the CNSC and the Department of Fisheries and Oceans (DFO). Under the MOU, the CNSC is now responsible for reviewing licence applications for potential impacts to fish and fish habitats and informing the DFO of all applications where a *Fisheries Act* authorization is anticipated. The CNSC will also monitor compliance with any condition relating to fish and fish habitat in CNSC licences. The issuance of *Fisheries Act* authorizations remains the responsibility of the DFO Minister.

Physical design

RATINGS FOR PHYSICAL DESIGN		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "physical design" SCA at CRL as "satisfactory" as the information assessed meets regulatory requirements.		

The "physical design" SCA relates to activities that impact upon the ability of structures, systems, and components (SSCs) and to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

For CRL, this SCA encompasses the following specific areas:

- Design governance
- Site characterization
- Facility design
- Structure design (no significant observations to report)
- System design (no significant observations to report)
- Component design (no significant observations to report)

Design governance

Requirements specified in AECL's conduct of design engineering document and associated procedures and instructions ensure that:

- design activities are defined, effectively planned, and controlled
- work activities are coordinated and progress monitored
- performance of work is verified to meet design, customer, and regulatory requirements in accordance with approved procedures and applicable codes and safety standards

Several documents were updated in 2013 to improve the overall design engineering process addressing topics such as:

- Conduct of design engineering
- Design engineering and configuration management
- Engineering change control, including reduced risk engineering change control
- Field change control
- Technical operability evaluation
- Environmental qualification
- Human factors
- Contractor supplied design
- Release of design documents for manufacturing and construction
- Conduct of procurement engineering

Changes were also made to safety engineering procedures that impact upon the control of design processes. The changes to safety engineering procedures are discussed in the safety analysis SCA.

Site characterization

AECL document *CRL Site Characteristics* provides details on the CRL site characteristics most commonly used in the preparation of other documentation, such as safety analysis reports. The information in this document is also intended to be used in the design of new, and modification of existing, nuclear facilities at CRL or CRL site infrastructure.

AECL revised and updated the document to include the lessons learned from Fukushima event. Some of the notable changes are:

- design basis tornado for the CRL site, which increased from a 1 to a 2 on the Enhanced Fujita Scale

- provisions of additional details added to the flood analysis to (a) summarize the analysis basis, its facts and assumptions, (b) address possible effects of a frozen river, and (c) review the models used to calculate flood levels and also the simulation software used to implement the models
- review of class IV power to address the expected improvements in class IV reliability as a result of class IV upgrade project
- information regarding the population around CRL which has been updated according to 2011 census data

Facility design

CNSC staff reviewed the design of two new facilities: the Fuel Packaging and Storage (FPS) Facility and the Shielded Modular Above-Ground Storage building (SMAGS 3), located in the waste management areas.

Fuel Packaging and Storage facility

AECL has over 750 tile holes (below-grade vertical cylindrical concrete pipes sitting on a poured concrete base and backfilled with sand) located in the Waste Management Area B containing spent fuel rods used in research reactors and as prototypes. Approximately 100 tile holes have shown signs of degradation (e.g., fuel corrosion, production of hydrogen gas). AECL designed and built the FPS facility in order to retrieve the spent fuel from specific tile holes and store them in a better controlled and monitored facility and up to current standards.

The storage block of the FPS facility is designed to last at a minimum 50 years and will provide safe interim storage for the packaged fuel until a disposal or a long-term storage facility is available. The Nuclear Waste Management Organization (NWMO) assumes responsibility for long-term management of Canada's used nuclear fuel. The NWMO estimates an operating repository will be available within the next 30 to 40 years.


The Fuel Packaging and Storage facility storage block

The safety analysis report for the FPS facility demonstrates the adequacy of the facility design, and the Commission granted the approval to operate the FPS facility [7]. For more information on the FPS facility, see the waste management SCA.

Shielded Modular Above-Ground Storage building

SMAGS are engineered facilities designed for the storage of packaged low-level solid radioactive waste. CNSC staff have reviewed the design requirements document for the SMAGS 3 and concluded the SMAGS 3 was designed to an appropriate set of codes and standards. Subsequently, CNSC staff granted AECL the approval to construct the SMAGS 3.

Fitness for service

RATINGS FOR FITNESS FOR SERVICE		
Overall Performance Ratings		
2011	**2012**	**2013**
BE	BE	BE
For the review period, CNSC staff continue to rate the "fitness for service" SCA at CRL as "below expectations" due to the aging and legacy issues of systems, structures and components, particularly the NRU reactor.		

The "fitness for service" SCA covers activities that impact the physical condition of SSCs to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

For CRL, this SCA encompasses the following specific areas:

- Equipment fitness for service / equipment performance
- Maintenance
- Structural integrity
- Aging management
- Chemistry control

Equipment fitness for service / equipment performance

During the review period, AECL addressed a number of issues previously reported to the Commission [4], including the NRU reactor ceiling repairs, the active drain system lines replacement, the NRU reactor fixed radiation monitors, and the fire water supply system. Hardware improvements for the NRU reactor have also been implemented through the IIP. These improvements were confirmed by CNSC staff during the IIP assessment, and found that, for most of the items assessed, the equipment inspections or replacements had progressed or had been completed as planned. For instance, CNSC staff confirmed the completion of inspections of Building 440's (Emergency Water Supply) 35 cm and 50 cm pipes and valves, the replacement of the small gasholders bellows, the replacement and inspection of the heat exchangers 23 and 50, and rectifier #2.

AECL continues to experience challenges due to equipment aging; however, in all instances, AECL has taken action to mitigate or correct the deficiencies. For example, there have been a number of issues with the NRU fuel rod flask and reactor control system that have been addressed by the replacement of the faulty components. AECL is implementing a more systematic approach to prevent recurrence of these events. CNSC staff will continue to monitor the reliability improvement of these NRU reactor systems during future assessments.

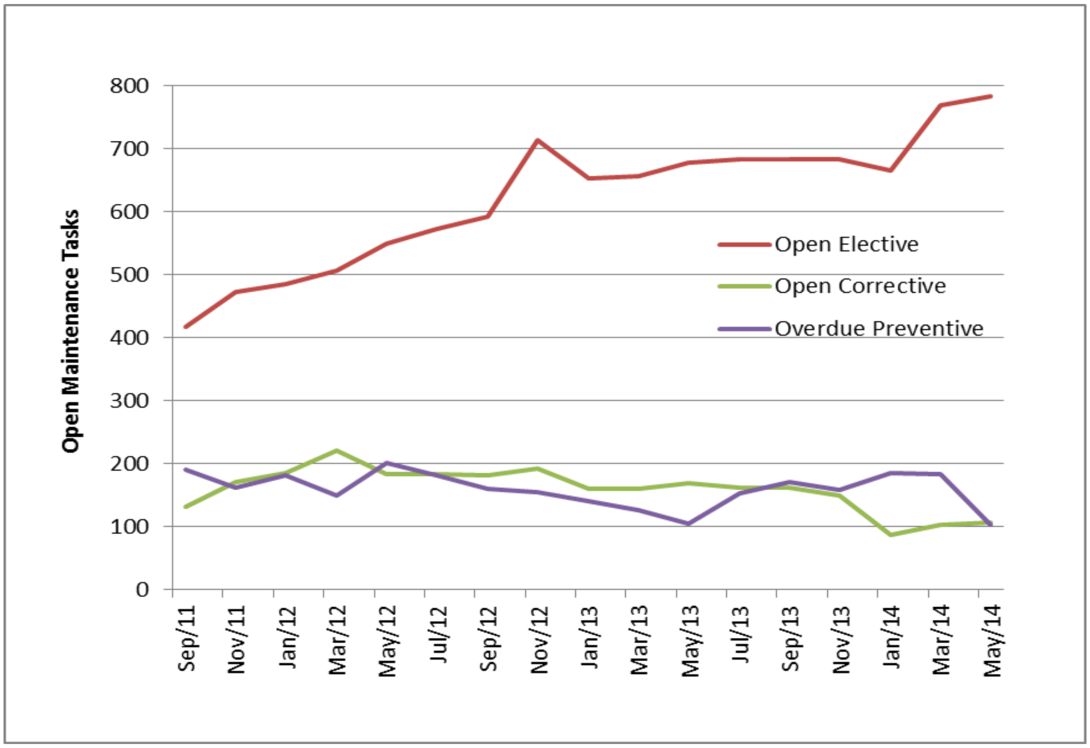
Finally, AECL has also reported a number of failures or degradations at the CRL steam system, which provides building heat to a majority of the CRL facilities and to some process systems. CNSC staff are satisfied by AECL's commitment to address the failures and degradation of the steam system, which has exceeded its design life, by repairing steam system components as they fail. In addition, AECL has launched a project to replace the Controlled Area-2 steam, condensate and compressed air systems. CNSC staff hold regular meetings with AECL to discuss the ongoing site infrastructure inspection, maintenance and systems replacement progress and implementation.

Maintenance

Licence condition 7.1 requires AECL to develop, implement and maintain a maintenance program for SSCs important to safety. From the review of AECL's governing documents for the conduct of maintenance at CRL, CNSC staff conclude that the program meets the requirements of the licence and the criteria described in the LCH. Future planned inspections will focus on the implementation of the maintenance program at CRL.

Given the regulatory significance of the NRU reactor at CRL, CNSC staff focused on maintenance backlogs for the NRU reactor which are indicators of maintenance effectiveness and the facility's equipment condition.

Figure 3: NRU reactor maintenance backlogs for CRL September 2011 to May 2014



As shown in figure 3, an improvement has been observed since 2011 with respect to the NRU reactor corrective maintenance backlog, while the preventive maintenance backlog has remained constant and the elective maintenance backlog has steadily increased. Elective maintenance is the classification of any work on isotope production SSCs for which identified potential or actual degradation is minor and does not threaten component design function or performance criteria. Due to elective maintenance being considered lower priority work than preventive maintenance, the backlog has grown over the year. There will always be a certain level of maintenance backlog, due in part to the normal work management process, emergent conditions, and equipment aging. A reduction of the maintenance backlog in the NRU facility will remain a focus area for CNSC staff for the remainder of the licence period.

AECL has improved the preventive maintenance program by establishing categories of preventive maintenance tasks, along with a preventive maintenance deferral process that requires escalated approvals to defer preventive maintenance work based on safety significance. AECL is also developing a process to better incorporate technical basis into the NRU reactor's preventive maintenance activities as part of the overall equipment reliability program for the NRU reactor. AECL is improving the information available for preventive maintenance to better support execution. Additional NRU reactor outages are planned for 2014 to reduce the maintenance backlog.

A key item for the improvement of equipment safety and reliability is AECL's system health program which is being rolled out with the assessment of 46 systems in the NRU reactor and three Molybdenum Production Facility (MPF) systems. Even though the system health program's implementation is new to CRL, AECL is planning to expand the monitoring of the system health program to include the Power House. CNSC staff's review of the program governing documents and selected output documents from the system health monitoring concluded that AECL's governance is in line with the industry guidance and practice. However, some of the system performance monitoring plans and system health reports were incomplete and did not, in all instances, identify key issues affecting system reliability, such as critical spare parts and obsolescence.

In December 2013, CNSC staff conducted an inspection of the system health program implementation. From the inspection, CNSC staff concluded that the program is not fully implemented. Progress on a number of initiatives is required to sustain the program and its implementation. CNSC staff also noted that system health goals and priorities are not provided to assist personnel in making decisions, taking actions and implementing changes that contribute to the safe and reliable operation of the facilities. Finally, CNSC staff observed that the system health program would benefit from self-assessments to confirm that it meets requirements and to identify opportunities for improvement. CNSC staff consider that these additional improvements are required for the program to fulfill its stated objectives to increase safety and reliability of the nuclear facilities at CRL. AECL has developed an action plan to address the inspection findings which was found acceptable by CNSC staff. Completion of actions is targeted for the end of 2014. CNSC staff are monitoring the progress to completion of these actions.

Structural integrity

To satisfy licence condition 7.1, AECL is required to establish inspection programs to monitor the structural integrity of fluid boundary systems and components and civil structures that are important to safety, including those in the Main Heavy Water System, the U-1 and U-2 Loops and the Loop Test Sections. AECL has developed programs using guidance from CSA standards N285.4, *Periodic inspection of CANDU nuclear power plant components*, and CSA N291, *Requirements for safety-related structures for CANDU nuclear power plants*.

CNSC staff have reviewed the governing program documents and identified elements of the programs that do not meet the CSA standards. AECL has committed to addressing these elements in upcoming program revisions. CNSC staff have also identified other areas for improvements such as meeting program schedules, implementing program updates and the timely submission of annual inspection reports. CNSC staff will continue to monitor the implementation of the programs primarily through desktop reviews of the annual inspection reports and dispositions of inspection findings prepared by AECL.

In addition to the periodic inspection program, AECL is required to implement an in-service inspection program for the NRU vessel. The NRU vessel in-service inspection program is being implemented in accordance with the current program document. CNSC staff carry out desktop reviews of the annual vessel condition monitoring assessment which summarizes the inspection activities and CNSC site inspectors carry out on-site monitoring. The information provided to date by AECL indicates that annulus side corrosion of the vessel wall has not progressed at a rate that would challenge the current structural integrity of the vessel; however, CNSC staff remain concerned that the possibility of a localized leak that could challenge operability of the vessel cannot be completely ruled out. CNSC staff requested that AECL provides updates on the leak mitigation strategies.

Aging management

Licence condition 7.4 requires AECL to develop, implement and maintain an aging management program at the CRL site. The progress of this initiative is tracked under the IIP for the NRU reactor. CNSC staff conducted a desktop review of AECL's submissions related to aging management, including: the aging management program documentation, obsolescence management program and the NRU aging management plan and NRU spare parts. Overall, CNSC staff conclude that AECL's aging/obsolescence management program and plan comply with the requirements in the LCH.

During the system health program inspection, CNSC staff confirmed that aging-related degradation mechanisms that required monitoring and inspections have been incorporated into the system health monitoring plans.

Chemistry control

AECL is required by licence condition 4.14 to implement and maintain a chemistry control program for the NRU reactor main heavy water system and the waste contained in the Fissile Solution Storage Tank (FISST). This involves monitoring and analysis of chemistry parameters to demonstrate compliance with limiting conditions for operation of these facilities. AECL reported two limit exceedances at the NRU facility and one limit exceedance at the MPF. The events consisted of a defected fuel at the NRU facility, which led to exceedances of AECL's concentration limits for uranium and iodine in the main heavy water system. AECL is taking steps to return water chemistry to the normal range which includes addressing issues with the purification system (evaporator and ion exchange column).

With respect to the MPF, AECL reported an exceedance of an operating limit regarding the aluminum concentration in FISST. CNSC staff followed up on the approach implemented by AECL and confirmed the mitigation measures returned the chemistry to normal.

Radiation protection

RATINGS FOR RADIATION PROTECTION		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "radiation protection" SCA at CRL as "satisfactory". AECL has implemented and maintained a radiation protection program to control the radiological hazards present in its facilities and to ascertain doses for each person who performs duties in connection with their licensed activities, as required by the *Radiation Protection Regulations*. In addition, doses to the public continue to be well below the regulatory annual public dose limit.		

The "radiation protection" SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled, and maintained as low as reasonably achievable (ALARA).

For CRL, this SCA encompasses the following specific areas:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated dose to the public

Application of ALARA

As required by the *Radiation Protection Regulations*, AECL implemented a radiation protection program that integrates ALARA into planning, scheduling and work control.

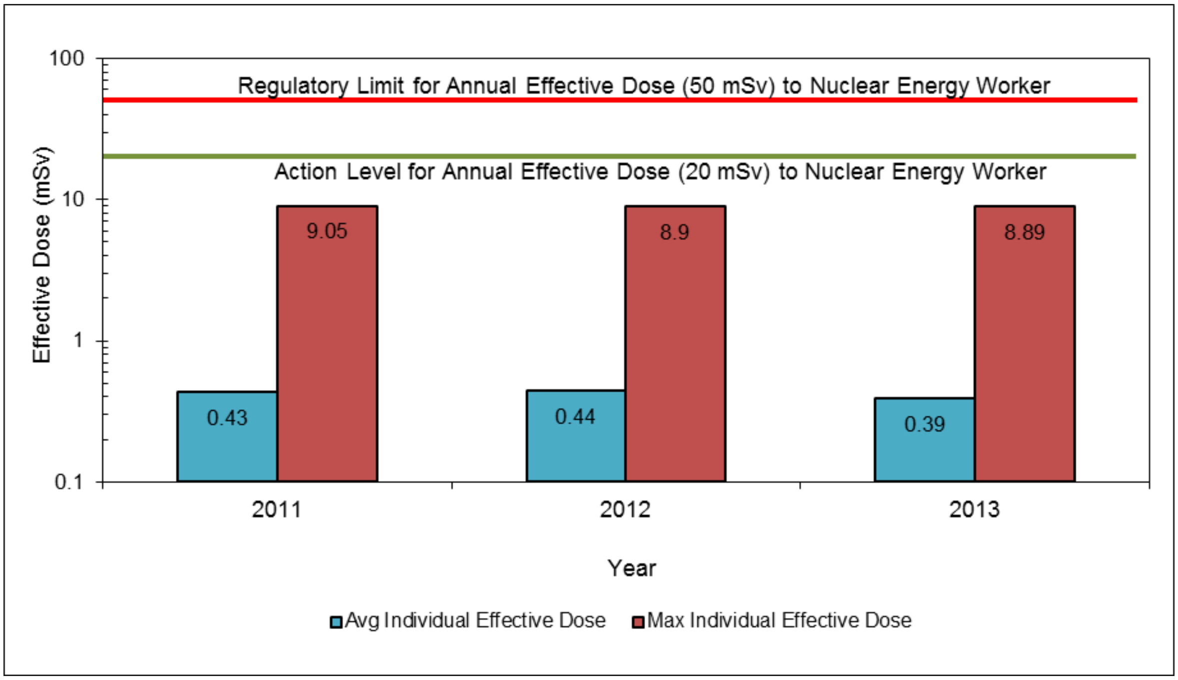
During the review period, AECL ensured that radiation exposures and doses to workers remain ALARA, taking into consideration social and economic factors.

Worker dose control

AECL has a well-established system in place to control radiation doses received by workers, which CNSC staff monitored for adequacy and effectiveness via inspections and document reviews. At no time from 2011 to 2013, did AECL report that an employee received a radiation dose exceeding the regulatory limits for nuclear energy workers, as specified in the *Radiation Protection Regulations*. Figure 4 provides the average and maximum individual annual effective worker doses at CRL from 2011 to 2013. Additional worker dose statistics can be found in appendix E.

CNSC staff's review of AECL's dose data for the CRL site concluded that AECL adequately controlled worker doses.

Figure 4: AECL-CRL worker effective dose (2011-2013)



Radiation protection program performance

AECL's performance in regards to radiation protection has been assessed through CNSC staff compliance activities. These activities included inspections of CRL facilities by CNSC site inspectors with a focus on radiation protection to assess compliance with regulatory and AECL's programmatic requirements, as well as to assess the effectiveness of the program's implementation.

Although these compliance activities identified areas for improvement, CNSC staff's assessment is that overall, AECL's corrective actions stemming from the findings have been appropriate, and that compliance with the radiation protection program has been acceptable.

One component of AECL's radiation protection program is its dosimetry service. In 2013, AECL discovered that approximately 1650 worker dose records were not transferred to the National Dose Registry as required by AECL's Dosimetry Service Licence [8]. This event was reported to the CNSC and also to the Commission via an EIR [9]. Upon further investigation, AECL reported an additional event where tritium doses were not assigned and subsequently not included in the dose totals for approximately 100 contractors and visitors. This event was also reported to the CNSC and to the Commission via CMD 14-M5: *Compliance Activities Following Discovery of Dose Records not submitted to the National Dose Registry*.

CNSC staff view the consequences of these two events as minimal, since the magnitude of each of the doses involved was small. To date, AECL has implemented several improvements to strengthen dosimetry record control, review, and acceptance within dosimetry services. However, the radiation protection program is dependent on the reliable provision of accurate dose results to optimize the control of work, to limit radiation exposure to acceptable levels, and to evaluate the effectiveness of the program. Therefore, future verification activities are planned by CNSC staff to ensure the accuracy and completeness of AECL's dose records. This will include a review of the dosimetry program with program elements and interfaces with AECL's operating licence.

Radiological hazard control

As part of its Radiation Protection program, AECL has established a number of action levels that, if reached, trigger its staff to establish the cause for reaching the action level and, if applicable, restore the effectiveness of the Radiation Protection program. AECL reports all action level exceedances to the CNSC.


Worker measuring dose rates

During the review period, no radiation exposures received by workers at the CRL site resulted in a dose that exceeded the regulatory limits. Furthermore, the maximum whole body dose has remained less than 20 mSv, with no worker exceeding any of AECL's dose action level in the years 2012 or 2013.

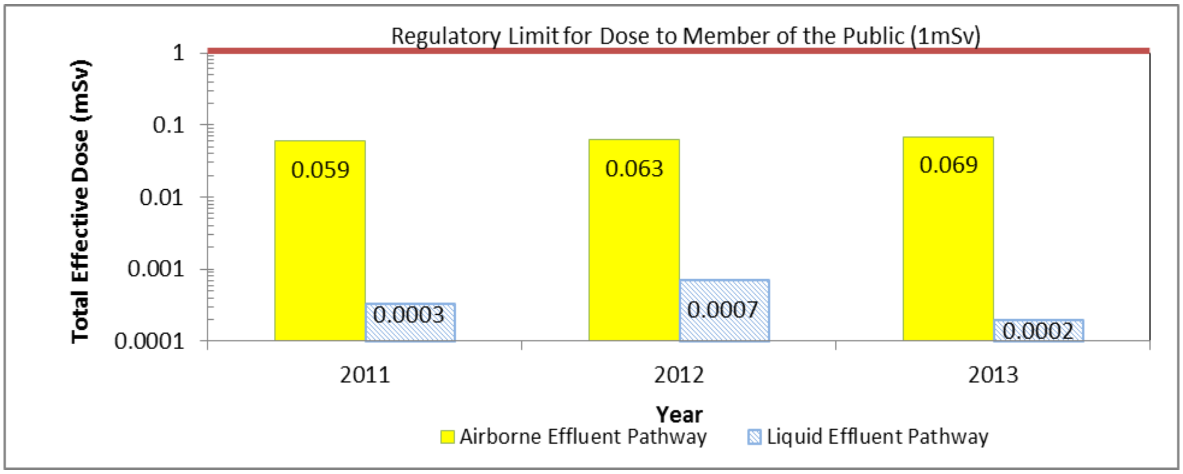
There was, however, one instance of an action level exceedance in 2011. In this case, a worker was assigned a skin dose of 273 mSv due to a local-area (1 cm^2) skin contamination event; this value exceeded AECL's action level of 50 mSv. In that case, CNSC staff determined that AECL took appropriate measures to decontaminate the individual, to investigate the cause and to enact corrective measures.

Estimated dose to the public

The dose to the public from CRL operations is calculated by using environmental monitoring results. Components including Ottawa River water, ambient air, sand along the Ottawa River shoreline, and food are measured both on the CRL site and off site in neighboring communities. Airborne and liquid exposure pathways such as inhalation and ingestion are also taken into account when determining public dose.

Doses to the public continue to be well below the regulatory annual public dose limit of 1 mSv, as shown in figure 5.

Figure 5: Effective dose to a member of the public (2011-2013)



Conventional health and safety

RATINGS FOR CONVENTIONAL HEALTH AND SAFETY		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "conventional health and safety" SCA at CRL as "satisfactory". Overall, compliance verification activities conducted throughout all licensed facilities at CRL confirm that AECL continues to view conventional health and safety as a paramount consideration in all activities. AECL has demonstrated a satisfactory ability to keep its workers safe from occupational injuries.		

The "conventional health and safety" SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

For CRL, this SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness

Performance

A key performance measure for this SCA is the number of Recordable Lost-Time Injuries (RLTIs) that occur per year. An RLTI is an injury that takes place at work and results in the worker being unable to return to work to carry out their duties for a period of time. In reviewing RLTIs, CNSC staff must also consider the severity of these injuries (e.g., the total days lost) and the frequency as they relate to the size of the workforce. The severity rate is a measure of the total number of days lost due to injury for every 200,000 person-hours worked at a site and the frequency is the number of fatalities and injuries (lost time and medically treated) due to accidents for every 200,000 person-hours worked at a site.

As per table 3, the frequency and the severity rates of RLTIs in 2013 are reduced below the levels in the previous two years (2011 and 2012). The reduction in severity rate is a direct result of increased management focus on the return to work program. This program supports safe and early return to work within the abilities of the injured worker, leading to fewer lost work days.

In 2013, AECL provided more training to its employees, increasing the awareness of occupational hazards, and has put further measures in place to reduce the exposure to conventional hazards (such as improved machine guarding, protective equipment and clothing and introduction of a safe lifting, hoisting and rigging procedure).

Table 3: Recordable lost-time injuries (RLTI), frequency and severity at CRL 2011-2013

Year	RLTIs	RLTI Frequency	RLTI Severity
2011	13	0.53	6.55
2012	21	0.68	5.65
2013	18	0.56	2.68

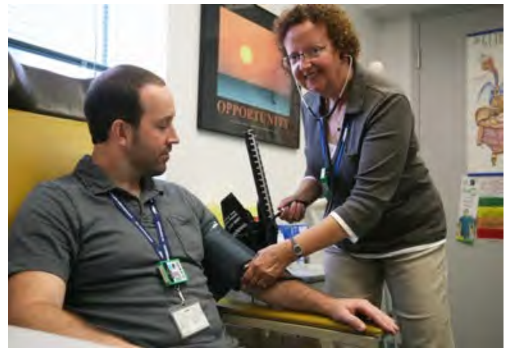
Practices

In addition to the NSCA and its regulations, AECL's activities and operations at the CRL site must comply with Part II of the *Canada Labour Code* and the *Canada Occupational Health and Safety Regulations*, the *Hazardous Products Act*, *Controlled Products Regulations*, *Workplace Hazardous Materials Information System*, and other applicable federal and provincial health and safety-related acts and regulations.

CNSC staff have confirmed through its various inspections that AECL has met the performance objectives and requirements for housekeeping and management of conventional hazards, in accordance with the regulatory requirements and AECL's own occupational health and safety program.

Awareness

AECL continues to develop and maintain a comprehensive Occupational Health and Safety program for the CRL site.



AECL nurse on the job

During the reporting period, AECL has improved aspects of the program based on best industry practices and results from incident investigations as well as results of internal focused audits. CNSC staff have noted improvements in the work authorization and approvals process and in the oversight and management of contractors.

In 2013, a Practical Learning Facility was constructed that allows enhanced hands-on training for conventional hazards encountered at CRL - such as confined space entry, Lock-Out Tag-Out, and working at heights (see specific area human performance program for more details). Additionally, AECL has executed due diligence training and rolled out a company-wide initiative called the "Rules to Live By". Both of these initiatives aim to heighten worker and management awareness of conventional hazards. CNSC staff will continue to monitor the effectiveness of these improvements through future inspections.

Environmental protection

RATINGS FOR ENVIRONMENTAL PROTECTION		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff rate the "environmental protection" SCA at CRL as "satisfactory". AECL continues to implement and maintain an environmental protection program to control and monitor liquid and air releases of nuclear and hazardous substances to the environment.		

The "environmental protection" SCA covers the programs that identify, control and monitor all releases of nuclear and hazardous substances, and the effects on the environment from facilities or as the result of licensed activities.

For CRL, this SCA encompasses the following specific areas:

- Environmental management system
- Effluent and emissions control (releases)
- Assessment and monitoring
- Protection of the public

Environmental management system

AECL must have adequate provision for protection of the environment via policies, programs and procedures at CRL, as required by the CNSC S-296, *Environmental Protection Policies, Programs and Procedures at Class I Nuclear Facilities and Uranium Mines and Mills*. AECL's environmental protection program consists of an environmental policy, along with comprehensive programs and procedures to protect the environment. These include an environmental monitoring program at CRL comprising of three integrated components: effluent monitoring, environmental monitoring, and groundwater monitoring. Through sampling and analysis for nuclear and hazardous substances, this program assists in verifying that releases from CRL do not pose hazards to the environment or human health.

The AECL environmental management system is ISO-14001 registered, and is subject to periodic audits and reviews to identify potential improvements.

Effluent and emissions control

CSA N288.5, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, was published in 2011 and listed within the LCH. AECL assessed the existing CRL effluent monitoring program against this standard to identify areas of non-conformance. Appropriate modifications to the program were made such that it is now fully compliant.

The supporting data for the environmental protection SCA section are located in appendix F and discussed below.

Nuclear substance releases

Annual liquid and airborne effluent release limits were introduced into the CRL operating licence in 2011 (appendix A of [1]). These limits are based on a dose limit to the critical group of 0.3 mSv due to the sum of all releases from CRL in any period of 12 consecutive months. During 2012 and 2013, there were no airborne or liquid exceedances of these release limits, either by individual parameter or in any 12-month period.

As part of its environmental protection program, AECL has established a number of action levels that if exceeded may indicate a loss of operational control. If an action level is reached, AECL is required to establish the cause and if applicable, restore the effectiveness of the program. AECL is required by the LCH to report all action level exceedances to the CNSC.

In 2012, there were no action level exceedances at the CRL site.

In 2013, there were no action level exceedances for liquid releases at the CRL site.

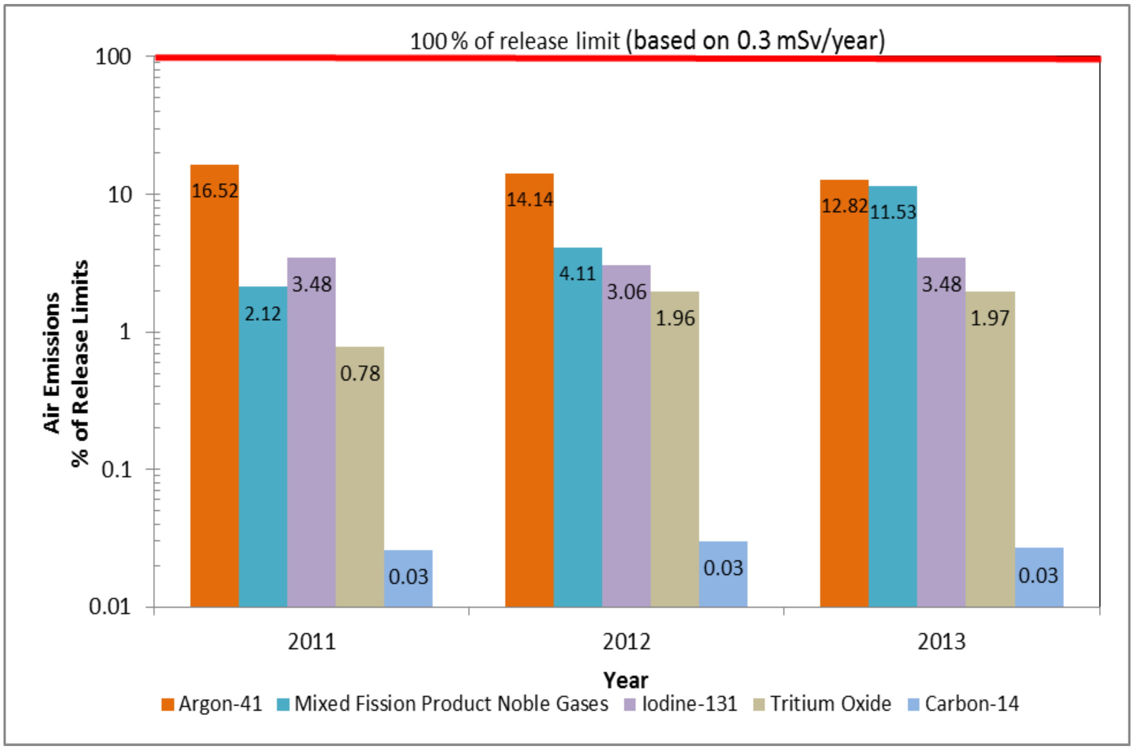
There were, however, 30 action level exceedances for airborne releases in 2013. Of particular note were 15 iodine-131 exceedances that occurred in October 2013 at different locations across the CRL site. The increased emissions did not result in an exceedance of regulatory limits for worker dose or environmental releases. AECL conducted a consolidated investigation into these exceedances to identify potential common causes. AECL's investigation concluded that the higher Iodine-131 emissions were related to operations of the MPF and the isotope production process. AECL has identified corrective and remedial actions, including reinstating more frequent operating equipment maintenance and cleaning. CNSC staff will monitor AECL's implementation of these corrective actions.

Airborne nuclear substance releases

AECL's radiological air effluent verification program at CRL comprises 51 monitoring points, including the NRU reactor stack and the MPF stack. Monitoring is either by direct measurement or by sampling and analysis for radionuclides.The main airborne contaminants are argon-41 from the NRU reactor stack, noble gases from the MPF, iodine-131 from the cemented molybdenum waste process, carbon-14 and tritium oxide (see appendix F).

The airborne radiological emissions from the CRL continue to be effectively controlled and below the annual release limits, as shown in figure 6.

Figure 6: AECL's CRL airborne nuclear substance releases (2011-2013)

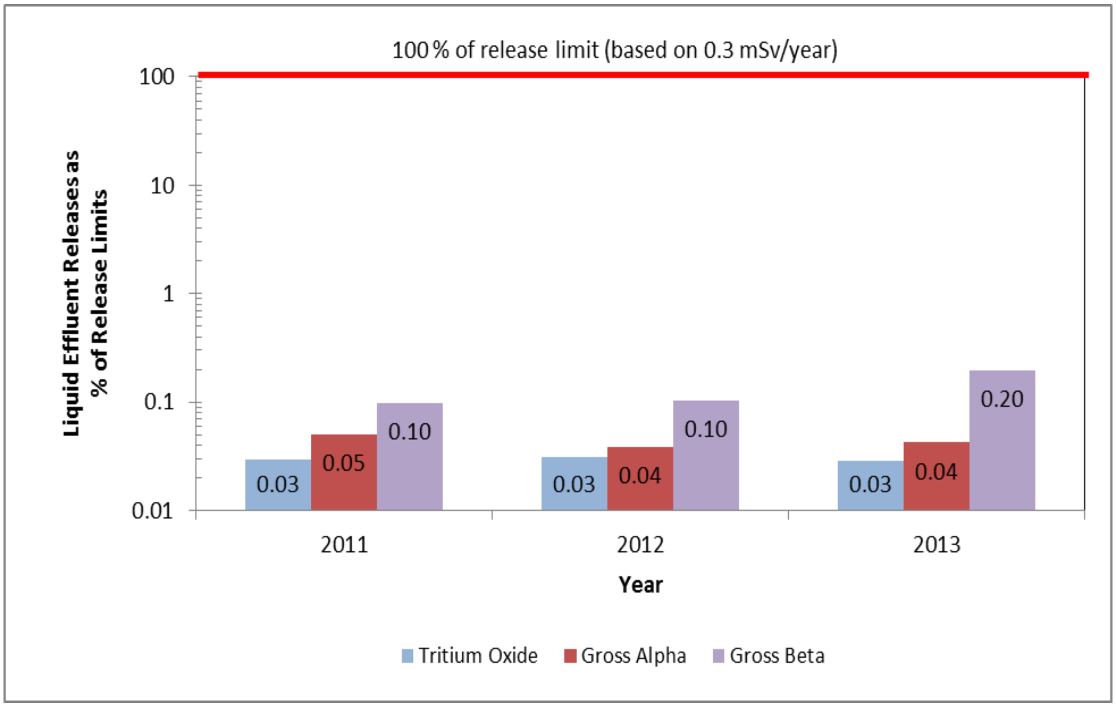


<u>Liquid nuclear substance releases</u>

AECL's nuclear liquid effluent verification program at CRL comprises 14 monitoring points for effluent streams flowing into the Ottawa River, discharges to Maskinonge Lake, and groundwater to the Ottawa River. Monitoring is either by direct measurement or by sampling and analysis for radionuclides including tritium oxide, gross alpha and gross beta.

The liquid nuclear emissions from the CRL continue to be effectively controlled and below the annual release limits, as shown in figure 7.

Figure 7: AECL's CRL liquid nuclear substance releases (2011-2013)



Airborne hazardous substance releases

The main stationary sources of hazardous effluents to air from the CRL site are the Powerhouse stacks. The Powerhouse burns Number 6 fuel oil to supply district heating and process steam to the main buildings. AECL estimates emissions using oil consumption data and emission factors provided by Environment Canada. The estimated emission results are compared to the compliance verification criteria set forth in the CRL's LCH. These criteria include limits for Air Contaminants such as: carbon monoxide, nitrogen oxides, sulphur dioxide, total particulate matter, particulate matter < 10 µm, particulate matter < 2.5 µm, and volatile organic compounds.

For 2012 and 2013, the estimated releases for each parameter were compliant with the compliance verification criteria set in the CRL LCH.

Liquid hazardous substance releases

AECL monitors 12 effluent streams that discharge to the Ottawa River from the CRL site for hazardous parameters, and compares the concentrations of significant effluent against compliance verification criteria set forth in the LCH and AECL's internal guideline values. A wide variety of parameters are measured including mercury, phenolics, zinc, iron, phosphorus, nickel, and Total Suspended Solids.

In 2012, there were no exceedances of the liquid compliance verification criteria set out in the CRL's LCH. In 2013, there was one exceedance of the criteria, for mercury in the Waste Treatment Centre's Liquid Water Evaporator.

The number of AECL guideline exceedances for 2012 and 2013 were 25 and 32, respectively. The exceedances occurred at the Waste Treatment Center (Liquid Waste Evaporator and Building 205 tanks) for phenolics, iron and Total Suspended Solids; at the Sanitary Outfall for Biological Oxygen Demand and nickel at the Storm Outfall (4F7) for iron. CNSC staff accept AECL's conclusion that there were no identified negative impacts on the environment due to guideline exceedances.

Assessment and monitoring

CSA N288.4, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, was revised and reissued in 2010 and listed within the LCH. AECL assessed the existing CRL environmental monitoring program against this standard to identify areas of non-conformance. Appropriate modifications to the program were made such that it is now fully compliant.

Environmental monitoring

AECL maintains a comprehensive environmental monitoring program for CRL to verify that radiation doses to members of the public, as a result of nuclear releases from the CRL site, remain ALARA, social and economic factors being taken into account. The program also serves to verify that hazardous releases do not pose hazards to human health and that neither nuclear releases, hazardous releases, nor physical stressors pose hazards to the environment.

The nuclear component of the program is conducted through routine collection and analysis of environmental samples from locations at the CRL site and in the surrounding area. Monitored media include ambient air, foodstuffs (such as milk, fish, garden fruits and vegetables), large game and farm animals, groundwater, Ottawa River water and other surface waters onsite and offsite. Monitoring of beach sand and river sediments is also performed.

The hazardous component focuses on onsite surface waters and groundwater. Environmental sampling for hazardous analysis is performed on nine surface monitoring points on the CRL site. It also includes monitoring for physical stressors, biodiversity (including species at risk) and fish impingement.

Environmental monitoring results in 2012 and 2013 continue to demonstrate AECL's successful implementation of an environmental monitoring program at CRL. The environmental monitoring program assists in verifying that releases from CRL do not pose hazards to the environment or human health.

In 2012, CNSC staff conducted an inspection of the environmental monitoring program at CRL. No compliance actions were identified.

Ottawa River monitoring

Along with monitoring surface water from locations on the CRL site, AECL also samples surface water at nine locations along the Ottawa River between Rolphton and Pembroke, and at 14 locations along streams outside the CRL boundary. Water samples are analyzed for radionuclides such as tritium, gross alpha, gross beta, total strontium and cesium-137. The sampling results for 2012 and 2013 demonstrate that radionuclide concentrations in the Ottawa River water remain very low. Tritium concentrations at all monitoring locations are well below the Maximum Acceptable Concentration of 7000 Bq/L indicated in Health Canada's *Guidelines for Canadian Drinking Water Quality*. Specifically, annual average concentrations of tritium in water ranged from 3 to 64 Bq/L in 2012 and from 2 to 43 Bq/L in 2013, with the maximum values occurring downstream at the CRL site boundary (Pointe au Baptême). Tritium concentrations decrease with distance from the CRL site, with average tritium concentrations at Petawawa and Pembroke of 4 Bq/L in 2012 and 2.5 Bq/L in 2013.

Groundwater monitoring

AECL's groundwater monitoring program involves approximately 180 monitoring wells located at 32 different monitoring sites. Groundwater from these wells is sampled on an annual or semi-annual frequency and analyzed for radionuclides including tritium, strontium-90, cobalt-60, gross beta, and gross alpha.


Workers sampling ground water at CRL

The legacy plumes in the waste management areas and Controlled Area 1 (built up area, non-radiological side) are contained within the CRL site. The Controlled Area 2 (built up area, radiological side) region contains two plumes that extend from the National Research Experimental (NRX) and the NRU reactor source areas to the Ottawa River. The NRX plume is dominated by strontium-90 and the NRU reactor plume is dominated by tritium. Groundwater monitoring results demonstrate that the plumes are essentially stable. Tritium concentrations downgradient of NRU are expected to decrease over time following the swap of the NRU rod bays water which occurred in November 2012.

Environmental assessment follow-up

In accordance with the *Canadian Environmental Assessment Act*, several environmental assessments have been completed for projects at the CRL site. Some of these assessments identified follow-up commitments to verify the accuracy of the assessments conclusions and the effectiveness of mitigation measures.

AECL is required by condition 10.5 of the CRL operating licence to report on the environmental assessment follow-up programs. To date, AECL has submitted the annual reports as required, and has completed many of the follow-up commitments. CNSC staff continues to review and assess AECL's follow-up reports.

Protection of the public

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in the CRL licence and LCH.

Review of hazardous (non-radiological) discharges to the environment for CRL in 2012 and 2013 indicate that no significant risks to the public or environment occurred during this period.

In 2013, CNSC staff conducted an inspection of the CRL hazardous waste management program. Most requirements of this program were effectively implemented and several positive operating practices were observed; however, some findings such as incomplete Waste Management Plans and not following the Waste Management program's process for disposing of hazardous waste were also identified. AECL provided an action plan to address the inspection findings, which has been accepted by CNSC staff. CNSC staff have continued and will continue to monitor the effective implementation of the corrective action plan.

Emergency management and fire protection

RATINGS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "emergency management and fire protection" SCA at CRL as "satisfactory". Overall, compliance verification activities conducted at CRL confirm that AECL continues to maintain a comprehensive and well-documented emergency management program and fire response that met applicable regulatory requirements.		

The "emergency management and fire protection" SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

For CRL, this SCA encompasses the following specific areas:

- Conventional emergency preparedness and response
- Nuclear emergency preparedness and response
- Fire emergency preparedness and response

Conventional emergency preparedness and response

AECL continues to maintain and enhance its conventional emergency preparedness and response capabilities at CRL. CNSC staff have verified the response programs against the regulatory criteria set out in the operating licence and the LCH. The programs continue to be maintained through training, and the execution of drills and exercises.

Nuclear emergency preparedness and response

AECL continues to maintain and improve its nuclear emergency preparedness and response capabilities at the CRL site. Proficiency within this area was achieved through regular and on-going training, drills and exercises, as specified in the site emergency management program documentation.

As per the CNSC inspection schedule, CNSC staff performed an inspection of a site stay-in exercise during the annual report review period. This inspection confirmed that AECL maintains sufficient provisions for emergency preparedness and response capability needed to mitigate the effects of an accidental release of nuclear and/or hazardous substances. However, areas for improvement were identified (which AECL has since addressed); these included immediate access to emergency facilities, communication protocols and alternate sheltering requirements for the affected building.

Fire emergency preparedness and response

CNSC staff performed two inspections of AECL's Industrial Fire Brigade response at CRL and concluded that improvements were required in the interoperability of responders. AECL has executed a comprehensive corrective action plan to ensure fire fighters can perform firefighting duties without undue delay.

CRL fire department

This was achieved by documenting interoperability requirements and training all responders on the expectations. CNSC staff will continue to monitor the effectiveness of these improvements via future inspections. Of note, significant investment has been made in acquiring additional firefighting equipment (aerial platform vehicle) to enhance the firefighting capabilities. This equipment was purchased in response to the events related to Fukushima. For more information on the status of Fukushima actions, see appendix G.

Waste management

RATINGS FOR WASTE MANAGEMENT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff conclude that the rating for "waste management" SCA at CRL is "satisfactory". All radioactive waste is managed in accordance with applicable regulations and internal procedures. The CRL waste management program documents and implements requirements for minimization, segregation, characterization, handling, monitoring, storing, and processing of radioactive waste.		

The "waste management" SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.

For CRL, this SCA encompasses the following specific areas:

- Waste characterization and minimization
- Waste management practices
- Decommissioning plans

Waste characterization and minimization

The Waste Management Areas (WMA) provides interim storage capability for the solid radioactive waste produced at the CRL from operational and decommissioning activities and from offsite organizations. Radioactive liquid waste is collected, sampled and transferred to the Waste Treatment Centre where it is processed prior to release to the process outfall.

AECL's waste management program establishes the requirements for waste management activities at AECL sites for both radioactive and hazardous wastes. The CRL waste management program identifies, documents and implements requirements for waste minimization at the source, and for segregation, characterization, packaging, processing, storage, and properly disposal of the waste.

Waste management practices

Waste management practices align and comply with the AECL's program requirements and procedures, CRL licence conditions, applicable federal and provincial acts, regulations and guidelines, and national/international codes, standards and guidelines.

During the review period, AECL has either completed a number of waste management projects or made significant progress including the following:

- As indicated previously in the physical design SCA, construction completion of the FPS facility and construction approval for the SMAGS 3 were granted to AECL
- Final repair of the active drain line between the decontamination centre (B468) and B242 with a like for like piping system
- Remediation of the active liquid waste in WMA "A". Radioactive liquid was successfully removed from the tanks and shipped offsite for processing
- WMA "C" engineered cover project completed. A multi-layer impermeable cover was installed over WMA "C" to prevent infiltration of rainwater and intrusion into the buried waste
- South Swamp Initiative: The permeable reactive barrier has been installed down-gradient of WMA "A" to intercept and treat the contaminated groundwater. Installation of the cover over WMA "A" is planned following completion of intrusive characterization activities in WMA "A"

The following subsection describes the progress of some projects under the Nuclear Legacy Liabilities Program, as previously described in section 1.5.

<u>Stored Liquid Waste Cementation project</u>

The intent of the Stored Liquid Waste Cementation (SLWC) project is to recover and solidify the remaining contents (liquid and/or sludge) of 20 legacy liquid waste tanks, and prepare the tanks for decommissioning.

AECL continues its care, maintenance and monitoring of the legacy tanks, and also improves the monitoring program to strengthen reliability. AECL removed almost 75 percent (32 m^3) of the radioactive liquid waste from Tank 40D (single walled direct buried with the most significant liquid inventory) in 2013 with further removal planned for 2014.

AECL engaged in negotiations with three proponents who had been selected based on their submissions in response to the SLWC project request for proposal. AECL has awarded three conceptual design contracts to contractors. AECL anticipates having the conceptual design selected by January 2015, which will provide basis for the project description preparation.

From a project perspective, AECL has developed product performance criteria to meet the interim storage and long-term waste management requirements and, through testing, reduced the risk of identifying potential concerns with increasing the waste product mass to the production scale.

AECL anticipates that the inventory of the remaining legacy tanks can be addressed by 2021/2022.

Very Low-Level Waste facility

The Very Low-Level Waste (VLLW) facility will provide for the long-term management of waste such as slightly contaminated soil, vegetation, concrete, asphalt and decommissioning rubble and building materials that is considered as exceeding the waste acceptance criteria and unconditional release limits for offsite landfills. Two preferred sites at CRL were selected to host the facility, the conceptual design is complete and the contract for the detailed design was awarded in December 2013.

Highly-Enriched Uranium Repatriation project

In April 2010, the governments of Canada and the United States (U.S.) committed to work cooperatively to repatriate spent highly-enriched uranium (HEU) fuel currently stored at Chalk River Laboratories to the United States. Repatriation activities are part of the Global Threat Reduction Initiative, a broad international effort to consolidate HEU inventories in fewer locations around the world. In March 2012, Prime Minister Harper announced that Canada and the U.S. were expanding their efforts to return additional inventories of HEU materials, including those in liquid form. HEU in Canada is essentially of U.S. origin, and has been used over decades in fuel for research reactors and for the production of medical isotopes. AECL is currently working to fulfill Canada's commitment to return these inventories to the U.S.

All shipments of HEU follow stringent transportation and security requirements. HEU is transported in packages (casks) that are specifically designed for this purpose. The CNSC, the U.S. NRC and the U.S. Department of Transportation certify these transportation packages. Certification of these packages is in accordance with international safety requirements established by the International Atomic Energy Agency (IAEA).

Shipments are also subject to stringent security plans. Specific details on shipments are considered prescribed information (as per the *General Nuclear Safety and Control Regulations*) and details on transportation activities are limited to persons who have a legitimate need to know. Transportation routes and security measures put in place are pre-approved and agreed to by authorities in both Canada and the U.S.

In 2013, AECL completed the repatriation of two disassembled Highly Enriched Uranium SLOWPOKE research reactor fuel cores to the U.S. In addition, the transport package for the repatriation of spent fuel rods from research reactors in Chalk River, were certified both in Canada and the U.S. The certification process for the transport package for HEU in liquid form remains on going.

In support of repatriation activities, AECL has undertaken a communication program that consists of the production and maintenance of online information (www.AECL.ca) and the provision of repatriation updates to local stakeholders.

Decommissioning plans

In March 2014, pursuant to the CRL licence condition 12.2, AECL submitted an updated version of the Comprehensive Preliminary Decommissioning Plan (CPDP). The CRL CPDP has been updated to reflect and incorporate changes since the last revision, including other changes resulting from the 2013 review of the AECL nuclear legacy liabilities cost estimate. CNSC staff reviewed AECL's submission and found it acceptable.

During the review period, several CRL buildings and facilities were planned for decommissioning. The decommissioning of the Pool Test Reactor has been completed and the space has been released for other uses. The Heavy Water Upgrading Plant decommissioning is progressing well with the goal of returning the building to other uses planned to take place in 2015/2016 at which time the end state report will be submitted to CNSC staff.

Regulatory approval has been granted by the Commission to decommission the Plutonium Tower, the Waste Water Evaporator and other ancillary buildings associated with the NRX reactor. The associated decommissioning activities are planned to begin within the 2015/2016 time period.

Security

RATINGS FOR SECURITY		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
AECL has sustained its "security" SCA during the review period at a satisfactory rating. AECL continues to implement a security program at CRL that meets the requirements of the *Nuclear Security Regulations* and associated regulatory documents.		

The "security" SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

For CRL, this SCA encompasses the following specific areas:

- Facilities and equipment
- Security practices
- Response arrangements
- Drills and exercises

Facilities and equipment

AECL is required to maintain security devices and equipment in accordance with manufacturer specifications. AECL reported some equipment deficiencies during the review period where devices were affected for brief periods resulting in AECL implementing compensatory measures until repairs were undertaken. All events were related to repeat issues of minor significance due in most part to system upgrades. AECL demonstrated the effective maintenance of facilities and equipment, and met regulatory requirements.


AECL Nuclear Response Force

CNSC staff conducted five security inspections and one security exercise during the review period. Findings related to facilities and equipment were technical in nature, where devices were showing signs of aging and in need of minor repairs and/or calibration. All findings have been closed to the satisfaction of CNSC staff. Action plans and corrective measures are currently being tracked.

Security practices

AECL is required to control access to the CRL site through physical and administrative security measures. The events related to security practices that were reported to CNSC staff were administrative in nature and of minor significance. AECL continues to demonstrate procedural compliance and is equipped with access control measures that meet regulatory requirements.

In late 2011, CNSC staff reported potential indicators of a reduced security culture at CRL. AECL conducted a third party review and are committed to enhancing the security culture as part of their overall security review. CNSC staff are satisfied with AECL's proposed path forward and will continue to monitor AECL's progress.

CNSC staff reported findings during five security inspections and the security exercise conducted during the review period. Various procedural issues with respect to Site Access Security Clearances were in need of review and updating. AECL has modernized procedures to enhance the security program and findings have been closed to the satisfaction of CNSC staff. AECL continues to maintain good practices through robust corporate governance.

Response arrangements

AECL maintains a qualified Nuclear Response Force (NRF) to meet the requirements of the *Nuclear Security Regulations* and of S-298, *Nuclear Response Force* (now REGDOC-2.12.1). AECL has reported issues related to response arrangements in the review period that were administrative in nature. Documents were corrected or updated and events are now closed.

The findings reported during CNSC staff's inspections that were related to response arrangements were linked to the NRF training documentation. CRL files were reviewed and corrections were made to the satisfaction of CNSC staff.

In previous years, AECL sent NRF recruits to the Bruce Power basic officer training course. In the summer of 2012, CRL conducted its first in-house NRF training course. This opportunity allowed AECL to produce site-specific training that will result in skilled members who are familiar with the facility.

Drills and exercises

AECL is required to hold drills every 30 days and an exercise every two years. CNSC staff have completed the third cycle of their performance testing program at high-security nuclear facilities in Canada, which included CRL. The third Force on Force exercise at CRL was evaluated in October 2012. The licensee received an evaluation that highlighted a marked improvement from previous exercises. Findings have been closed to the satisfaction of CNSC staff. AECL continues to support the performance testing program.

Safeguards and non-proliferation

RATINGS FOR SAFEGUARDS AND NON-PROLIFERATION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
Based on the information assessed from 2011 to 2013, CNSC staff conclude that the implementation of the safeguards program for the "safeguards and non-proliferation" SCA at CRL met all applicable regulatory requirements with a satisfactory performance.		

The "safeguards and non-proliferation" SCA covers the programs required for the successful implementation of the obligations arising from the Canada/ and the International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the treaty on the *Non-Proliferation of Nuclear Weapons*.

For CRL, this SCA encompasses the following specific areas:

- Nuclear material accountancy and control
- Access and assistance to the IAEA
- Operational and design information
- Safeguards equipment, containment and surveillance

Nuclear material accountancy and control

During the review period, CRL provided the CNSC and IAEA with all nuclear material accounting reports and information in an accurate and timely manner, as required by RD-336, *Accounting and Reporting of Nuclear Material*.

Access and assistance to the IAEA

AECL has granted access and assistance to the IAEA both for inspection activities and for the maintenance of the IAEA's equipment installed at CRL. From 2011 to 2013, the IAEA conducted in total 96 inspections at various facilities at CRL. Details of the IAEA inspections can be found in table 4.

Table 4: IAEA verification activities at CRL

Year	SNRI	PIV	DIV	UI	Total
2011	12	5	3	12	32
2012	10	12	7	8	37
2013	13	7	2	5	27
Total Inspections					96

SNRI - Short Notice Random Inspection
PIV - Physical Inventory Verification
UI - Unannounced Inspection
DIV - Design Information Verification

The IAEA has indicated that the results from their inspection activities at CRL were satisfactory and no actions were requested from either facility. On this basis, the IAEA concluded that all nuclear material at CRL facilities remained in peaceful activities.

Operational and design information

AECL submits annual operational program and quarterly updates, as required. These documents provide a forward-looking plan of CRL's activities and are updated by AECL, as needed. AECL also submits information under the *Additional Protocol to the Canada - IAEA Safeguards Agreement*, including a description of each building, the scale of its operations, and future plans for nuclear fuel research and development activities. In addition, Design Information Questionnaire documents were updated as required for various facilities and submitted to CNSC staff.

Safeguards equipment, containment and surveillance

AECL continues to provide assistance to the IAEA for the installation and maintenance of the IAEA's equipment at CRL.

In 2013, the IAEA installed remotely monitored safeguard equipment, specifically at the new FPS Facility (see waste management SCA for more details on the FPS facility). The IAEA also upgraded the cameras at the NRU reactor with the Next Generation Surveillance System.

Packaging and transport

RATINGS FOR PACKAGING AND TRANSPORT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff rate the "packaging and transport" SCA at CRL as "satisfactory". AECL continues to effectively implement the transport program at the CRL site. The transport of nuclear substances to and from the CRL site continues to be performed in a safe manner.		

The "packaging and transport" SCA covers the safe packaging and transport of nuclear substances shipped to and from the CRL site. CRL has a packaging and transport program that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations* and the *Transportation of Dangerous Goods Regulations*.

For CRL, this SCA encompasses the following specific areas:

- Package design and maintenance (no significant observations to report)
- Packaging and transport

Packaging and transport

During the review period, CNSC staff performed an inspection of AECL's radioactive material transportation program to verify compliance with the regulatory requirements. There were no findings noted during the inspection. CNSC staff conclude that the program continues to be effectively implemented and that the transport of nuclear substances to and from CRL is performed in a safe manner.

2.2 Whiteshell Laboratories

2.2.1 Overview

Figure 8: Whiteshell Laboratories, near Pinawa, Manitoba

(Source: AECL)

AECL operates the Whiteshell Laboratories (WL), comprising nuclear facilities under a research and test establishment decommissioning licence, located near the town of Pinawa, Manitoba. The licence was issued for a 10-year period commencing on January 1, 2009 and running to December 31, 2018 [10].

The WL site encompasses an area of 4,375 hectares. The site comprises of a number of nuclear and non-nuclear facilities and activities, including the Whiteshell Reactor (WR-1), the Shielded Facilities, the liquid and solid radioactive waste management facilities, and various research laboratories.

The facility operated for approximately 40 years as a nuclear research and test establishment, first under an operating licence issued by the Atomic Energy Control Board, and since then coming into force of the NSCA under an operating licence issued by the CNSC. Based on its decision to discontinue operations at WL, AECL applied for a licence to decommission the facility in 2002.

AECL's decommissioning activities included the demolition of redundant non-nuclear buildings, continued decommissioning of Building 300 (Research and Development Complex), and the construction of enabling facilities and remediation of existing buildings, such as the construction of the SMAGS building and the remediation of the Shielded Facilities area to support decommissioning activities.

Of the major facilities that were operated on the site, the Van de Graff Accelerator and the Neutron Generator were fully decommissioned during the previous licensing period. The WR-1 reactor at WL is permanently shut-down and de-fuelled. In keeping with the evolution of international best practices, AECL's decommissioning strategy has been moving toward reduced deferment periods. Therefore, the decommissioning of WR-1 initially planned for 2024 is planned to start in 2015.

CNSC staff continue to verify implementation of AECL's programs at WL and assess them against the performance objectives and compliance verification criteria defined in the regulations and the licence. Inspections have been carried out by CNSC staff during the review period. Details of these are shared in the various SCA within the report.

An update on the performance of WL operations by SCA follows. In 2013, the ratings for each SCA are based on CNSC staff's assessment for the review period. The information in this report covers the complete 2013 calendar year and, when applicable, compares information to previous years. The report also provides recent updates on key issues through June 30, 2014.

2.2.2 Public information and disclosure

As mentioned in section 1.4, AECL's corporate Public Information Program (PIP) meets the requirements of RD/GD-99.3. However, there is no distinct public disclosure approach for WL that reflects the different nature of the site when compared to CRL. The protocol should be distinct from the requirements outlined in a licence or LCH, and must focus on communications with all the key audiences for WL, as identified in section 3.2 of AECL's PIP. A new version of the PIP (with disclosure protocol) has been submitted and is currently being reviewed by CNSC staff.

CNSC staff were satisfied, based on the information reviewed, that AECL has kept the Sagkeeng First Nation (who reside in close proximity to WL) informed regarding AECL's activities at WL. CNSC staff encourage AECL to continue to provide the Sagkeeng First Nation with information updates and further establish direct lines of communication with the appropriate representative(s).

2.2.3 Safety and control areas

Table 5 presents the ratings for WL for the year 2013. All SCA ratings are "satisfactory" or "fully satisfactory" for the reporting period which remains unchanged from reports previously made to the Commission [11].

Table 5: Performance ratings for Whiteshell Laboratories

Safety and control area	Rating
Management system	**SA**
Human performance management	**SA**
Operating performance	**SA**
Safety analysis	**SA**
Physical design	**SA**
Fitness for service	**SA**
Radiation protection	**SA**
Conventional health and safety	**SA**
Environmental protection	**SA**
Emergency management and fire protection	**SA**
Waste management	**SA**
Security	**FS**
Safeguards and non-proliferation	**SA**
Packaging and transport	**SA**

Notes:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in the subsection of the report
- The information presented below is site specific; general trends are not identified

Management system

RATINGS FOR MANAGEMENT SYSTEM		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "management system" SCA for WL as "satisfactory" as the decommissioning quality assurance program is well established and effectively implemented.		

The "management system" SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture. For WL, this SCA encompasses the following specific areas:

- Management system
- Organization (see section 1.2 on AECL restructuring)
- Performance assessment, improvement and management review
- Operating experience (no significant observations to report)
- Change management (no significant observations to report)
- Safety culture (no significant observations to report)
- Configuration management (no significant observations to report)
- Records management (no significant observations to report)
- Management of contractors
- Business continuity (no significant observations to report).

Management system

The activities at WL are broadly governed under the AECL corporate management system, and more specifically defined in the *WL Decommissioning Quality Assurance Plan* which is required by licence condition 2.1. CNSC staff have reviewed and accepted this document as it meets CSA N286.6-98, *Decommissioning Quality Assurance for Nuclear Power Plants*. AECL has proceeded to carry out the decommissioning activities at WL in accordance with this program.

During the reporting period, AECL developed a *Detailed Decommissioning Plan* (DDP), describing the decommissioning work of WR-1 and Building 100. This document describes a relatively complex component of the WL decommissioning activities.

Performance assessment, improvement and management review

According to CSA N286.6-98, AECL must evaluate its effectiveness in achieving organizational goals, using both self and independent assessments. In addition, a formal review of the effectiveness of its Decommissioning Quality Assurance program shall be conducted annually.

CNSC staff reviewed the results of AECL's assessments and identified some minor areas for improvement. These areas included the adequacy of AECL's assessment methodology as it was not evident that AECL's methodology ensured all components of the program would be assessed.

AECL committed to conducting future assessments using AECL's "Management System Assessment Framework" instead of the previously used methodology. This activity is in progress and CNSC staff will continue to review and assess the results of these and future assessments.

Management of contractors

AECL stated that its Decommissioning Quality Assurance program applies to all staff and contractors who participate in, or support, projects or activities. However, CNSC staff determined that the information included in the DDP does not provide a clear description of how AECL would manage external contractors involved in this project.

To clarify some aspects, AECL was requested to ensure all requirements of CSA N286.6-98 are fully addressed by all workers, including contractors, involved in AECL decommissioning activities. This activity is currently in progress. CNSC staff will continue to monitor the progress of this improvement.

Human performance management

RATINGS FOR HUMAN PERFORMANCE MANAGEMENT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "human performance management" SCA for WL as "satisfactory". AECL has implemented a human performance program that ensures personnel receive the appropriate training to safely carry out their duties.		

The "human performance management" SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and who have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. For WL, this SCA encompasses the following specific areas:

- Human performance program (no significant observations to report)
- Personnel training
- Personnel certification
- Work organization and job design (no significant observations to report)
- Fitness for duty (no significant observations to report)

Personnel training

During an inspection in October 2013, CNSC staff reviewed the training records relating to the AECL corporate training plan for employees in decommissioning and waste management. The review of these records verified that AECL has established a training program to ensure staff are trained prior to conducting work at WL.

Personnel certification

CNSC staff verified during an inspection that personnel assigned to the industrial radiography were Certified Exposure Device Operators/Qualified Operators. Their certification cards were reviewed and found valid.

Operating performance

RATINGS FOR OPERATING PERFORMANCE		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "operating performance" SCA for WL as "satisfactory". Procedures are in place and followed by AECL staff. Events are reported as per the requirements and actions are put in place to avoid recurrence.		

The "operating performance" SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

For WL, this SCA encompasses the following specific areas:

- Conduct of licensed activity
- Procedures
- Reporting and trending

Conduct of licensed activity

Facilities at WL are governed by AECL's *Facility Authorization* and *Conduct of Operations* documents, which describe the roles and responsibilities of positions with authority within AECL's organization.

In May 2011, AECL revised four of these documents. CNSC staff's review noted that some functional responsibilities were not clearly and completely documented in the revised documents for all positions within the AECL's organization. AECL committed to submitting the revised facility authorizations in 2014/2015. As this activity is still in progress, CNSC staff will continue to monitor progress of these improvements.

WR-1 reactor hall

Procedures

CNSC staff conducted semi-annual inspections under the baseline compliance program. CNSC staff's inspections confirmed that programs, procedures, and work plans for the decommissioning and operations at WL remain in place. Some minor issues have been reported, such as posting of radiation warning signs and maintenance records of instrumentation. All were corrected to the satisfaction of CNSC staff.

CNSC staff reviewed the WL Annual Safety Report during the review period. AECL has satisfactorily addressed all CNSC staff's comments and recommendations relating to these reports.

Reporting and trending

The requirements for reporting unplanned situations or events at WL to the CNSC are prescribed in licence condition 9. AECL has complied with the requirements for submission of these reports during the review period.

As stated previously, AECL categorizes reportable events by Significance Level as follows:

- Significance Level 1: Highly significant problem
- Significance Level 2: Significant problem
- Significance Level 3: Problem
- Significance Level 4: Minor problem/improvement

Events reported to the CNSC by Significance Level category are presented in table 6:

Table 6: Reportable events for WL (2011-2013)

	2011	2012	2013
Level 1	0	0	0
Level 2	0	0	0
Level 3	7	4	1
Level 4	3	1	3
Total	**10**	**5**	**4**

CNSC staff have reviewed the reportable events and their associated corrective action plans. All actions have been closed to CNSC staff's satisfaction. These events did not have an impact on the health and safety of the public, workers or the environment.

Safety analysis

RATINGS FOR SAFETY ANALYSIS		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "safety analysis" SCA for WL as "satisfactory". AECL's safety analysis is in line with the Fukushima actions and no other activities with fissionable material occur at WL other than what is stored.		

The "safety analysis" SCA covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

For WL, this SCA encompasses the following specific areas:

- Deterministic safety analysis
- Hazard analysis
- Criticality safety

Deterministic safety analysis

In April 2012, AECL commenced operation of the SMAGS building for the storage of low- and intermediate-level waste. As required by the licence for the operation of a newly constructed nuclear facility, AECL submitted the SAR: *Safety and Hazard Assessment for the SMAGS facility at WL*. CNSC staff's review concluded that AECL met the requirements of the licence, and that the operation of the SMAGS facility provided adequate protection for the health and safety of persons, workers and the environment.

Following the events at the Fukushima site in Japan, CNSC staff requested all Class I nuclear facilities review the lessons learned and re-examine the facilities safety case. During the review, AECL identified no significant gaps for WL, thus adequately addressing the request from CNSC staff. However, AECL identified areas for improvement to update the WL safety case documentation. During the review period, AECL began the revisions to the SAR documentation, with the submission of these revised documents due to CNSC staff in December 2014. For more information on the status of Fukushima actions, see appendix G.

Hazard analysis

Fire protection

AECL has a fire protection program in place to minimize both the probability of occurrence and the consequences of fire at WL and comply with the requirements of the *National Building Code* (2005), the *National Fire Code* (2005), and National Fire Protection Association, NFPA-801: *Fire Protection for Facilities Handling Radioactive Material* (2008). There were no significant reportable events during the review period that had an effect on the licensees' fire protection program or its implementation.

AECL has reported the completion of all the recommendations of the Biennially Independent Third Party Review and all the corrective actions relating to the focused fire protection inspection, with the exception of replacing an aging fire alarm system due to the complexity of the system and the decommissioning activities. The replacement of the fire alarm system is currently underway. This activity is planned to be completed by the end of the fiscal year 2014/2015.

Criticality safety

There remain no activities associated with fissionable material at WL, other than storage of used fuel in the Concrete Canister Storage Facility and the waste management area's standpipes, which AECL and CNSC staff consider to be low risk and low priority.

The nuclear criticality safety program at AECL is a corporate-wide program, and is used at both WL and CRL. AECL has implemented limits to be used as the Upper Subcritical Limits (USL) until all Criticality Safety Documents are revised to include explicit USLs. CNSC staff have reviewed the temporary USLs and concluded the limits are consistent with CNSC regulatory requirements.

Physical design

RATINGS FOR PHYSICAL DESIGN		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "physical design" SCA as "satisfactory" as changes at the WL are controlled as per the Engineering Change Control procedure.		

The "physical design" SCA relates to activities that impact the ability of SSCs to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

Given that the WL site is undergoing decommissioning, there is very little work on physical design.

For WL, this SCA encompasses the following specific areas:

- Design governance
- Site characterization (no significant observations to report)
- Facility design (no significant observations to report)

Design governance

For more details on AECL's design governance, see the corresponding CRL section.

Fitness for service

RATINGS FOR FITNESS FOR SERVICE		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "fitness for service" SCA as satisfactory. A periodic inspection plan is effectively in place at WL.		

The "fitness for service" SCA covers activities that impact the physical condition of SSCs to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

For WL, this SCA encompasses the following specific areas:

- Equipment fitness for service / equipment performance (no significant observations to report)
- Maintenance
- Structural integrity

Maintenance

In 2009, the Periodic Inspection Plan, met the requirements of CSA N291-08, *Requirement for Safety Related Structures for CANDU Nuclear Power Plants*, for the WMA storage structures, and was developed following a 2008 fitness-for-service evaluation. This plan was implemented at WL to ensure the waste storage structures continued to be fit for service.

CNSC staff reviewed the inspection and maintenance related information provided in AECL's Annual Safety Reports, which confirmed that inspection and maintenance activities of the waste storage structures have been conducted and no significant issues have been identified. Additionally, CNSC staff have reviewed the SAR and the Commissioning Report of the new SMAGS building, and concluded the proposed SMAGS maintenance program is appropriate.

In the winter of 2013, some water leakage (in the form of icicles) was detected between the seam of the roof and the north-east wall structure of the SMAGS. The leakage was caused from drainage water freezing in the scupper causing new melting water to pool and make its way through the seam. The leakage was not infringing on any of the waste bins currently stored in the SMAGS. In February 2014, a heat tape was installed to eliminate any ice buildup.

Structural integrity

The standpipes are vertical tile holes, partially or fully covered, buried in the ground, containing historical radioactive waste. In 2009, AECL provided a technical document to demonstrate that the standpipe structures are fit for service, in which AECL stated there was considerable planning on developing testing and monitoring methods for these structures. Field work to complete the inspection and monitoring activities for the standpipe was performed in 2012. Excavation work around the standpipes, in order to examine the condition of the concrete, was done during the summer of 2013. The results will be provided to CNSC staff for review.

AECL continues to perform the annual inspection of the WMA concrete bunkers in accordance with the Periodic Inspection Plan. The inspection findings are evaluated by AECL and the information is submitted to CNSC staff for review and acceptance. No significant degradation has been identified in the inspections but some minor repairs will be carried out. AECL has provided target dates for these repairs. CNSC staff plan to conduct an inspection on the implementation of the periodic inspection program in the next 12 to 15 months.

Radiation protection

RATINGS FOR RADIATION PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "radiation protection" SCA as "satisfactory". AECL has implemented and maintained a radiation protection program to control radiological hazards, ascertain doses to workers, and estimate doses to the public.		

The "radiation protection" SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled, and maintained as low as reasonably achievable (ALARA).

For WL, this SCA encompasses the following specific areas:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated doses to the public

Application of ALARA

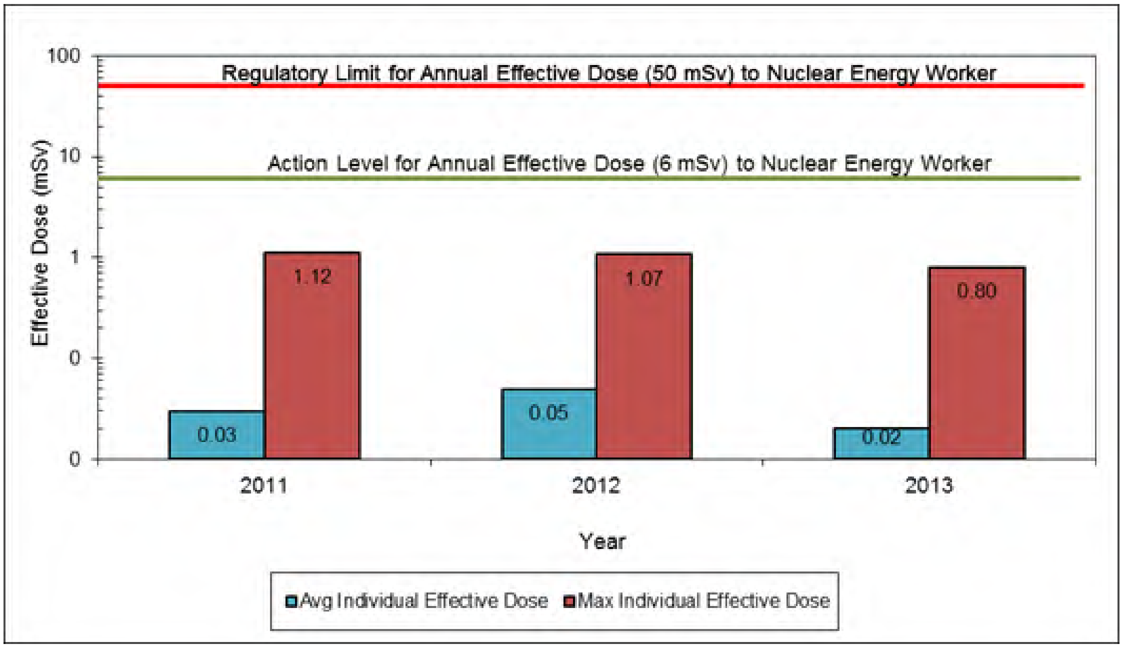
AECL continues to strive to maintain doses to workers ALARA. An example of which was the development and implementation of the document: *Job Scope and Safety Analysis*, which provides an all hazards integrated approach to planning and executing decommissioning work and non-routine nuclear facility activities. Through this process, AECL maintains exposures and potential for unplanned exposure ALARA through the application of "remove the hazard", "guard the hazard" and "guard the worker" hazard controls and safety measures. The focus has been on defining clear limiting conditions for work and applying aggressive safe back-out points for early detection of unexpected or abnormal hazards.

As a result of this process, AECL has executed radiological work in the 2009 to 2013 period with minimal dose consequence, no internal intakes and no significant contamination or exposure events. Examples of this include the Building 300 plutonium laboratory glove box removal, the hot cell facility windows refurbishment, and the warm cells active drain line and ventilation duct removal.

Worker dose control

CNSC staff review of dose data from 2011 to 2013 indicates that radiation doses to workers are being adequately controlled to levels well below the regulatory limits (figure 9). During the review period, the maximum individual effective annual dose for a Nuclear Energy Worker (NEW) was 1.12 mSv, or 2.24 percent of the annual regulatory limit of 50 mSv. Annual dose averages include all reported doses, including zero values.

Figure 9: Effective dose statistics for nuclear energy workers at AECL's WL (2011-2013)



Radiation protection program performance

AECL continues to maintain and implement a radiation protection program, including its own dosimetry service licensed by the CNSC to ascertain whole-body dose, extremity beta/gamma dose, and internal dose. When applicable, neutron whole-body dose is monitored using CR-39 dosimeters supplied by Health Canada's CNSC licensed National Dosimetry Services. For immediate monitoring of individual gamma doses, direct reading electronic dosimeters are used.

Radiological hazard control

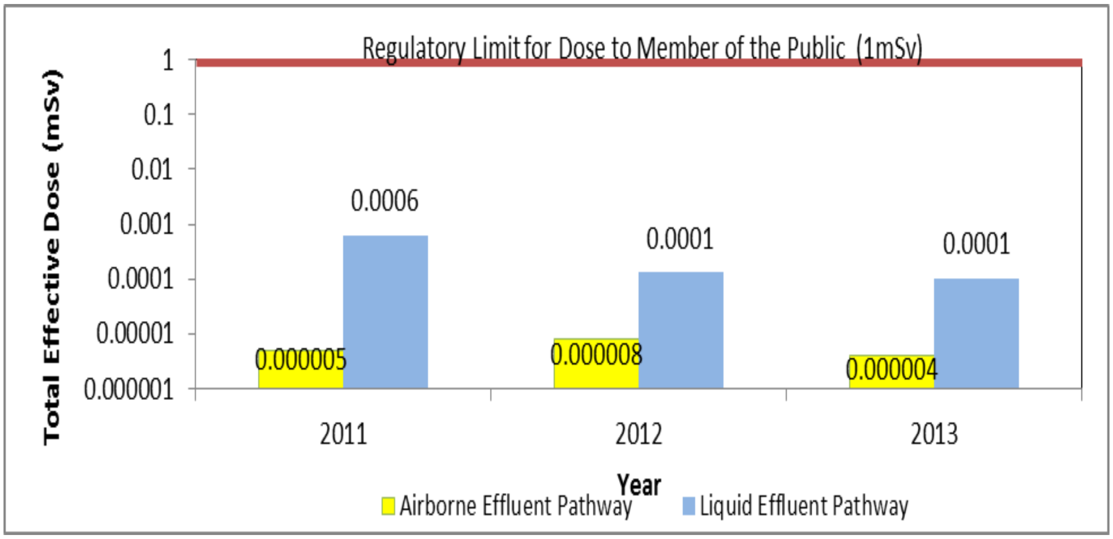
Action levels have been established as part of the WL radiation protection program. If one is reached, it triggers AECL staff to establish the cause for reaching the action level and, if applicable, restore the effectiveness of the radiation protection program.There have been no action level exceedances at WL over the review period.

AECL continues to effectively maintain and implement a surface contamination monitoring program to effectively control contamination at WL.

Estimated dose to the public

The dose to the public from WL activities is calculated by using environmental monitoring results. The dose due to airborne exposure pathways was estimated by multiplying the WL total air release, as a fraction of the derived release limit (DRL), by 1 mSv and is negligible. The dose due to the liquid exposure pathways was calculated using the river water, fish, game meat and vegetable components. Doses to the public continue to be well below the regulatory annual public dose limit of 1 mSv, as seen in figure 10.

Figure 10: Total effective dose (mSv) to a member of the public (2011-2013)



Conventional health and safety

RATINGS FOR CONVENTIONAL HEALTH AND SAFETY		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "conventional health and safety" SCA at WL as "satisfactory" as AECL continues to view conventional health and safety as a paramount consideration in all decommissioning activities.		

The "conventional health and safety" SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

For WL, this SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness (no significant observations to report)

Performance

A key performance measure for this SCA is the number of RLTIs that occur per year. An RLTI is an injury that takes place at work and results in the worker being unable to return to work to carry out their duties for a period of time. In reviewing RLTIs, CNSC staff must consider the severity of these injuries (e.g., the total days lost) and the frequency as they relate to the size of the workforce. The severity rate is a measure of the total number of days lost due to injury for every 200,000 person-hours worked at a site and the frequency is the number of fatalities and injuries (lost time and medically treated) due to accidents for every 200,000 person-hours worked at a site.

As per table 7, the number of RLTIs and their frequency is relatively stable; however, the severity rate is increasing. This means a considerable number of injuries at WL are resulting in extended absences from the workplace. Although most of these injuries are minor (requiring first aid), improvements to the return to work program are still required to minimize the number of days lost. AECL is currently in the process of implementing these improvement actions.

Table 7: Recordable lost-time injuries (RLTI), frequency and severity at WL 2011-2013

Year	RLTIs	RLTI Frequency	RLTI Severity
2011	8	2.28	9.98
2012	5	1.69	12.19
2013	7	2.29	20.27

Practices

In addition to the NSCA and regulations, AECL's activities and operations at the WL site must comply with the *Canada Labour Code* Part II and the Canada *Occupational Health and Safety Regulations, Hazardous Products Act, Controlled Products Regulations, Workplace Hazardous Materials Information System*, and other applicable federal and provincial health and safety related acts and regulations.

Environmental protection

RATINGS FOR ENVIRONMENTAL PROTECTION		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff rate the "environmental protection" SCA at WL as "satisfactory". AECL continues to implement and maintain an environmental protection program to control and monitor liquid and air releases of radioactive and hazardous substances to the environment.		

The "environmental protection" SCA covers the programs that identify, control and monitor all releases of radioactive and hazardous substances, and the effects on the environment from facilities or as the result of licensed activities.

For WL, this SCA encompasses the following specific areas:

- Environmental management system
- Effluent and emissions control (releases)
- Assessment and monitoring
- Protection of the public

Environmental management system

AECL worker gathering samples for environmental monitoring at WL

Licensees must have adequate provision for the protection of the environment via policies, programs and procedures, as required by REGDOC-2.9.1, *Environmental Protection: Environmental Protection Policies, Programs and Procedures*. AECL's environmental protection program consists of an environmental policy along with comprehensive programs and procedures to protect the environment. This includes an effluent monitoring program and an environmental monitoring program at WL. Through sampling and analysis of nuclear and non-nuclear substances, these programs assist in verifying that releases from WL do not pose hazards to the environment or human health.

AECL's environmental management system is ISO-14001 registered, and is subject to periodic audits and reviews to identify potential improvements.

Effluent and emissions control

CSA N288.5, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, was published in 2011. Unlike CRL, as specified earlier in the report, AECL is currently transitioning toward this standard at WL with a target date of March 2015.

Nuclear substance releases

Established DRLs for airborne and liquid effluents are listed in the WL licence. The DRLs represent the maximum radionuclide releases to the environment to maintain the public annual dose below the 1 mSv annual regulatory dose limit. During 2012 and 2013, there were no airborne or liquid exceedances of these release limits. The total releases of airborne and liquid effluents for 2012 and 2013 were well below the 1 mSv limit.

As part of its environmental protection program, AECL has established a number of action levels, which if exceeded may indicate a loss of operational control. If an action level is reached or exceeded, AECL is required to establish the cause and, if applicable, restore the effectiveness of the program. AECL is required to report all action level exceedances to the CNSC.

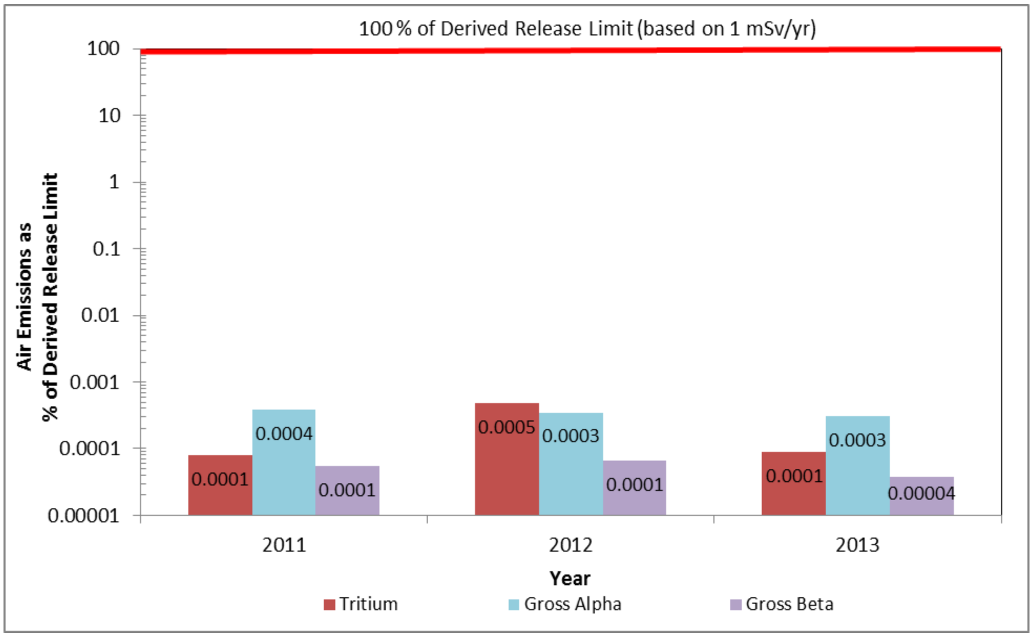
In 2012 and 2013, there were no action level exceedances of airborne or liquid releases at WL.

Airborne nuclear substance releases

AECL's radiological air effluent verification program at WL comprises eight monitoring points, including the Hot Cells Facility, Immobilized Fuel Test Facility, Reactor Building, Active Liquid Waste Treatment Centre and the Incinerator and Compactor/Baler in the waste management area. Monitoring is by sampling and analysis for radionuclides, including tritium, gross alpha and gross beta.

The airborne radiological emissions from WL continue to be effectively controlled and below the annual DRLs, as shown in figure 11.

Figure 11: Airborne nuclear substance releases for WL (2011-2013)

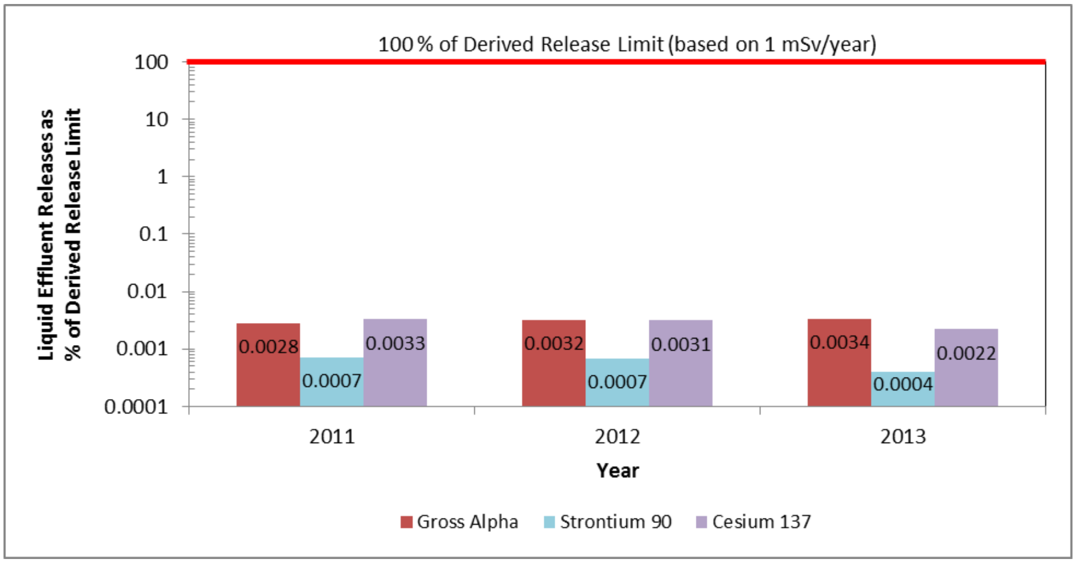


<u>Liquid nuclear substance releases</u>

AECL's radiological liquid effluent verification program for WL comprises eight monitoring points for process water outfall flowing into the Winnipeg River, discharges from the sewage lagoon and the waste management area's two drainage ditches. Monitoring is by sampling and analysis for radionuclides, gross alpha, strontium-90 and cesium-137.

The liquid radiological emissions from the WL continue to be effectively controlled and below the annual DRLs, as shown in figure 12.

Figure 12: Liquid nuclear substance releases for WL (2011-2013)



Airborne hazardous substance releases

The main stationary sources of non-radiological effluents to air from the WL are related to fuel combustion for building heating and steam generation purposes, and inadvertent losses of halocarbons used in research, cooling and fire suppression applications. The main source of fuel combustion releases is the combustion of Number 2 fuel oil and propane gas to generate heat. AECL does not routinely monitor these emissions instead estimates are calculated using oil consumption data and emission factors provided by Environment Canada.

The fuel consumption data is used to estimate the air emissions for Criteria Air Contaminants. Those that exceed the National Pollutant Release Inventory threshold are then reported to Environment Canada. Estimated emissions between 2012 and 2013 remained low and fall below the reporting thresholds.

Liquid hazardous substance releases

The WL routinely discharges, in various liquid effluents, many non-radiological substances to the environment (the Winnipeg River) via the sewage lagoon, process sewer outfall, drainage ditches and internal liquid discharges. In total, AECL routinely monitors nine different monitoring points for non-radiological parameters and compares the performance of significant effluent concentrations against AECL guidelines.

A wide variety of parameters are measured including mercury, phenolics, copper, zinc, iron, nickel, and total suspended solids. The number of guideline exceedances for 2012 and 2013 were five and two respectively. The guideline exceedances occurred at the Active Liquid Waste Treatment Center for copper, iron and mercury in 2012, and iron and phenolics in 2013. All lagoon, ditches and Outfall emissions conformed to AECL emission guidelines. In cases of reoccurring exceedences, AECL investigates the cause and potential corrective actions. CNSC staff are tracking these exceedences through the review of the annual safety reports.

Assessment and monitoring

A revision to CSA N288.4, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, was issued in 2010. In 2010, AECL assessed the WL environmental monitoring system against the revised standard to identify areas of non-compliance and make appropriate modifications to the program. In 2012, AECL initiated work on the identified subtask activities required to implement the revised standard. This transition is still in progress.

Environmental monitoring

AECL maintains a comprehensive environmental monitoring program for WL to verify that radiation doses to members of the public as a result of radioactive releases from WL remain ALARA, social and economic factors being taken into account. The program also serves to verify that non-radioactive releases do not pose hazards to human health and that neither radioactive releases, non-radioactive releases, nor physical stressors pose hazards to the environment.

The radiological component of the environmental monitoring program is conducted through the routine collection and analysis of environmental samples from locations at the WL site and in the surrounding area. Monitored media include ambient air, precipitation, fish, garden vegetables, game meat, groundwater, Winnipeg River water and river sediments.

The non-radiological component focuses on groundwater samples from wells located at the waste management area lagoon and landfill.

Environmental monitoring results in 2012 and 2013 continue to demonstrate AECL's successful implementation of this program at WL.

Winnipeg River monitoring

AECL samples surface water at four locations along the Winnipeg River between Pinawa and the Great Falls generating station. Water samples are analyzed for radionuclides such as tritium, gross alpha, gross beta and strontium-90. The sampling results for 2012 and 2013 demonstrate that radionuclide concentration in the Winnipeg River water remain very low. Specifically, annual average concentrations of tritium in water ranged from 2.5 to 3.5 Bq/L, which is well below the Maximum Acceptable Concentration of 7000 Bq/L indicated in Health Canada's *Guidelines for Canadian Drinking Water Quality*.

Protection of the public

At WL, systems that discharge conventional (non-radiological) contaminants to the environment are not regulated by the province since WL is a federal site. As a result, AECL has developed its own AECL guidelines to manage non-radiological liquid releases. See the specific area "effluent and emission control" for additional information.

CNSC staff receives reports of discharges to the environment through the reporting requirements outlined in the WL licence.

Review of non-radioactive discharges to the environment for WL in 2012 and 2013 indicate that no significant risks to the public or environment occurred during the licensing period.

Emergency management and fire protection

RATINGS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "emergency management and fire protection" SCA at WL as "satisfactory". Overall, compliance verification activities conducted confirm that AECL continues to maintain a comprehensive and well-documented emergency management program that meets all applicable regulatory requirements.		

The "emergency management and fire protection" SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

For WL, this SCA encompasses the following specific areas:

- Conventional emergency preparedness and response
- Nuclear emergency preparedness and response (no significant observations to report)

- Fire emergency preparedness and response (no significant observations to report)

Conventional emergency preparedness and response

The AECL *WL Site Emergency Plan* and related site specific emergency procedures were reviewed by CNSC staff and determined to be consistent with the requirements of G-225, *Emergency Planning at Class I Nuclear Facilities and Uranium Mines and Mills*. AECL's emergency preparedness documentation is appropriate for the anticipated degree of emergencies at the WL site.

Waste management

RATINGS FOR WASTE MANAGEMENT		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff conclude that the rating for "waste management" SCA at WL was "satisfactory". All radioactive waste is managed in accordance with applicable regulations and internal procedures.		

The "waste management" SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.

For WL, this SCA encompasses the following specific areas:

- Waste characterization and minimization
- Waste management practices
- Decommissioning plans

Waste characterization and minimization

Dismantling and demolition waste produced at WL are radiologically screened and segregated at the source as either "Likely Clean" or "Contaminated". Likely Clean waste is monitored for radiological clearance. If found clean, the waste is either dispositioned for reuse or recycling where possible, or disposed of in the WL landfill or transferred to an appropriate storage or process facility for hazardous material. Contaminated waste will be decontaminated to meet clearance criteria where feasible or characterized and sent to the WMA for processing as per CSA N292.3, *Management of low- and intermediate-level radioactive waste*.

Waste management practices

The WMA provides storage facilities for radioactive wastes and small volumes of hazardous industrial waste. It consists of an organic incinerator, the new SMAGS building, bunkers and Quonset storage buildings used to store low-level radioactive waste (LLW) and intermediate-level radioactive waste (referred to in this report as medium-level waste, or MLW) generated from WL decommissioning.

Table 8 provides information on the percentage of space that is filled and the estimate number of years of storage space remaining in the waste storage building. There are also two empty standpipes in the WMA.

Table 8: Status of waste storage buildings at WL (as of December 31, 2013)

Building No.	% Full	Years of Storage Space Remaining
LLW B5	100 (sealed)	N/A
LLW B6	60	1
MLW B4	70	2-3
MLW B6 *	60	2-3
MLW B7	85	2-5
431 (LLW Storage Building)	60	3
433 (LLW Storage Building)	80	2
SMAGS Building #1	5	10
Soil Storage Compound	0.5	10

* MLW B6 is currently not accepting waste due to water ingress issues.

The Concrete Canister Storage Facility is located adjacent to the WMA and has stored irradiated fuel since 1975. In January 2014, AECL reported that canister C-5 is slightly leaning (less than 1°). AECL will continue to survey the canister to ensure that there is no movement with that canister. CNSC staff continue to monitor the results of AECL's surveys during monthly licensing meeting.

To study the distribution of dose received by living organisms, AECL constructed a cesium pond in 1966. This pond was decommissioned in 2013 with work on segregating the cesium soil being completed in 2013. The soil is presently stock piled within the fenced area of the WMA for the short term, while AECL assesses long-term storage. Concrete blocks have been used to form a retaining wall around the north and west sides of the stock pile. On the inside of the retaining wall, a sand fill space was placed in a geo-membrane. This membrane acts as a silt fence and porewater pressure drainage for removing water from the soil. Finally, a large tarp was placed over the pile to prevent erosion. To support the conclusion, these measures ensure the pile remains in a safe state and that the environment is protected. AECL has submitted additional information. CNSC staff are currently reviewing this information.

Decommissioning plans

AECL decided to reduce the deferment period of the decommissioning of its installations. Therefore, AECL presented to CNSC staff the detailed decommissioning plan for WR-1 in September 2013. As previously indicated, work is planned to start in 2015. This work will consist of the removal of the remaining systems like the reactor vessels and the primary heat transport system, to name two. Building 200 (Active Liquids Waste Treatment Centre) and Building 411 (Decontamination Centre) are planned to be decommissioned next. The activities presently conducted in these buildings will be moved to Building 300. The activities described above fall under the Nuclear Legacy Liabilities Program, as previously described in section 1.5.

Security

RATINGS FOR SECURITY		
Overall Performance Ratings		
2011	2012	2013
FS	FS	FS
Based on the information assessed, CNSC staff continue to rate the SCA "security" as "fully satisfactory" at WL. AECL has implemented a security program that meets the *Nuclear Security Regulations* and associated regulatory documents.		

The "security" SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

For WL, this SCA encompasses the following specific areas:

- Facilities and equipment
- Response arrangements
- Security practices
- Drills and exercises

Facilities and equipment

During the review period, AECL demonstrated the effective maintenance of facilities and equipment, and met regulatory requirements at WL.

Response arrangements

AECL maintains a security force of qualified Nuclear Security Officers at WL to meet the requirements of the *Nuclear Security Regulations*. The security force employs a response strategy based on defence-in-depth and the graded approach. Arrangements also exist with the Royal Canadian Mounted Police (RCMP), its offsite response force.

Security practices

AECL continues to demonstrate procedural compliance and is equipped with access control measures at WL that meet regulatory requirements. AECL maintains good practices through robust corporate governance.

Drills and exercises

AECL continues to conduct security exercises every two years at WL in coordination with the offsite response force as per section 36(2) of the *Nuclear Security Regulations*. AECL conducted a successful security exercise in October 2013 where AECL demonstrated effective intervention capabilities against a credible threat in coordination with the RCMP. The physical protection system was realistically tested and assessed.

Safeguards and non-proliferation

RATINGS FOR SAFEGUARDS AND NON-PROLIFERATION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
Based on the information assessed from 2011 to 2013, CNSC staff conclude that the implementation of the safeguards program for the "safeguards and non-proliferation" SCA at WL met all applicable regulatory requirements with a "satisfactory" rating.		

The "safeguards and non-proliferation" SCA covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements, as well as all other measures arising from the treaty on the *Non-Proliferation of Nuclear Weapons*.

For WL, this SCA encompasses the following specific areas:

- Nuclear material accountancy and control
- Access and assistance to the IAEA
- Operational and design information
- Safeguards equipment, containment and surveillance

Nuclear material accountancy and control

During the review period, AECL provided the CNSC and IAEA with all nuclear material accounting reports and information in an accurate and timely manner, as required by RD-336, *Accounting and Reporting of Nuclear Material*.

Access and assistance to the IAEA

From 2011 to 2013, the IAEA conducted six inspections at WL. Details of the IAEA inspections can be found in table 9:

Table 9: Verification activities by the IAEA at WL

Year	SNRI	PIV	DIV	Total
2011	1	0	1	2
2012	1	0	1	2
2013	0	1	1	2
Total Inspections				6

SNRI - Short Notice Random Inspection
PIV - Physical Inventory Verification
DIV - Design Information Verification

The IAEA has indicated that the results from their inspection activities at WL were satisfactory and no actions were requested from AECL. On this basis, the IAEA concluded that all nuclear material at this site remained in peaceful activities.

Safeguards equipment, containment and surveillance

There is no IAEA equipment installed at WL.

Operational and design information

AECL submits annual operational program and quarterly updates, as required. These documents provide a forward-looking plan of WL's activities, and are updated by AECL as needed. AECL also submits information under the *Additional Protocol to the Canada - IAEA Safeguards Agreement*, including a description of each building, the scale of its operations, and future plans for nuclear fuel research and development activities. In addition, Design Information Questionnaire documents were updated as required for various facilities and submitted to CNSC staff.

Packaging and transport

RATINGS FOR PACKAGING AND TRANSPORT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "packaging and transport" SCA for WL as "satisfactory". Transportation of dangerous goods training is in place and the handling, packaging and offering for transport of radioactive material is conducted by certified personnel.		

The "packaging and transport" SCA covers programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

For WL, this SCA encompasses the following specific area:

- Packaging and transport

Packaging and transport

AECL must adhere to the *Packaging and Transport of Nuclear Substances Regulations* and *Transport Canada's Transportation of Dangerous Goods Regulations* for all shipments leaving the site.

AECL is required to have appropriate training for personnel involved in the handling, offering for transport and transport of dangerous goods, and is required to issue a training certificate to those workers. During an inspection, training certificates were reviewed and found to be missing required information. This has been satisfactorily addressed by AECL.

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PART II: PROJECTS

3 OVERVIEW

Port Hope Area Initiative

The Port Hope Area Initiative (PHAI) comprises two community-based projects to develop and implement a safe, local, long-term management solutions for historic low-level radioactive waste (LLRW) in Port Hope and Port Granby. The PHAI is defined by a legal agreement between the Government of Canada and the Municipalities of Port Hope and Clarington for the management of the historic LLRW within each of the respective communities [12]. The agreement came into effect in March 2001.

Under the terms of the agreement, the Government of Canada, through Natural Resources Canada (NRCan) has made a financial commitment to clean up and to provide long-term safe management of the historic LLRW in Port Hope and Port Granby (see appendix D for more information). These wastes arose from the activities of a former federal Crown Corporation (Eldorado Nuclear) and its private sector predecessors.

AECL was engaged by NRCan as the proponent for environmental and licensing approvals associated with the PHAI projects and as overall project manager. Under the governance framework established by NRCan, the PHAI Management Office is led by AECL, and the responsibility for all major contracting activities is assigned to Public Works and Government Services Canada (PWGSC). A tripartite federal steering committee oversees the PHAI Management Office and provides strategic direction to the General Manager (AECL). The PHAI Management Office conducts its work and coordinates its activities with those of the participating organizations: AECL, NRCan and PWGSC.

The PHAI includes two distinct and separate projects:

- The Port Hope Long-Term Low-Level Radioactive Waste Management Project (the "Port Hope Project")
- The Port Granby Long-Term Low-Level Radioactive Waste Management Project (the "Port Granby Project")

The status for each project (Port Hope versus Port Granby) is presented separately in the following sections (3.2 and 3.3). Currently, the projects are at the same stage of development and therefore, the information presented per SCA is very similar and may appear to be duplication. However, it was deemed important to separate the two projects into distinct sections as the information that will be included in future reports will differ as the projects progress independently.

3.1 Public information and disclosure

AECL is currently implementing its *PHAI Phase II Communication Plan* and is committed to disclosing information about the projects with stakeholders in a timely, accurate and comprehensive manner.

In 2013, AECL conducted public information activities for PHAI that met CNSC regulatory requirements. These activities included:

- The posting recent project news and updates and environmental monitoring data to the website www.phai.ca
- The Public Information Exchange, which is located at the PHAI Management Office, is open five days a week and contains two 3-D, to scale models to help visualize how the engineered mound will look post-construction
- Citizen Liaison Groups for the Port Hope and Port Granby Projects have been launched to supplement the exchange of information with communities; the groups, which meet on a quarterly basis, each consists of volunteer citizen members who meet with AECL team leaders to discuss the project activities and community concerns
- AECL has conducted outreach activities at fairs and trade shows, site tours (37 in 2013), newsletters (mailed to 15, 000 residents), and PHAI Facebook (received about 4,500 views)
- AECL plans to update its Communication plan to reflect the progress on the projects in 2014

Residents attending a public information session

To engage Aboriginal groups interested in the PHAI, AECL also conducted activities such as regular meetings, workshops, site tours, and invitations to join a community liaison group. Based on the information received, CNSC staff are satisfied that AECL's Aboriginal engagement activities related to the PHAI are appropriate to keep interested Aboriginal audiences informed.

3.2 Port Hope Project

3.2.1 Overview

The purpose of the Port Hope Project (PHP) is to remediate sites containing historic low-level radioactive waste (LLRW) and other specified industrial waste located in the Municipality of Port Hope, and to consolidate and manage this waste in a new Long-Term Low-Level Radioactive Waste Management Facility (LTWMF) developed on lands comprising and adjacent to the existing Welcome Waste Management Facility (WMF). The current contents of the Welcome WMF will be incorporated into the new LTWMF.

Figure 13: The municipality of Port Hope

(Source: AECL)

The historic LLRW is the result of radium and uranium refining activities associated with the processing of pitchblende ores during the period from 1933 to 1955. Process residues and other materials were discarded or used in construction and landscaping activities at various locations within the community. The historic LLRW currently exists within licensed facilities including the existing Welcome WMF, and at miscellaneous unlicensed sites including the Port Hope Harbor and the former municipal landfill site.

PHP activities include the construction and operation of the LTWMF, remediation of the existing Welcome WMF and remediation of sites containing historic LLRW located within the Municipality of Port Hope.

The PHP is being conducted in three phases – transition, implementation and closure.

- Phase I (transition) activities are confined to the continued operation, care and maintenance of the Welcome WMF, assumed from Cameco in March 2012
- Phase II (implementation) activities include the operation, care and maintenance of the Welcome WMF; redevelopment of the facility into the Port Hope LTWMF; operation, care and maintenance of the LTWMF; and offsite remedial activities
- Phase III (closure) activities include long-term maintenance and monitoring of the Port Hope LTWMF

In 2014, the second year of Phase II of the PHP, AECL is preparing for construction of the LTWMF, completing construction of the new water treatment plant, and delineating contaminated offsite areas to facilitate development of remediation plans. As the project proceeds, AECL continues to inform and engage the public through various mechanisms under their public information program including the Port Hope Citizen Liaison Group. Further details regarding the public information program can be found in section 3.1 of this report.

Phase II activities are governed under the PHP licence [13], which was issued on November 15, 2012. Under that licence, AECL is required to implement programs for PHP to ensure compliance with the accepted design, safe conduct of the approved activities and protection of people and the environment. These programs are referenced in the LCH [14].

CNSC staff continue to verify implementation of AECL's programs with respect to this project and assess them against the performance objectives and compliance verification criteria defined in the regulations, the licence and the LCH. Verification activities include desktop reviews and site inspections. Many program documents referenced in the LCH are currently undergoing revision; desktop reviews of these will be conducted by CNSC staff. The most recent site inspection was conducted on October 29, 2013.

As previously stated, the information presented per SCA is very similar between the two projects. It is important to separate the two projects into distinct sections because the information that will be included in future annual reports will differ as the projects progress independently. Therefore, an update on the status of the PHP by SCA follows. Prior to 2012, the PHP performance was not rated according to the SCAs. In 2012, the ratings assessed for each SCA were based on information submitted in support of the licence application. In 2013, the ratings for each SCA were based on CNSC staff assessment for the review period. The review period for the PHP is from November 15, 2012 (licence issuance) to December 31, 2013; recent updates on key issues through June 30, 2014 are also provided.

It must be noted that many of the specific areas under the SCAs do not apply to the PHP, and this is reflected in the discussion below. This is due largely to the nature of the project. Unlike CRL and WL, the PHP is not a nuclear facility. Further, many of the activities in Phase II, upon which AECL embarked with the issuance of the current licence, involve conventional construction, for example construction of the new Water Treatment Plant (WTP).

3.2.2 Safety and control areas

Table 10 presents the ratings for PHP for the year 2013. All SCA ratings are "satisfactory" for the reporting period which remains unchanged from reports previously made to the Commission [15].

Table 10: Performance ratings for Port Hope project for 2013

Safety and control area	Rating
Management system	**SA**
Human performance management	**SA**
Operating performance	**SA**
Safety analysis	**N/A**
Physical design	**SA**
Fitness for service	**SA**
Radiation protection	**SA**
Conventional health and safety	**SA**
Environmental protection	**SA**
Emergency management and fire protection	**SA**
Waste management	**N/A**
Security	**SA**
Safeguards and non-proliferation	**N/A**
Packaging and transport	**SA**

Notes:

- For specific areas within the SCAs where there were no significant observations from CNSC staff compliance verification activities, no information is given in the subsection of the report.
- The information presented below is site specific; general trends are not identified.

Management system

RATINGS FOR MANAGEMENT SYSTEM		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "management system" SCA for the PHP as "satisfactory". AECL continues to implement the *PHAI Quality Assurance Plan* and conducts oversight activities.		

The "management system" SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

For the PHP, this SCA encompasses the following specific areas:

- Management system
- Operating experience
- Safety culture
- Records management (no significant observations to report)
- Management of contractors

Management system

The activities of the PHP are broadly governed under the AECL corporate management system, and more specifically guided by the *PHAI Quality Assurance Plan*. This plan summarizes the processes and practices applicable to the PHAI licensed activities during execution of Phase II and clarifies the extent of their applicability to participants. These processes and practices comply with the quality management system defined in CSA-ISO 9001:08 *Quality Management Systems – Requirements*. The Quality Assurance plan, and adherence to it, is a requirement of licence condition 2.2.

Operating experience

As previously stated in the report, the OPEX program at AECL comprises the processes that ensure the organization uses the experience both from within the organization and from industry peers to improve the safety of operations, improve operational performance, and reduce the significance and the occurrence of unplanned events.

PHP reviews OPEX bulletins for relevance and applicability through the Improvement Action process.

Safety culture

AECL staff receives mandatory training in Human Performance to help reduce human error and thus, the frequency and severity of events at PHP. Initiatives by AECL's Human Performance Branch are designed, amongst other things, to strengthen AECL's safety culture.

During the review period, safety culture related training conducted for PHP staff included *Field Observation and Coaching Fundamentals; Reinforcing Leadership Development; Communicating for Leadership Success and Building Trust;* and *Coaching for Peak Performance*.

Management of contractors

AECL's responsibilities include defining the licence requirements to be included in contracts awarded by PWGSC for the execution of construction and remediation activities. AECL conducts oversight to ensure licence requirements are met. The *PHAI Oversight Procedure* governs how AECL oversight is conducted to confirm compliance with licensing commitments, technical requirements, and contractual obligations.

Within the review period, AECL conducted oversight for the WTP construction, the abandoned WMF pipeline resurvey, small scale site resurveys, known sites investigation, the Sculthorpe Marsh investigation, and dust monitoring associated with the construction of the new WTP.

Human performance management

RATINGS FOR HUMAN PERFORMANCE MANAGEMENT		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "human performance management" SCA for the PHP as "satisfactory". AECL continues to implement an acceptable training program to ensure AECL staff has the necessary skills and knowledge to safely carry out their duties.		

The "human performance management" SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are available in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. For the PHP, this SCA encompasses the following specific area:

- Personnel training

Personnel training

A training program, and adherence to it, is a requirement under licence condition 2.5. To meet this requirement, AECL has implemented the *PHAI Training Plan*. During the review period, AECL conducted 17 training courses for PHP staff including those reported under the specific area safety culture, above.

CNSC staff conducted a general assessment of facility operations during an inspection in October 2013. At that time, CNSC staff reviewed training records for facility managers and operational staff and found them complete. AECL's corporate database is utilized to identify and track training needs, and to file staff training records.

Operating performance

RATINGS FOR OPERATING PERFORMANCE		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continues to rate the "operating performance" SCA at PHP as "satisfactory". AECL continues to meet licensing and regulatory requirements in conducting Phase II activities, implementing procedures and reporting on activities.		

The "operating performance" SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

For the PHP, this SCA encompasses the following specific areas:

- Conduct of licensed activity
- Procedures
- Reporting and trending

Conduct of licensed activity

Licensed activities for Phase II, the current phase of the PHP, include:

- the operation of the existing Welcome Waste Management Facility (WMF)
- the construction of the new Water Treatment Plant (WTP)
- the construction of the new Long-Term Waste Management Facility (LTWMF)
- offsite remediation site

AECL plans to conduct the Phase II licensed activities over a 10-year timeframe.

Operation of Welcome Waste Management Facility

The Welcome WMF was transferred from Cameco to AECL on March 31, 2010. Under the licence, AECL is authorized to operate and maintain the Welcome WMF, as per the operational procedures and protocols specified in the *Licensing Manual – Information in Support of the Port Hope Long-Term Low-Level Radioactive Waste Management Project Licence Application*.

CNSC staff conducted a general assessment of facility operations during an inspection in October 2013. At that time, CNSC staff visually inspected the WTP, the treatment ponds and the interceptor ditch and observed that the facility was maintained in good operating condition.

Construction of the new Water Treatment Plant

AECL is required, under licence condition 2.6, to construct the new WTP in accordance with design documentation specified in the LCH. Construction of the WTP is being managed and overseen by PWGSC; AECL continues to conduct oversight activities for WTP construction as well as dust monitoring associated with the construction.

The building envelope of the new WTP was completed in the fall of 2013. Fitting of the building with water treatment equipment is ongoing. The plan for active commissioning has been submitted by AECL, as required under section 3.2.6 of the LCH, and has been accepted by CNSC staff.

Construction of the new Long Term Waste Management Facility and remediation of Welcome Waste Management Facility

AECL has begun site preparation activities, including removal of trees and shrubs, in preparation for construction of the LTWMF.

Before initiating remediation of the Welcome WMF, AECL is required under licence condition 2.6 to construct and commission the new WTP. However, AECL has requested authorization to conduct some construction activities prior to commissioning the WTP, in order to maintain its current project schedule. These early works include construction of Cell 1 of the LTWMF containment mound (into which contents of the existing mound will be transferred); construction of onsite infrastructure and support facilities; and excavation and temporary onsite stockpiling of affected soil. CNSC staff have reviewed AECL's submissions with respect to this work and have granted the authorization to proceed.

Offsite remediation sites

AECL is required, under licence condition 2.6, to remediate sites containing historic LLRW within the Municipality of Port Hope in accordance with design documentation specified in section 3.2.6 of the LCH.

Currently, AECL is conducting a radiological resurvey of the small-scale sites in Port Hope to characterize and delineate the contamination. The survey includes exterior gamma scanning, borehole testing and soil sampling, and interior contamination monitoring. During the review period, AECL made significant progress toward delineating contamination at the small scale sites including full radiological survey of 450 sites; and partial survey (radon monitoring) at 950 sites. There are approximately 4,800 small scale sites. Resurvey of these sites began in 2012 and is expected to continue into 2016.

Detailed design descriptions for the groups of small scale sites were submitted by AECL before licensing and accepted by CNSC staff. Following resurvey, AECL will submit site specific remediation plans for CNSC staff review and acceptance. The basic remediation strategy at all sites will involve the excavation of the contaminated material and transfer to the LTWMF. The clean-up criteria are given in appendix C to the current licence.

AECL is required, under licence condition 2.1, to conduct remedial work in accordance with the clean-up criteria specified in appendix C to the licence. AECL will verify completion of remedial activities utilizing its *Remediation Verification Standard Operating Procedure*. CNSC staff will conduct independent oversight and verification of remediation activities.

Procedures

AECL maintains a suite of procedures specifically applicable to the activities of the PHP. These procedures are designed to operate within the broader framework of AECL's corporate documented programs. During the review period, project-specific procedures relating to commissioning of the WTP and authorization of early works were submitted to the CNSC for review and acceptance.

Reporting and trending

As specified in licence condition 2.3, AECL is required to submit written reports for action level exceedances; quarterly liquid effluent monitoring; quarterly liquid effluent toxicity testing; annual compliance data; and a report of any failure that resulted in, or could have resulted in the release of a nuclear substance or hazardous substance from the facility. AECL has complied with the requirements for submission of these reports during the review period.

AECL reported three consecutive action level exceedances (0.0320mg/L, 0.0590 mg/L, and 0.051 mg/L) of arsenic in liquid effluent from the existing WTP in July 2013. The action level for arsenic is 0.0264 mg/L. AECL promptly instituted corrective actions and established a new procedure to prevent reoccurrence. No regulatory concerns were identified during CNSC staff's review of these event reports.

It should be noted that the events did not lead to an exceedance of the monthly effluent release limit for arsenic, as specified in appendix B of the licence (monthly average limit of 0.50 mg/L). For more information on these exceedances, see the environmental protection SCA section of this report.

Safety analysis

RATINGS FOR SAFETY ANALYSIS		
Overall Performance Ratings		
2011	2012	2013
N/A	N/A	N/A
Not applicable		

The "safety analysis" SCA covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards. There is no specific requirement for conducting safety analysis in support of an application for a Waste Nuclear Substance Licence, such as that which governs the PHP.

Physical design

RATINGS FOR PHYSICAL DESIGN		
Overall Performance Ratings		
2011	2012	2013
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "physical design" SCA at PHP as "satisfactory". AECL continues to implement internal verification processes to ensure licence and legislative requirements for facility design are met.		

The "physical design" SCA relates to activities that impact the ability of structures, systems and components (SSCs) to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

For the PHP, this SCA encompasses the following specific areas:

- Design governance
- Facility design

Design governance

All design and equipment changes are subject to the controls defined in the *PHAI Quality Assurance Plan*. Details on the plan can be viewed under the management system SCA.

AECL workers reviewing design drawings

Facility design

The detailed design documentation for the LTWMF and the WTP were assessed and accepted by CNSC staff prior to issuance of the licence, and are referenced in section 3.2.6 of the LCH. Under licence condition 2.6, AECL is required to conduct project activities in accordance with the design documentation.

The proposed new WTP is a two-stage treatment process with chemical precipitation and clarification followed by a reverse osmosis stage using specific membrane technology manufactured by "ROCHEM".

Because the Port Hope LTWMF is not a nuclear facility and the ROCHEM units will not be used as nuclear equipment, CNSC staff assigned non-nuclear Class 6 for the certification of the units. Consequently, CSA B51, *Boiler, pressure vessel, and pressure piping code*, is the governing standard for registration of the units with the Technical Standards and Safety Authority.

Fitness for service

RATINGS FOR FITNESS FOR SERVICE		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "fitness for service" SCA at PHP as "satisfactory". AECL continues to implement an acceptable program to ensure structures and equipment performs as its intended function.		

The "fitness for service" SCA covers activities that impact the physical condition of SSCs to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

For the PHP, this SCA encompasses the following specific areas:

- Equipment fitness for service / equipment performance (no significant observations to report)
- Maintenance
- Structural integrity (no significant observations to report)
- Aging management (no significant observations to report)

Maintenance

AECL continues to maintain the existing facilities in accordance with the previous licensee's (Cameco) operational procedures and protocols, as accepted by CNSC staff at the time of licensing.

Radiation protection

RATINGS FOR RADIATION PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "radiation protection" SCA at PHP as "satisfactory". AECL continues to implement and maintain a radiation protection program to control radiological hazards, ascertain doses to workers, and estimate doses to the public.		

The "radiation protection" SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled, and maintained as low as reasonably achievable (ALARA).

For the PHP, this SCA encompasses the following specific areas:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated dose to the public

AECL is required by the *Radiation Protection Regulations*, and licence condition 2.7, to implement and maintain a radiation protection program for the PHP. The *PHAI Radiation Protection Plan* is referenced in section 3.2.7 of the LCH and forms the primary compliance criteria for radiation protection.

Application of ALARA

The *PHAI Radiation Protection Plan* has been developed and implemented at PHP. It defines the radiation protection measures applicable to PHAI projects and is consistent with AECL's corporate radiation protection program.

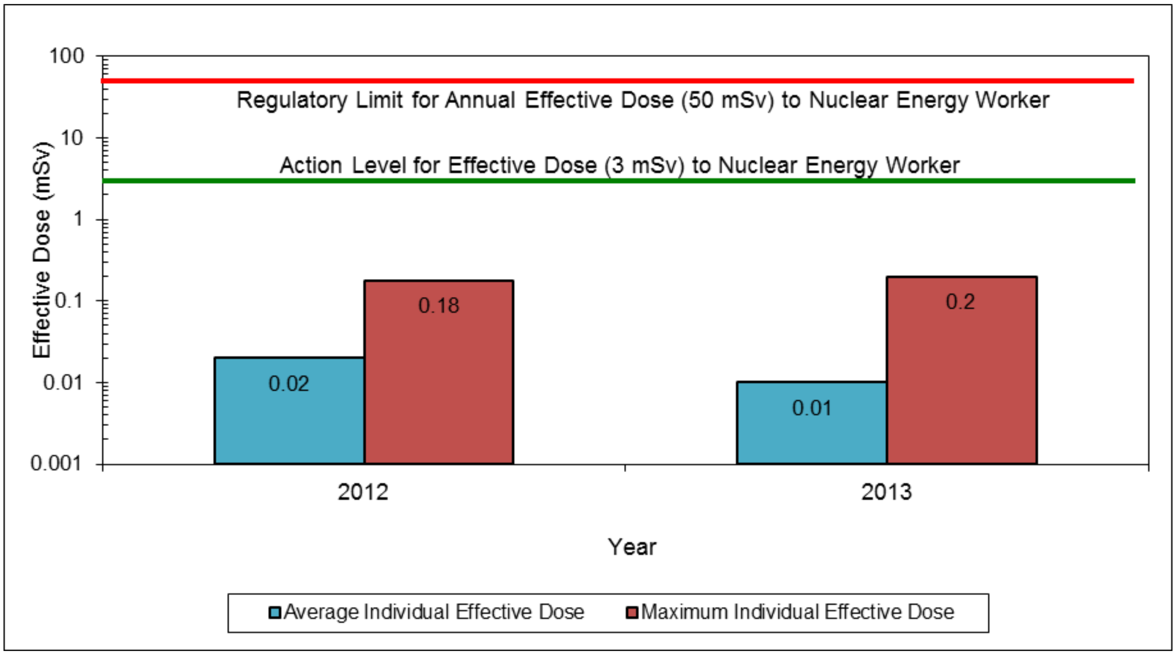
The *PHAI Radiation Protection Plan* describes the basis for protection from ionizing radiation, and for ascertaining and recording radiation exposures and doses during the PHP activities. It also defines a management framework and processes that are designed to ensure that radiation exposures arising from project activities will be maintained below regulatory dose limits and ALARA.

Worker dose control

The system to control radiation exposures and doses to workers is established in the *PHAI Radiation Protection Plan*. All employees working regularly at PHP wear thermo luminescent dosimeters (TLDs) for external radiation exposure monitoring; these are provided by AECL's licensed dosimetry service. To date, AECL has not monitored worker doses independently between the two projects (see figures 14 and 16).

CNSC staff have concluded, following review of AECL's dose data for PHP, that AECL adequately controlled radiation doses to workers during the review period. The maximum doses to workers were 0.18 mSv and 0.20 mSv in 2012 and 2013, respectively; this is well below the CNSC's regulatory effective dose limit for nuclear energy workers.

Figure 14: Effective dose statistics for nuclear energy workers at AECL's PHP



Radiation protection program performance

AECL's performance in its radiation protection program has been assessed through various CNSC compliance activities, including inspections and desktop reviews. CNSC staff's assessment is that, overall, AECL's compliance with the *Radiation Protection Regulations* and licence requirements has been acceptable.

AECL worker retrieving environmental TLD from perimeter fence

As part of the *PHAI Radiation Protection Plan*, AECL has established a number of action levels. Radon monitors are deployed in five separate locations onsite: four are located at the boundaries of the waste mound (north, south, east and west), and one is located at the operations trailer near the collection pond. An action level for occupational radiation exposure of 50 Bq/m^3 for radon was established by AECL for Phase II construction and remediation activities; this action level was being applied to the ambient radon concentration in air measured by these monitors.

During the review period, AECL reported a total of eight action level exceedances over all monitoring locations. An elevated radon concentration at the locations being monitored results in negligible risks to workers since it occurs at locations where currently persons are not located for long periods of time. CNSC staff conclude that the radiation dose action levels for workers implemented by AECL are effective to control both internal and external components of radiation dose, and the *PHAI Radiation Protection Plan* assures that appropriate protective measures are in place for workers.

Radiological hazard control

Site specific contamination control requirements are implemented by AECL at PHP, consistent with the *PHAI Radiation Protection Plan*. These requirements include personal protective equipment and clothing requirements for workers and visitors, and contamination monitoring checks for personnel and equipment. During the review period, there were no incidents of personnel contamination that resulted in a risk to workers or members of the public.

Estimated dose to the public

Under the *Radiation Protection Regulations*, AECL is required to estimate dose to the public due to the PHP. Environmental TLDs posted on the perimeter fence at the Port Hope WMF are utilized for this purpose.

Monitoring results for the review period indicate an estimated dose to the public well below the regulatory limit of 1 mSv/year.

Conventional health and safety

RATINGS FOR CONVENTIONAL HEALTH AND SAFETY		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "conventional health and safety" SCA at PHP as "satisfactory". AECL continues to maintain an acceptable conventional health and safety program as no lost-time injuries have occurred at PHP during the review period.		

The "conventional health and safety" SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

For the PHP, this SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness (no significant observations to report)

Performance

One of the key indicators of performance with respect to conventional health and safety is recordable lost-time injury incidents (RLTI). An RLTI is an injury that takes place at work and results in the worker being unable to return to work to carry out their duties for a period of time. In reviewing RLTIs, CNSC staff must also consider the severity of these injuries (e.g. the total days lost) and the frequency as they relate to the size of the workforce. The severity rate is a measure of the total number of days lost due to injury for every 200,000 person-hours worked at a site and the frequency is the number of fatalities and injuries (lost time and medically treated) due to accidents for every 200,000 person-hours worked at a site.

As can be seen from table 11, AECL has had no lost-time injury incidents at PHP.

Table 11: Recordable lost-time injuries (RLTI), frequency and severity at PHP 2011-2013

Year	RLTIs	RLTI Frequency	RLTI Severity
2011	0	0	0
2012	0	0	0
2013	0	0	0

Practices

In addition to the *Nuclear Safety and Control Act* and its regulations, project activities at the PHP must comply with Part II of the *Canada Labour Code*, the *Canada Occupational Health and Safety Regulations* and other applicable federal and provincial health and safety-related acts and regulations.

Under licence condition 2.8, AECL is required to have a program for occupational health and safety for the PHP. The *PHAI Occupational Safety and Health (OSH) Plan*, which is referenced in section 3.2.8 of the LCH, is the primary criteria for assessing compliance, and defines the OSH program applicable to the PHP. It is consistent with AECL's corporate OSH program which covers the company-wide procedures, training, oversight and reporting. The plan also includes oversight mechanism to ensure that all workers, including contractors, follow proper health and safety procedures.

The Port Hope/Port Granby Site Safety and Health Committee oversees site specific health and safety matters, meets a minimum of nine times per year, and conducts regular site inspections.

Environmental protection

RATINGS FOR ENVIRONMENTAL PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "environmental protection" SCA at PHP as "satisfactory". AECL continues to implement and maintain an acceptable environmental program, and effectively monitors and controls effluent releases.		

The "environmental protection" SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

For the PHP, this SCA encompasses the following specific areas:

- Effluent and emissions control (releases)
- Assessment and monitoring

Effluent and emissions control (releases)

Licence conditions 2.9 and 2.10 require AECL to implement an environmental protection program, and to monitor and control releases to the environment, respectively. These requirements pertain specifically to liquid effluent releases, as there are no atmospheric release limits for this site. AECL has implemented programs to meet these requirements at the PHP including the *Environmental Management and Protection Plan for On-Site Construction and Remediation Activities* and the *Environmental Monitoring Plan*, both of which are consistent with AECL's corporate environmental management system.

CNSC staff reviewed the data submitted for the review period and found that all treated liquid effluent releases were monitored and no exceedances of the licence release limits occurred. Similarly, tests for toxicity conducted over the same timeframe demonstrated that the effluent was non-acutely lethal. Effluent monitoring results for this period can be found in appendix F.

CNSC staff conducted a general assessment of facility operations during an inspection in October 2013. At that time, analytical results for samples collected during the inspection were well below the release limits specified in the licence.

As specified in section 3.2.9 of the LCH, action level exceedances are reportable by AECL when three consecutive exceedances occur. AECL reported three consecutive exceedances of arsenic in July 2013. The WTP was shut down, and effluent was re-circulated for further treatment as per AECL's procedure. Following internal investigation, AECL determined that seasonal dry periods, which increase arsenic concentrations, combined with the necessity to continue operation of the WTP to maintain safe levels in the east collection pond, had resulted in the exceedances. The capacity in the east collection pond had been significantly reduced as a result of construction activities. AECL subsequently issued the *Brand Road Welcome Waste Management Facility Effluent Action Level Exceedance Mitigation Procedure* to address this issue. CNSC staff are satisfied with AECL's investigation and the corrective actions taken.

Regulatory oversight with respect to environmental protection is also provided by Environment Canada and the Ontario Ministry of Environment. In 2013, a joint regulatory group comprising the CNSC, Environment Canada and the Ontario Ministry of Environment was established to coordinate regulatory oversight in this area.

Assessment and monitoring

<u>Groundwater monitoring</u>

Groundwater monitoring for radium-226, arsenic, and pH is conducted at the Welcome WMF in order to identify changes in groundwater conditions around the site. The results of groundwater sampling conducted in 2013 were consistent with the historical groundwater monitoring data from Cameco, the former licensee.

Offsite surface water monitoring

Offsite surface water monitoring for arsenic, radium-226, uranium, and pH was conducted on a monthly basis at Brand's Creek, the main stream in the watershed, which is located west of the Welcome WMF.

CNSC staff reviewed the results of this sampling for 2013 and found that concentrations of these contaminants remain within background levels.

Brand Creek environmental monitoring

Environmental assessment follow-up monitoring

As required under licence condition 2.11, AECL is continuing to conduct environmental assessment follow-up monitoring to obtain environmental baseline data, including offsite suspended particulate matter, groundwater, soil, sediment, surface water, and drainage water.

Emergency management and fire protection

RATINGS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "emergency management and fire protection" SCA at PHP as "satisfactory". AECL maintains an acceptable emergency response plan, and has arranged service agreements with local emergency response organizations.		

The "emergency management and fire protection" SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

For the PHP, this SCA encompasses the following specific areas:

- Conventional emergency preparedness and response
- Fire emergency preparedness and response

AECL is required to have an emergency preparedness program under licence condition 2.12. The *PHAI Emergency Plan*, which is consistent with AECL's corporate emergency preparedness program, describes planning and operational requirements for response to an emergency directly or indirectly affecting the PHP during Phase II. The *PHAI Emergency Plan* is referenced in section 3.2.10 of the LCH and forms the primary compliance verification criteria for this SCA.

Conventional emergency preparedness and response

In 2012, AECL signed emergency response agreements/memorandums of understanding with the Northumberland County Emergency Medical Services, Port Hope Police Services, and Northumberland Ontario Provincial Police. The PHAI does not have dedicated security or fire personnel.

Fire emergency preparedness and response

Fire has been identified as one of the potential hazards associated with PHP sites and buildings. However, because PHP is not a nuclear facility, the specific area of fire emergency preparedness and response is not addressed separately in this report. Mitigation measures and response to fire incidents are covered in the *PHAI Emergency Plan* and the emergency response agreements/memorandums of understanding as noted above.

Waste management

RATINGS FOR WASTE MANAGEMENT		
Overall Performance Ratings		
2011	**2012**	**2013**
N/A	N/A	N/A
Not applicable		

The "waste management" SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning. This SCA is not relevant to the PHP as waste management is the core operation for the project. The PHP is a remediation project to provide suitably constructed, environmentally safe, socially acceptable and appropriately controlled long-term management for historic LLRW.

Security

RATINGS FOR SECURITY		
Overall Performance Ratings		
2011	**2012**	**2013**
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "security" SCA at PHP as "satisfactory". AECL continues to implement and maintain an acceptable security program for the PHP.		

The "security" SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

For the PHP, this SCA encompasses the following specific area:

- Security practices

Security practices

In response to licence condition 2.13, which requires that a security program be in place for the PHP, AECL has implemented the *PHAI Security Plan* that establishes the security arrangements required for the PHAI projects.

Safeguards and non-proliferation

RATINGS FOR SAFEGUARDS AND NON-PROLIFERATION		
Overall Performance Ratings		
2011	2012	2013
N/A	N/A	N/A
Not Applicable		

The "safeguards and non-proliferation" SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements, as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.

No safeguarded material is currently stored at the Welcome WMF; consequently, the SCA for safeguards does not apply. However, discussions are ongoing between CNSC staff and the IAEA with respect to currently-safeguarded material stored at Cameco's Port Hope Conversion Facility and that is destined for the Port Hope LTWMF. CNSC staff requested that IAEA reconsider their proposal to install IAEA neutron slabs to monitor the transfer of safeguarded material to the Port Hope LTWMF and proposed, instead, that an inspection-based scheme be employed. In order to accept the safeguarded wastes at Port Hope LTWMF, AECL will be required to implement a safeguards program based on criteria established via this dialogue.

Packaging and transport

RATINGS FOR PACKAGING AND TRANSPORT		
Overall Performance Ratings		
2011	2012	2013
Not rated	SA	SA
For the review period, CNSC staff continue to rate the "packaging and transport" SCA at PHP as "satisfactory". AECL continues to implement and maintain an acceptable program for radioactive material in anticipation of waste transfer slated to begin in 2015.		

The "packaging and transport" SCA covers programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

For the PHP, this SCA encompasses the following specific area:

- Packaging and transport

Packaging and transport

AECL has in place the *PHAI Radioactive Material Transportation Plan* to govern transport of radioactive material. During the review period, no radioactive material was transported.

3.3 Port Granby Project

3.3.1 Overview

Located in the Municipality of Clarington, the Port Granby WMF contains LLRW including process residues, scrap equipment, industrial trash and soils that were received at the site between 1955 and 1988. The waste storage area is a relatively flat central plateau that terminates in steep bluffs, falling approximately 35 metres to the shore of Lake Ontario. On either side of the central plateau are east or west gorges; it was into these gorges that wastes were initially placed. Later trenches were dug in the central plateau and were used to house wastes.

Figure 15: The Port Granby waste management facility

(Source: AECL)

The purpose of the Port Granby Project (PGP) is to construct a new LTWMF, away from the shores of Lake Ontario, and to provide long-term storage for the contents of the existing WMF, which will then be remediated.

PGP activities include the construction and operation of the LTWMF; construction of the new WTP; remediation of the existing Port Granby WMF; and decommissioning of the existing WTP.

The PGP is being conducted in three phases – transition, implementation and closure.

- Phase I (transition) activities are confined to the continued operation, care and maintenance of the Port Granby WMF, assumed from Cameco in March 2010
- Phase II (implementation) activities include the operation, care and maintenance of the Port Granby WMF, development of the new LTWMF, and remediation of the existing WMF
- Phase III (closure) activities include long-term maintenance and monitoring of the Port Granby LTWMF

In 2014, the third year of Phase II of the PGP, AECL is preparing for construction of the LTWMF, and completing construction of the new WTP. As the project proceeds, AECL continues to inform and engage the public through various mechanisms under its public information program including the Port Granby Citizen Liaison Group. Further details regarding the public information program can be found in section 3.1 of this report.

Phase II activities are governed under the PGP licence [16], which was issued in November 2011. Under that licence, AECL is required to implement programs to ensure compliance with the accepted design, safe conduct of the approved activities and protection of people and the environment. These programs are referenced in the LCH [17].

CNSC staff continue to verify implementation of AECL's programs with respect to this project and assess them against the performance objectives and compliance verification criteria defined in the regulations, the licence and the LCH. Verification includes desktop reviews and site inspections. Many program documents referenced in the LCH are currently undergoing revision; desktop reviews of these will be conducted by CNSC staff. The most recent site inspection was conducted on October 29, 2013.

As previously stated, the information presented per SCA is very similar between the two projects. It is important to separate the two projects into distinct sections because the information that will be included in future annual reports will differ as the projects progress independently. An update on the status of the PGP by SCA follows. Ratings are provided for each SCA for 2011, 2012 and 2013. In 2011, the ratings assessed for each SCA were based on information submitted in support of the licence application. In 2012 and 2013, the ratings for each SCA were based on CNSC's staff assessment for the review period that calendar year. The review period for PGP includes 2013, and provides recent updates on key issues through June 30, 2014.

Many of the specific areas under the SCAs do not apply to the PGP, and this is reflected in the discussion below. This is due largely to the nature of the project. Unlike CRL and WL, the PGP is not a nuclear facility. Further, many of the activities in Phase II, upon which AECL embarked with the issuance of the current licence, involve conventional construction, for example construction of the new WTP.

3.3.2 Safety and Control Areas

Table 12 presents the ratings for PGP for the year 2013. All SCA ratings are "satisfactory" for the reporting period which remains unchanged from reports previously made to the Commission [18].

Table 12: Performance ratings for Port Granby Project, 2013

Safety and control area	Rating
Management system	**SA**
Human performance management	**SA**
Operating performance	**SA**
Safety analysis	**N/A**
Physical design	**SA**
Fitness for service	**SA**
Radiation protection	**SA**
Conventional health and safety	**SA**
Environmental protection	**SA**
Emergency management and fire protection	**SA**
Waste management	**N/A**
Security	**SA**
Safeguards and non-proliferation	**N/A**
Packaging and transport	**SA**

Notes:

- For specific areas within the SCAs where there were no significant observations from CNSC's staff compliance verification activities, no information is given in the subsection of the report
- The information presented below is site specific; general trends are not identified

Management system

RATINGS FOR MANAGEMENT SYSTEM		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continues to rate the "management system" SCA for the PGP as "satisfactory". AECL continues to implement the *PHAI Quality Assurance Plan*, and conducts oversight activities.		

The "management system" SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture. For the PGP, this SCA encompasses the following specific areas:

- Management system
- Operating experience
- Safety culture

- Records management (no significant observations to report)
- Management of contractors

Management system

The activities of the PGP are broadly governed under AECL's corporate management system, and more specifically guided by the *PHAI Quality Assurance Plan*. The plan summarizes the processes and practices applicable to the PHAI licensed activities during execution of Phase II and clarifies the extent of their applicability to participants. These processes and practices satisfy the requirements identified above and comply with the quality management system defined in CSA-ISO 9001:08 *Quality Management Systems – Requirements.* The quality assurance plan (and adherence to it) is a requirement of condition 2.3 of the licence.

Operating experience

As previously stated in the report, the OPEX program at AECL comprises the processes that ensure the organization uses the experience both from within the organization and from industry peers to improve the safety of operations, improve operational performance, and reduce the significance and the occurrence of unplanned events.

PGP reviews OPEX bulletins for relevance and applicability through the Improvement Action process.

Safety culture

AECL staff receives mandatory training in Human Performance to help reduce human error and thus, the frequency and severity of events at AECL. Initiatives of AECL's Human Performance Branch are designed, amongst other things, to strengthen AECL's safety culture.

During the review period, safety culture related training conducted for PGP staff included *Leadership Academy; Field Observation and Coaching Fundamentals; Nuclear Safety Culture Workshop; Communicating for Leadership Success and Building Trust;* and *Coaching for Peak Performance*.

Management of contractors

AECL's responsibilities within the PHAI Management Office include defining the licence requirements to be included in contracts awarded by PWGSC for the execution of construction and remediation activities. AECL conducts oversight to ensure licence requirements are met. The *PHAI Oversight Procedure* governs how AECL oversight is conducted to confirm compliance with licensing commitments, technical requirements, and contractual obligations.

Within the review period, AECL conducted oversight of the construction of the new WTP and the Elliott Road upgrades.

Human performance management

RATINGS FOR HUMAN PERFORMANCE MANGEMENT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "human performance management" SCA at PGP as "satisfactory". AECL continues to implement an acceptable training program to ensure staff has the necessary skills and knowledge to safely carry out their duties.		

The "human performance management" SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are available in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. For the PGP, this SCA encompasses the following specific area:

- Personnel training

Personnel training

A training program, and adherence to it, is a requirement of the PGP licence. To meet this obligation, AECL has implemented the *PHAI Training Plan*. During the review period, AECL conducted 41 training courses for PGP including those reported under "safety culture", as listed in "safety culture".

CNSC staff conducted a general assessment of facility operations in October 2013. At that time, CNSC staff reviewed training records for facility managers and operational staff and found them complete. AECL's corporate database is utilized to identify and track training needs, and to file staff training records.

Operating performance

RATINGS FOR OPERATING PERFORMANCE		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "operating performance" SCA at PGP as "satisfactory". AECL continues to meet licence and legislative requirements in conducting Phase II activities, implementing procedures and reporting on activities.		

The "operating performance" SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

For the PGP, this SCA encompasses the following specific areas:

- Conduct of licensed activity
- Procedures
- Reporting and trending

Conduct of licensed activity

Licensed activities for Phase II, the current phase of the PGP, include:

- the operation of the existing Port Granby Waste Management Facility (WMF)
- the construction of the new Water Treatment Plant (WTP)
- the construction of the new Long-Term Waste Management Facility (LTWMF) and remediation of the existing WMF

Operation of the existing Port Granby Waste Management Facility

The Port Granby WMF was transferred from Cameco to AECL on March 29, 2012. At that time, AECL was authorized by the licence to continue operation and maintenance of the existing Port Granby WMF, as per the operational procedures and protocols specified in the *Licensing Manual – Information in Support of the Port Granby Long-Term Low-Level Radioactive Waste Management Project Licence Application*.

Construction of the new Water Treatment Plant

AECL is required, under licence condition 2.7, to construct the new WTP in accordance with design documentation specified in section 3.2.7 of the LCH. Construction of the WTP is being managed and overseen by PWGSC; AECL continues to conduct oversight activities for construction of the new WTP.

The building envelope of the new WTP was completed in the fall of 2013. Fitting of the building with water treatment equipment is ongoing.

The plan for active commissioning has been submitted by AECL, as required under section 3.2.7 of the LCH, and accepted by CNSC staff.

Construction of the Long-Term Waste Management Facility and Remediation of Port Granby Waste Management Facility

The tendering process for the final construction contract for the new LTWMF is underway. The contract will include the construction of the Lakeshore Road underpass, removal of LLRW from the existing WMF and emplacement in the new LTWMF, and remediation of the existing WMF.

Potentially contaminated trees currently growing on the existing WMF must be removed to facilitate excavation activities. AECL has developed a plan for assessing the contamination of the trees which includes core sampling a select number of trees and scanning for contamination. AECL has identified and tagged the trees which will be sampled. The strategy for removal and disposal of the trees that will be determined based on the assessment results.

In 2009, Leader Resources Corp. proposed to construct a renewable energy project, consisting of five wind turbines, on property adjacent to the Port Granby LTWMF. AECL subsequently commissioned an independent study to evaluate the impact of the proposed project on AECL's dust management plan. AECL's response is consistent with the broad responsibility of licensees to assess external hazards to ensure the ongoing safe operation of their facility. The study concluded that the wakes from the proposed wind turbines will not impact AECL's operations with respect to data collection and dust management. Currently, Leader Resources Corp.'s application for a Renewable Energy Approval remains under review by the Ontario Ministry of Environment and Climate Change. CNSC staff will continue to monitor the progress of the wind turbine project to ensure that AECL's licensing requirements continue to be met.

Procedures

AECL maintains a suite of procedures specifically applicable to the activities of the PGP. These procedures are designed to operate within the broader framework of AECL's corporate documented programs. During the review period, project-specific procedures relating to commissioning of the WTP and to investigation of toxicity test failures were submitted to the CNSC for review and acceptance.

Reporting and trending

As specified in licence condition 2.4, AECL is required to submit written reports for action level exceedances; quarterly liquid effluent monitoring; quarterly liquid effluent toxicity testing; annual operational and compliance data; any failure that resulted in, or could have resulted in the release of a nuclear substance or hazardous substance from the facility; and quarterly project progress. Written reports at completion of project activities are also required.

Safety analysis

RATINGS FOR SAFETY ANALYSIS		
Overall Performance Ratings		
2011	**2012**	**2013**
N/A	N/A	N/A
Not applicable		

►

The "safety analysis" SCA covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility, and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards. There is no specific requirement for conducting safety analysis in support of an application for a Waste Nuclear Substance Licence, such as that which governs the PGP.

Physical design

RATINGS FOR PHYSICAL DESIGN		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "physical design" SCA at PGP as "satisfactory". AECL continues to implement and maintain an internal verification process to ensure licence and legislative requirements for facility design are met.		

The "physical design" SCA relates to activities that impact the ability of SSCs to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

For the PGP, this SCA encompasses the following specific areas:

- Design governance
- Facility design

Design governance

All design and equipment changes are subject to the controls defined in the *PHAI Quality Assurance Plan*. Details on this plan can be viewed under the management system SCA.

Facility design

The detailed design documentation for the LTWMF and the WTP were assessed and accepted by CNSC staff prior to issuance of the licence, and are referenced in section 3.2.7 of the LCH.

The plan for active commissioning has been submitted by AECL, as required under section 3.2.7 of the LCH, and has been accepted by CNSC staff. Commissioning of the WTP is expected to take place during the summer of 2014.

Fitness for service

RATINGS FOR FITNESS FOR SERVICE		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "fitness for service" SCA at PGP as "satisfactory". AECL continues to implement and maintain an acceptable program for maintenance at the Port Granby WMF.		

The "fitness for service" SCA covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

For the PGP, this SCA encompasses the following specific areas:

- Equipment fitness for service / equipment performance (no significant observations to report)
- Maintenance
- Structural integrity
- Aging management (no significant observations to report)

As the existing WMF and WTP are replaced by the new LTWMF and WTP, reporting under specific areas not relevant during this review period is anticipated.

Maintenance

AECL continues to maintain the existing facilities in accordance with the previous licensee's (Cameco) operational procedures and protocols, as referenced in section 2.4.1 of the LCH.

For the new facilities (LTWMF and WTP), AECL will be required to develop new procedures which will be incorporated into the LCH.

Structural integrity

Geo-technical inspections are conducted semi-annually by AECL to ensure that the integrity of the existing WMF is not compromised by erosion or slope instability.

Port Granby Bluffs

Further assessments for remedial actions are triggered, if active erosion extends to within 15 metres horizontally of the upper fence line. Verification conducted by CNSC staff during the review period included desktop reviews of reports produced by AECL's geotechnical consultants. CNSC staff also conducted a geo-technical inspection in August 2013. Based on these verification activities, CNSC staff concluded that, for the review period, the integrity of the existing WMF was not at risk and no remedial actions were required.

Radiation protection

RATINGS FOR RADIATION PROTECTION		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "radiation protection" SCA at PGP as "satisfactory". AECL continues to implement and maintain a radiation protection program to control radiological hazards, ascertain doses to workers, and estimate doses to the public.		

The "radiation protection" SCA covers the implementation of a radiation protection program, in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled, and maintained as low as reasonably achievable (ALARA).

For the PGP, this SCA encompasses the following specific areas:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated dose to the public

Application of ALARA

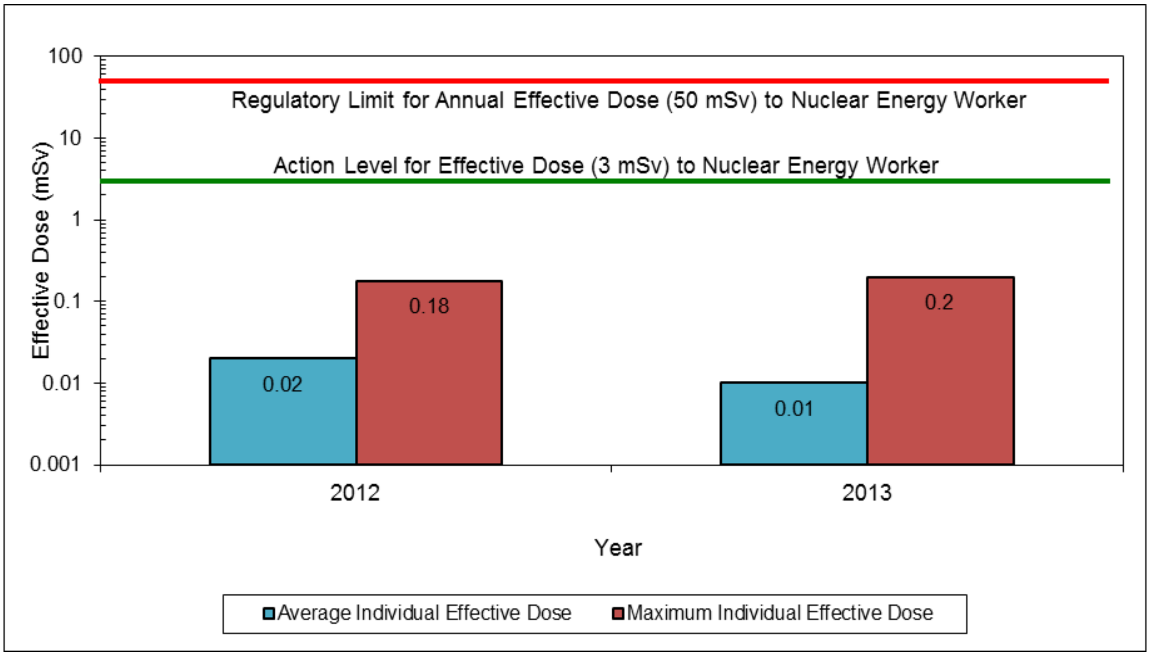
As required by the *Radiation Protection Regulations* and by its licence, AECL continues to implement the *PHAI Radiation Protection Plan* for the PGP. The *PHAI Radiation Protection Plan* defines the radiation protection measures applicable to PGP, consistent with AECL's corporate radiation protection program. The *PHAI Radiation Protection Plan* describes the basis for protection from ionizing radiation, and for ascertaining and recording radiation exposures and doses during the PGP activities. It also defines a management framework and processes designed to ensure that radiation exposures arising from project activities will be maintained below regulatory dose limits and ALARA.

Worker dose control

The system to control radiation exposures and doses to workers is established in the *PHAI Radiation Protection Plan*, implemented for PGP. All employees working regularly at PGP wear TLDs for external radiation exposure monitoring, provided by AECL's in-house licensed dosimetry service. To date, AECL has not monitored worker doses independently between the two projects (see figures 14 and 16).

CNSC staff have concluded, following review of AECL's dose data, that AECL adequately controlled radiation doses to workers at PGP during the review period. The maximum doses to workers were 0.18 mSv and 0.20 mSv in 2012 and 2013, respectively; this is well below the CNSC's regulatory effective dose limit for nuclear energy workers.

Figure 16: Effective dose statistics for nuclear energy workers at AECL's PGP



Radiation protection program performance

AECL is required by the *Radiation Protection Regulations* and licence condition 2.8, to implement and maintain a radiation protection program for the PGP. The *PHAI Radiation Protection Plan* is referenced in section 3.2.8 of the LCH and forms the primary compliance criteria for radiation protection. Action levels for occupational radiation exposure from Phase II activities are also referenced in the LCH.

AECL's performance in radiation protection has been assessed through various CNSC compliance activities including desktop reviews and inspections. CNSC staff's assessment is that, overall, AECL's compliance with the *Radiation Protection Regulations* and CNSC licence requirements has been acceptable.

As part of the *PHAI Radiation Protection Plan*, AECL has established a number of action levels. Radon monitors are deployed in five separate locations on site: at the boundaries of the buried waste, and near the lagoon. An action level for occupational radiation exposure of 50 Bq/m^3 for radon was established by AECL for Phase II construction and remediation activities; this action level was being applied to the ambient radon concentration in air measured by these monitors.

During the review period, AECL reported three exceedances of this action level at three of the five monitoring locations. An elevated radon concentration at the locations being monitored result in negligible risks to workers, since it occurs at locations where currently persons are not located for long periods of time. CNSC staff conclude that the radiation dose action levels for workers implemented by AECL are effective in the control of both internal and external components of radiation dose, and the *PHAI Radiation Protection Plan* assures that appropriate protective measures are in place for workers.

Radiological hazard control

Site specific contamination control requirements are implemented by AECL at PGP, consistent with the *PHAI Radiation Protection Plan*. These requirements include personal protective equipment and clothing requirements for workers and visitors, and contamination monitoring checks for personnel and equipment. During the review period, there were no incidents of personnel contamination that resulted in a risk to workers or members of the public.

Estimated dose to the public

Under the *Radiation Protection Regulations*, AECL is required to estimate dose to the public due to the PGP. Environmental TLDs posted on the perimeter fence at the Port Granby WMF are utilized for this purpose.

Monitoring results for the review period indicate an estimated dose to the public is well below the regulatory limit of 1 mSv/year.

Conventional health and safety

RATINGS FOR CONVENTIONAL HEALTH AND SAFETY		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "conventional health and safety" SCA at PGP as "satisfactory". AECL continues to maintain an acceptable conventional health and safety program and has had no lost-time injuries at PGP during the review period.		

The "conventional health and safety" SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

For the PGP, this SCA encompasses the following specific areas:

- Performance
- Practices
- Awareness (no significant observations to report)

Performance

One of the key indicators of performance with respect to conventional health and safety is recordable lost-time injury incidents (RLTI). An RLTI is an injury that takes place at work and results in the worker being unable to return to work to carry out their duties for a period of time. In reviewing RLTIs, CNSC staff must also consider the severity of these injuries (e.g., the total days lost) and the frequency as they relate to the size of the workforce. The severity rate is a measure of the total number of days lost due to injury for every 200,000 person-hours worked at a site and the frequency is the number of fatalities and injuries (lost time and medically treated) due to accidents for every 200,000 person-hours worked at a site.

As can be seen from table 13 below, AECL has had no lost-time injury incidents at PGP.

Table 13: Recordable lost-time injuries (RLTI), frequency and severity at PGP, 2011-2013

Year	RLTIs	RLTI Frequency	RLTI Severity
2011	0	0	0
2012	0	0	0
2013	0	0	0

Practices

In addition to the *Nuclear Safety and Control Act* and its associated regulations, all project activities at the PGP must comply with Part II of the *Canada Labour Code*, the *Canada Occupational Health and Safety Regulations* and other applicable federal and provincial health and safety-related acts and regulations.

Under licence condition 2.9, AECL is required to have a program for occupational health and safety for the PGP. The *PHAI Occupational Safety and Health (OSH) Plan*, which is referenced in section 3.2.9 of the LCH, defines the OSH program applicable to the PGP. It is consistent with AECL's corporate OSH program which covers the company-wide procedures, training, oversight and reporting. The plan includes an oversight mechanism to ensure that all workers, including contractors, follow proper health and safety procedures.

The Port Hope/Port Granby Site Safety and Health Committee oversees site specific health and safety matters, meets a minimum of nine times per year, and conducts regular site inspections.

Environmental protection

RATINGS FOR ENVIRONMENTAL PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "environmental protection" SCA at PGP as "satisfactory". AECL continues to implement and maintain an acceptable environmental program, to effectively monitor and control effluent releases.		

The "environmental protection" SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

For the PGP, this SCA encompasses the following specific areas:

- Effluent and emissions control (releases)
- Assessment and monitoring

Effluent and emissions control (releases)

AECL is required, by the licence, to implement an environmental protection program and to monitor and control releases to the environment. This pertains specifically to liquid effluent releases as there are no atmospheric release limits for this site. AECL has implemented programs to meet these requirements at the PGP including the *Environmental Management and Protection Plan for On-Site Construction and Remediation Activities* and the *Environmental Monitoring Plan*, both of which are consistent with AECL's corporate environmental management system.

CNSC staff reviewed data submitted for the review period and found that all treated liquid effluent releases were monitored and no exceedances of the licence release limits occurred. Similarly, tests for toxicity conducted over the same timeframe demonstrated that the effluent was non-acutely lethal. Effluent monitoring results for this period can be found in appendix F.

CNSC staff conducted a general assessment during an inspection in October 2013. Analytical results for samples collected during that inspection were well below the release limits specified in the licence.

AECL reported a toxicity test failure for the WTP effluent in January 2013. Following an investigation (by AECL and CNSC staff), laboratory error was determined to be the cause. As a result of this event, AECL has developed a procedure for investigating toxicity test failures which has been reviewed and accepted by CNSC staff.

AECL is currently characterizing contaminants in the groundwater stream collected from the northern perimeter sub-drain in order to assess whether they could pose an unreasonable risk to the environment. This stream is combined with the treated effluent forming the total interceptor discharge stream which is monitored prior to release into Lake Ontario. The work is being done at the request of CNSC staff, based on observations of potentially elevated contaminant concentrations in this stream.

Assessment and monitoring

AECL continues to implement environmental monitoring programs that establish baseline conditions around the site. These include groundwater monitoring, bluff seepage monitoring, geo-technical monitoring, and environmental assessment follow-up monitoring.

<u>Groundwater monitoring</u>

Groundwater monitoring for radium-226, arsenic, uranium, fluoride, nitrate and ammonium is conducted at the Port Granby WMF in order to identify changes in groundwater conditions around the site. The results of groundwater sampling conducted in 2012 and 2013 are consistent with the historical groundwater monitoring data.

<u>Bluff seepage monitoring</u>

Bluff seepage from the south bluffs at Port Granby WMF has been sampled for radium-226, arsenic, uranium and total suspended solids on a quarterly basis since June 2012, at the request of CNSC staff. Results submitted for the review period indicate there is no unreasonable impact to the aquatic environment.

<u>Environmental assessment follow-up monitoring</u>

As required under licence condition 2.12, AECL continues to conduct environmental assessment follow-up monitoring to obtain environmental baseline data, including offsite suspended particulate matter, noise, groundwater, soil, sediment, surface water and drainage water. CNSC staff have reviewed the results for the review period and found that the offsite environmental quality data were within environmental background level or below the PHAI cleanup criteria.

Emergency management and fire protection

RATINGS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "emergency management and fire protection" SCA at PGP as "satisfactory". AECL continues to implement an acceptable emergency response plan.		

The "emergency management and fire protection" SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

For the PGP, this SCA encompasses the following specific areas:

- Conventional emergency preparedness and response
- Fire emergency preparedness and response

AECL is required, under licence condition 2.13, to have an emergency preparedness program for the PGP. The *PHAI Emergency Plan*, which is consistent with AECL's corporate emergency preparedness program, describes planning and operational requirements for response to an emergency directly or indirectly affecting the PGP during Phase II activities. The *PHAI Emergency Plan* is referenced in section 3.2.11 of the LCH and forms the primary compliance criteria for emergency management and fire protection.

Conventional emergency preparedness and response

In 2012, AECL signed emergency response agreements/memorandums of understanding with the Whitby Detachment of the Ontario Provincial Police, Durham Regional Police Service, Durham Region EMS and Clarington Fire Services. The PGP does not have dedicated security or fire personnel due to the size, location and nature of the project.

Subsequent to signing the emergency response agreements/memorandums of understanding, AECL developed the *PHAI Incident Response Coordination Procedure.* This procedure describes responsibilities of PHAI management office personnel and the processes used for planning and managing response to emergencies/incidents under the *PHAI Emergency Plan*.

Fire emergency preparedness and response

Fire has been identified as one of the potential hazards associated with PGP sites and buildings. However, as PGP is not a nuclear facility, the specific area of fire emergency preparedness and response is not addressed separately in this report. Mitigation measures and response to fire incidents are covered in the *PHAI Emergency Plan* and the emergency response agreements/memorandums of understanding as noted above.

Waste management

RATINGS FOR WASTE MANAGEMENT		
Overall Performance Ratings		
2011	**2012**	**2013**
N/A	N/A	N/A
Not applicable		

The "waste management" SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning. This SCA is not relevant to the PGP, because waste management is the core operation for the project. The PGP is a remediation project to provide suitably constructed, environmentally safe, socially acceptable and appropriately controlled long-term management for historic low-level radioactive waste.

Security

RATINGS FOR SECURITY		
Overall Performance Ratings		
2011	**2012**	**2013**
SA	SA	SA
For the review period, CNSC staff continue to rate the "security" SCA at PGP as "satisfactory". AECL continues to implement and maintain an acceptable security program for the PGP.		

The "security" SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

For the PGP, this SCA encompasses the following specific area:

- Security practices

Security Practices

AECL is required, under section 3.2.12 of the LCH to have a security program for the PGP. In response, AECL has implemented the *PHAI Security Plan* that establishes the security arrangements required for the PHAI projects.

Safeguards and non-proliferation

RATINGS FOR SAFEGUARDS AND NON-PROLIFERATION		
Overall Performance Ratings		
2011	2012	2013
N/A	N/A	N/A
Not Applicable		

The "safeguards and non-proliferation" SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements, as well as all other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

This SCA is not relevant to the PGP as the material that will be handled under this remediation project has no obligations arising from the Canada/IAEA safeguards agreement.

Packaging and transport

RATINGS FOR PACKAGING AND TRANSPORT		
Overall Performance Ratings		
2011	2012	2013
SA	SA	SA
For the review period, CNSC staff continue to rate the "packaging and transport" SCA at PGP as "satisfactory". AECL continues to implement and maintain an acceptable program for radioactive material in anticipation of waste transfer slated to begin in 2015.		

The "packaging and transport" SCA covers programs for the safe packaging and transport of nuclear substances to and from the licensed facility.

For the PGP, this SCA encompasses the following specific area:

- Packaging and transport

Packaging and transport

AECL has implemented the *PHAI Radioactive Material Transportation Plan* to govern transport of radioactive material. The plan meets regulatory requirements and is consistent with AECL's corporate program for radioactive material transportation. Under this plan, contaminated material will be transported to the LTWMF via the prescribed internal haul routes. No waste will be transported on public roads. During the review period, no radioactive material was transported.

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REFERENCES

[1] *Nuclear Research and Test Establishment Operating Licence, Atomic Energy of Canada Limited*, NRTEOL-01.01/2016 (e-Doc 4419693).

[2] NRTEOL-LCH-01, *Licence Conditions Handbook for Chalk River Laboratories*, Revision 1, February 15, 2013 (e-Doc 4073666).

[3] Letter from C. Nache to T. Arthur, *Update Number 1 to the CRL Handbook NRTEOL-LCH-01, Revision 1*, dated August 14, 2013 (e-Doc 4113894).

[4] CMD 13-M14: *Report for the Performance of Atomic Energy of Canada Limited Chalk River Laboratories*, dated February 2, 2013 (e-Doc 4033119).

[5] CMD 19-M25: *Significant Development Report No. 2009-1*, dated June 11, 2009 (e-Doc 3382610).

[6] CMD 13-M27: *Event Initial Report Atomic Energy of Canada Limited: NRU Reactor - Operator Error on February 27, 2013*, dated May 15, 2013 (e-Doc 4120367).

[7] Record of Proceedings, Including Reasons for Decision in the Matter of Atomic Energy of Canada Limited, *Application for Approval to Operate the Fuel Packaging and Storage Facility*, March 18, 2014 (e-Doc 4404833).

[8] AECL's Dosimetry Service Licence No. 20004-17-16.3 (e-Doc 4044699).

[9] Event Initial Report: *AECL Dosimetry Licence: Late Submission of Dose Records to the National Dose Registry*, dated May 17, 2013 (e-Doc 4138036).

[10] *Whiteshell Laboratories Decommissioning Licence*, NRTEDL-08.02/2018 (e-Doc 3987115).

[11] CMD 12-M47: *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* (e-Doc 3990749)

[12] Legal Agreement between Natural Resources Canada, Town of Port Hope, Township of Hope and Municipality of Clarington, *An Agreement for the Cleanup and Long-Term Safe Management of Low-Level Radioactive Waste Situate in the Town of Port Hope, the Township of Hope and the Municipality of Clarington*, dated March 29, 2001 (amended October 2003, October 2006, and December 2009), available at http://phai.ca/en/public-documents/protocols-agreements.

[13] *Waste Nuclear Substance Licence*, WNSL-W1-2310.00/2022, *Port Hope Long-Term Low-Level Radioactive Waste Management Project*, dated November 15, 2012 (e-Doc 3990347).

[14] *Port Hope LTWMF Licence Conditions Handbook*, dated November 16, 2012 (e-Doc 3989304).

[15] CMD 12-H10: *Application by Atomic Energy of Canada Limited for Amendment of Waste Nuclear Substance Licence for the Port Hope Long-Term Low-Level Radioactive Waste Management Project*, dated October 24, 2012 (e-Doc 3989283).

[16] *Waste Nuclear Substance Licence* WNSL-W1-2311.00/2021, *Port Granby Long-Term Low-Level Radioactive Waste Management Project*, dated November 2011 (e-Doc 3767237).

[17] *Port Granby LTWMF Licence Conditions Handbook*, dated March 30, 2012 (e-Doc 3846439).

[18] CMD 11-H10: *Application by Atomic Energy of Canada Limited for a Waste Nuclear Substance Licence for the Port Granby Long-Term Low-Level Radioactive Waste Management Project*, dated September 27, 2011 (e-Doc 3767261).

GLOSSARY

Commission

A corporate body of not more than seven members, established under the *Nuclear Safety and Control Act* and appointed by the Governor in Council, to perform the following functions:

- Regulate the development, production and use of nuclear energy and the production, possession, use and transport of nuclear substances
- Regulate the production, possession and use of prescribed equipment and prescribed information
- Implement measures respecting international control of the development, production, transport and use of nuclear energy and nuclear substances, including those respecting the non-proliferation of nuclear weapons and nuclear explosive devices
- Disseminate scientific, technical and regulatory information concerning the activities of the CNSC and the effects on the environment and on the health and safety of persons, of the development, production, possession, transport and uses referred to above

Commission Member Document (CMD)

A document prepared for Commission hearings and meetings by CNSC staff, proponents and interveners. Each CMD is assigned a specific identification number.

Derived Release Limit (DRL)

A limit imposed by the CNSC on the release of a radioactive substance from a licensed nuclear facility, such that compliance with the DRL gives reasonable assurance that the regulatory dose limit is not exceeded.

Effective Dose

The sum of the products, in sieverts, obtained by multiplying the equivalent dose of radiation received by and committed to each organ or tissue set out in column 1 of an item of schedule 1 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

Equivalent Dose

The product, in sieverts, obtained by multiplying the absorbed dose of radiation of the type set out in column 1 of an item of schedule 2 of the *Radiation Protection Regulations*, by the weighting factor set out in column 2 of that item.

Fissionable

Fissionable refers to the capability to undergo fission.

Fissile Solution Storage Tank (FISST)

A radioactive waste vessel used for the storage of fissile liquid waste resulting from the processing of irradiated targets for the production of medical isotopes (Molybdenum-99 and Xenon isotopes), from 1986 to 2003.

Frequency Rate

The number of fatalities and injuries (lost time and medically treated) due to accidents for every 200,000 person-hours (approximately 100 person-years) worked at a site.

International Atomic Energy Agency (IAEA)

An independent international organization related to the United Nations system. The IAEA, located in Vienna, works with its Member States and multiple partners worldwide to promote safe, secure and peaceful nuclear technologies. The IAEA reports annually to the UN General Assembly and, when appropriate, to the Security Council regarding non-compliance by States with their safeguards obligations, as well as on matters relating to international peace and security.

Lost-Time Incident

An injury that takes place at work and results in the worker being unable to return to work for a period of time.

Severity Rate

A measure of the total number of days lost due to injury for every 200,000 person-hours worked at a site.

Severe Accident Management Program (SAMP)

A document that establishes

(a) actions to be taken during the course of a severe accident to prevent escalation of the accident into an event involving severe damage to the reactor core, to mitigate the consequences of the accident, or to achieve a safe, stable state of the reactor over the long term

(b) preparatory measures necessary for implementation of such actions

Note: SAMPs are sometimes referred to as severe accident management guidelines.

APPENDIX A: SAFETY AND CONTROL AREA FRAMEWORK

The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas (SCAs), including the SCA for security. The specific areas within each SCA have been identified by CNSC staff. The specific areas are different for Chalk River Laboratories, Whiteshell Laboratories, the Port Hope project, and the Port Granby project. The 14 SCAs are grouped according to their functional area as management, facility and equipment, or core control processes.

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A:1 Safety and Control Area Framework

Functional area	Safety and control area	Definition	Chalk River Laboratories specific areas	Whiteshell Laboratories specific areas	Port Hope specific areas	Port Granby specific areas
Management	**management system**	Covers the framework that establishes the process and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture	• Management System • Organization • Performance Assessment, Improvement and Management Review • Operating Experience • Change Management • Safety Culture • Records Management • Management of Contractors • Business Continuity	• Management System • Organization • Performance Assessment, Improvement and Management Review • Operating Experience • Change Management • Safety Culture • Configuration Management • Records Management • Management of Contractors • Business Continuity	• Management System • Operating Experience • Safety Culture • Records Management • Management of Contractors	• Management System • Operating Experience • Safety Culture • Records Management • Management of Contractors
	human performance management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that enough licensee staff are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safety carry out their duties.	• Human Performance Program • Personnel Training • Personnel Certification • Work Organization and Job Design • Fitness for Duty	• Human Performance Program • Personnel Training • Personnel Certification • Work Organization and Job Design • Fitness for Duty	• Personnel Training	• Personnel Training
	operating performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	• Conduct of Licensed Activity • Procedures • Reporting and Trending • Outage Management Performance	• Conduct of Licensed Activity • Procedures • Reporting and Trending	• Conduct of Licensed Activity • Procedures • Reporting and Trending	• Conduct of Licensed Activity • Procedures • Reporting and Trending

Functional area	Safety and control area	Definition	Chalk River Laboratories specific areas	Whiteshell Laboratories specific areas	Port Hope specific areas	Port Granby specific areas
	safety analysis	Includes maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.	• Deterministic Safety Analysis • Hazard Analysis • Probabilistic Safety Analysis • Criticality Safety • Severe Accident Analysis • Environmental Risk Assessment	• Deterministic Safety Analysis • Hazard Analysis • Criticality Safety	Not Applicable	Not Applicable
Facility and equipment	**physical design**	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis, given new information arising over time and taking changes in the external environment into account.	• Design Governance • Site Characterization • Facility Design • Structure Design • System Design • Component Design	• Design Governance • Site Characterization • Facility Design	• Design Governance • Facility Design	• Design Governance • Facility Design

Functional area	Safety and control area	Definition	Chalk River Laboratories specific areas	Whiteshell Laboratories specific areas	Port Hope specific areas	Port Granby specific areas
	fitness for service	Covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	• Equipment Fitness for Service/ Equipment Performance • Maintenance • Structural Integrity • Aging Management • Chemistry Control	• Equipment Fitness for Service/ Equipment Performance • Maintenance • Structural Integrity	• Equipment Fitness for Service/ Equipment Performance • Maintenance • Structural Integrity • Aging Management	• Equipment Fitness for Service/ Equipment Performance • Maintenance • Structural Integrity • Aging Management
Core control processes	**radiation protection**	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. This program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled, and maintained as low as reasonably achievable (ALARA).	• Application of ALARA • Worker Dose Control • Radiation Protection Program Performance • Radiological Hazard Control • Estimated Dose to Public	• Application of ALARA • Worker Dose Control • Radiation Protection Program Performance • Radiological Hazard Control • Estimated Dose to Public	• Application of ALARA • Worker Dose Control • Radiation Protection Program Performance • Radiological Hazard Control • Estimated Dose to Public	• Application of ALARA • Worker Dose Control • Radiation Protection Program Performance • Radiological Hazard Control • Estimated Dose to Public
	conventional health and safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.	• Performance • Practices • Awareness	• Performance • Practices • Awareness	• Performance • Practices • Awareness	• Performance • Practices • Awareness

Functional area	Safety and control area	Definition	Chalk River Laboratories specific areas	Whiteshell Laboratories specific areas	Port Hope specific areas	Port Granby specific areas
Core control processes (Cont'd.)	**environmental protection**	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	• Environmental Management System • Effluent and Emissions Control • Assessment and Monitoring • Protection of the Public	• Environmental Management System • Effluent and Emissions Control • Assessment and Monitoring • Protection of the Public	• Effluent and Emissions Control • Assessment and Monitoring	• Effluent and Emissions Control • Assessment and Monitoring
	emergency management and fire protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.	• Conventional Emergency Preparedness and Response • Nuclear Emergency Preparedness and Response • Fire Emergency Preparedness and Response	• Conventional Emergency Preparedness and Response • Nuclear Emergency Preparedness and Response • Fire Emergency Preparedness and Response	• Conventional Emergency Preparedness and Response • Fire Emergency Preparedness and Response	• Conventional Emergency Preparedness and Response • Fire Emergency Preparedness and Response
	waste management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning.	• Waste Characterization and Minimization • Waste Management Practices • Decommissioning Plans	• Waste Characterization and Minimization • Waste Management Practices • Decommissioning Plans	Not Applicable	Not Applicable

Functional area	Safety and control area	Definition	Chalk River Laboratories specific areas	Whiteshell Laboratories specific areas	Port Hope specific areas	Port Granby specific areas
	security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in the facility's licence, in orders, or in expectations for the facility or activity.	• Facilities and Equipment • Response Arrangements • Security Practices • Drills and Exercises	• Facilities and Equipment • Response Arrangements • Security Practices • Drills and Exercises	• Security Practices	• Security Practices
	safeguards and non-proliferation	Covers the programs required for the successful implementation of the obligations arising from the Canada/IAEA Safeguards Agreement.	• Nuclear Material Accountancy and Control • Access and Assistance to the IAEA • Operational and Design Information • Safeguards Equipment, Containment, and Surveillance	• Nuclear Material Accountancy and Control • Access and Assistance to the IAEA • Operational and Design Information • Safeguards Equipment, Containment, and Surveillance	Not Applicable	Not Applicable
	packaging and transport	Includes programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.	• Package Design and Maintenance • Packaging and Transport	• Packaging and Transport	• Packaging and Transport	• Packaging and Transport

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APPENDIX B: RATING METHODOLOGY AND DEFINITIONS

Performance ratings used in this report are defined as follows:

Fully Satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the SCA or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall area is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

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APPENDIX C: TREND IN SAFETY AND CONTROL AREA RATINGS

Table C-1: AECL's CRL trend in safety and control area ratings

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	BE	BE	BE	BE	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	UA	BE	BE	BE	BE
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-2: AECL's WL trend in safety and control area ratings

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	FS	FS	FS
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-3: AECL's PHP trend in safety and control area ratings

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	*Not Rated*			SA	SA
Human performance management				SA	SA
Operating performance				SA	SA
Safety analysis				N/A	N/A
Physical design				SA	SA
Fitness for service				SA	SA
Radiation protection				SA	SA
Conventional health and safety				SA	SA
Environmental protection				SA	SA
Emergency management and fire protection				SA	SA
Waste management				N/A	N/A
Security				SA	SA
Safeguards and non-proliferation				N/A	N/A
Packaging and transport				SA	SA

Table C-4: AECL's PGP trend in safety and control area ratings

Safety and control areas	2009 rating	2010 rating	2011 rating	2012 rating	2013 rating
Management system	*Not Rated*		SA	SA	SA
Human performance management			SA	SA	SA
Operating performance			SA	SA	SA
Safety analysis			N/A	N/A	N/A
Physical design			SA	SA	SA
Fitness for service			SA	SA	SA
Radiation protection			SA	SA	SA
Conventional health and safety			SA	SA	SA
Environmental protection			SA	SA	SA
Emergency management and fire protection			SA	SA	SA
Waste management			N/A	N/A	N/A
Security			SA	SA	SA
Safeguards and non-proliferation			N/A	N /A	N/A
Packaging and transport			SA	SA	SA

APPENDIX D: FINANCIAL GUARANTEES

The following table outlines the costs of decommissioning AECL nuclear sites and projects as net present values.

Table D-1: AECL financial guarantees listed per Nuclear Site/Projects

Facility	Canadian dollar amount
Chalk River Laboratories	6 100 000 000 (December 2013)
Whiteshell Laboratories	1 636 800 000 (March 2013)
Port Hope Project	1 007 000 000 (January 2012)
Port Granby Project	273 000 000 (January 2012)
Total financial guarantee for the four facilities	**9 016 800 000**

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APPENDIX E: WORKER DOSE DATA

Chalk River Laboratories

Table E-1: AECL's CRL EFFECTIVE DOSE (2009-2013)

Dose statistics	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	4754	4745	4879	4903	5080	50 mSv/yr
Average annual effective dose (mSv)	0.66	0.55	0.43	0.44	0.39	
Maximum annual effective dose (mSv)	17.04	11.86	9.05	8.90	8.89	

Table E-2: AECL's CRL EXTREMITY DOSE (2009-2013)

Dose statistic	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	358	328	317	312	323	500 mSv/yr
Average annual extremity dose (mSv)	3.70	1.32	2.11	2.43	2.73	
Maximum annual extremity dose (mSv)	36.56	7.23	38.62	18.53	72.10	

Table E-3: AECL-CRL SKIN DOSE (2009-2013)

Dose statistic	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	4754	4745	4879	4903	5080	500 mSv/yr
Average annual skin dose (mSv)	0.81	0.66	0.52	0.50	0.46	
Maximum annual skin dose (mSv)	22.03	23.32	16.21	12.23	13.08	

Whiteshell Laboratories

Table E-4: AECL's WL WORKER EFFECTIVE DOSE (2009-2013)

Dose statistics	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	781	798	771	746	846	**50 mSv/yr**
Average annual effective dose (mSv)	0.06	0.03	0.03	0.05	0.02	
Maximum annual effective Dose (mSv)	1.3	0.89	1.12	1.07	0.8	

Table E-5: AECL's WL EXTREMITY DOSE (2009-2013)

Dose statistic	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	37	27	33	34	10	**500 mSv/yr**
Average annual extremity Dose (mSv)	1.2	0.4	0.38	1.00	0.19	
Maximum annual extremity dose (mSv)	6.2	1.8	1.9	4.28	0.07	

Table E-6: AECL's WL SKIN DOSE (2009-2013)

Dose statistic	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored	781	798	771	746	846	**500 mSv/yr**
Average annual skin dose (mSv)	0.08	0.03	0.03	0.07	0.03	
Maximum annual skin dose (mSv)	4.1	1.2	1.2	3.97	1.27	

Port Hope Area Initiative (includes Port Hope and Port Granby Projects)

Table E-7: AECL's PHAI EFFECTIVE DOSE (2012-2013)

Dose statistic	2009	2010	2011	2012	2013	Regulatory Limit
Total persons monitored				60	118	**50 mSv/yr**
Average annual skin dose (mSv)				0.02	0.01	
Maximum annual skin dose (mSv)				0.18	0.2	

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APPENDIX F: ENVIRONMENTAL DATA

TABLE F-1: AECL's CRL AIRBORNE & LIQUID NUCLEAR SUBSTANCE RELEASES AS COMPARED TO LICENCE LISTED RELEASE LIMITS (2012-2013)

Radionuclide	Release limit	2012	2013
Airborne releases (Bq/year)			
Argon-41	6.60E+16	9.33E+15	8.46E+15
Carbon-14	2.14E+15	6.41E+11	5.74E+11
Tritium Oxide	1.25E+16	2.45E+14	2.46E+14
Iodine-131	3.96E+12	1.21E+11	1.38E+11
Mixed fision product noble gases (BqMeV/year)	4.96E+16	2.04E+15	5.72E+15
Liquid releases (Bq/year)			
Tritium Oxide	1.03E+17	3.21E+13	2.95E+13
Gross Alpha	1.32E+12	5.07E+08	5.60E+08
Gross Beta	2.70E+13	2.79E+10	5.28E+10

TABLE F-2: AECL's CRL HAZARDOUS LIQUID EFFLUENT RELEASES AS COMPARED TO COMPLIANCE VERIFICATION CRITERIA (LCH) (2012-2013)

Monitoring point	Parameter (mg/L)	Compliance verification criteria (monthly averages)	2012 average	2013 average
Waste Treatment Center Liquid Waste Evaporator Distillate (WTC_LWE)	Phosphorous	1	0.1	0.01
	Total Suspended Solids	25	2	0.34
	Oil/Grease	15	1	2.52
	Chromium	0.5	0.0012	0.00025
	Copper	0.5	0.0021	0.00106
	Lead	0.1	0.002	0.00042
	Mercury	0.001	0.00018	0.00028
	Nickel	0.5	0.0016	0.00083
	Zinc	0.5	0.00091	0.00009
Process Outfall (PRO) pH		6 to 9	7.11	7.08

TABLE F-3: AECL's CRL HAZARDOUS AIRBORNE EFFLUENT RELEASES AS COMPARED TO COMPLIANCE VERIFICATION CRITERIA (LCH) (2012-2013)

Emissions source	Criteria air contaminants (Mg)	Compliance verification criteria (annual)	2012 releases	2013 releases
Number 6 Heating Oil Burned at the Powerhouse	Carbon Monoxide	8.0	5.787	6.178
	Nitrogen Oxides	75.0	50.571	56.412
	Sulphur Dioxides	315.0	175.245	173.398
	Total Particulates Matter	24.0	13.985	14.126
	Particulate Matter < 10 µm	21.0	12.037	12.150
	Particulate Matter < 2.5 µm	15.0	7.841	7.907
	Volatile Organic Compounds	0.5	0.328	0.350

TABLE F-4: AECL's WL AIRBORNE RADIOLOGICAL RELEASES AS COMPARED TO DERIVED RELEASE LIMITS (2011-2013)

Radionuclide	Derived release limit	2011	2012	2013
Tritium (Bq/week)	7.64E+14	6.01E+08	3.66E+09	6.77E+08
Gross Alpha (Bq/week)	5.84E+08	2.23E+03	2.02E+03	1.78E+03
Gross Beta (Bq/week)	1.19E+10	6.47E+03	7.76E+03	4.41E+03

TABLE F-5: AECL's WL LIQUID RADIOLOGICAL RELEASES AS COMPARED TO DERIVED RELEASE LIMITS (2011-2013)

Radionuclide	Release limit	2011	2012	2013
Gross Alpha (Bq/month)	2.80E+11	7.960E+06	8.950E+06	9.500E+06
Strontium 90 (Bq/month)	1.46E+12	1.042E+07	9.900E+06	5.810E+06
Cesium 137 (Bq/month)	2.41E+11	7.991E+06	7.564E+06	5.330E+06

TABLE F-6: AECL's PHP HAZARDOUS LIQUID EFFLUENT RELEASES AS COMPARED TO COMPLIANCE VERIFICATION CRITERIA (LCH) (2012-2013)

Parameter	2012[1]	2013	Release limits (monthly average)	% of release limit in 2013
Radium-226 (Bq/L)	0.058	0.048	0.37	13%
Arsenic (mg/L)	0.26	0.012	0.50	2.4%
pH	7.68	7.51	6 – 9	
Toxicity testing	Pass	Pass	Effluent cannot be toxic	

1. Sampling started April 2012

TABLE F-7: AECL's PGP HAZARDOUS LIQUID EFFLUENT RELEASES AS COMPARED TO COMPLIANCE VERIFICATION CRITERIA (LCH) (2012-2013)

Parameter	2012[1]	2013	Release limits (monthly average)	% of release limit in 2013
Radium-226 (Bq/L)	<0.058	<0.057	0.37	< 15%
pH	7.68	7.8	6 – 9	
Toxicity testing	Pass	Pass	Effluent cannot be toxic	

1. Sampling started April 2012

APPENDIX G: Status of Fukushima Actions

TABLE G-1: STATUS OF FUKUSHIMA ACTIONS FOR CHALK RIVER LABORATORIES

Fukushima Safety Review Activities	Implementation Timelines		
	Short term (2011-2012)	Medium term (2013-2014)	Long term (2015-2016)
Strengthening Reactor Defense-in-Depth			
1. Safety Assessment of NRU and Nuclear Facilities at CRL	• Complete screening of safety features of NRU and nuclear facilities, based on lessons learned from the Fukushima nuclear event **Completed**	• Further evaluate / verify performance of safety features of NRU and nuclear facilities, based on developed guidelines **In progress**	• Implementation of identified safety control procedures and safety system component upgrades
	• Upgrade the availability of safety-related equipments if necessary **Completed**	• Enhance modelling capabilities **In Progress**	• Training on newly implemented safety control procedures
	• Develop guidelines for further evaluating / verifying safety features of NRU and nuclear facilities **Completed**	• Identify potential improvements in safety control procedures and safety system component upgrade **In progress**	
2. Assessment of CRL Specific External Hazards	• Assess CRL-specific external hazards (seismic, flooding, fire and extreme weather condition, etc.) **Completed**		

Fukushima Safety Review Activities	Implementation Timelines		
	Short term (2011-2012)	**Medium term (2013-2014)**	**Long term (2015-2016)**
3. Assessment of Plant Equipment and Instrumentation and Potential Upgrades		• Evaluate / verify existing safety qualified equipments and instruments • Identify potential improvements in existing safety qualified equipments and instruments **In progress**	• Implementation of identified improvements of existing safety qualified equipments and instruments
4. Severe Accident Management Program (including guidelines, procedures, implementations and training)	• Develop plan / guidelines for Severe Accident Management Program **Completed**	• Examine existing Severe Accident Assessments • Develop procedures of Severe Accident Management Program (including interface with EOP) **Completed**	• Implementation of Severe Accident Management Program • Training on Severe Accident Management Program
Enhancing Emergency Response			
5. Assess Emergency Plans (On-site)	• Re-examine existing onsite emergency plans **Completed**		• Communication and implementation of updated Emergency Plans

Fukushima Safety Review Activities	Implementation Timelines		
	Short term (2011-2012)	Medium term (2013-2014)	Long term (2015-2016)
6. Update Emergency Facilities and Equipment (On-site)	• Upgrade availability and performance of emergency facilities and equipments if necessary **Completed**		• Complete review and improvement of emergency facilities and equipments • Complete update the emergency procedures

TABLE G-2: STATUS OF FUKUSHIMA ACTIONS FOR WHITESHELL LABORATORIES

Fukushima Safety Review Activities	Whiteshell Laboratories
Strengthening Defence-in-depth	• Revise Safety Analyses Reports **In progress**
Enhancing Emergency Response	• Emergency response plans were reviewed and found adequate **Completed**

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APPENDIX H: CHANGES TO LICENCE AND LICENCE CONDITIONS HANDBOOK(S)

H-1: AECL's CRL CHANGES TO LICENCE AND LICENCE CONDITIONS HANDBOOK

Licence

The CRL operating licence NRTEOL-01.01/2016 was amended once [1] to extend the due date for licence condition 16.3 regarding the submission of a plan for the future of NRU Reactor from June 30, 2014 to June 30, 2015.

At the time of drafting this report, AECL has expressed its intent to apply for

- amendment to the CRL site licence expiry date
- transfer of the CRL operating licence from AECL to a new operating organization

Licence Conditions Handbook

Revision 1 to the LCH for CRL, incorporating all previously CNSC approved updates, was issued on February 15, 2013 [2]. There was one CNSC approved update to Revision 1 of the LCH [3]. The more significant changes are shown in Table H-1.

Table H-1: AECL's CRL CHANGES TO THE LCH

Section	Description of change	Revision type
4.4	Added new compliance verification criteria (CVC) to clarify the requirements for decommissioning and the release for reuse and/or removal of decommissioned property.	Technical
4.16	Added new CVCs to clarify the requirements for reporting on chemistry and hours of work indicators.	Technical
5.1	Added the IAEA documents GSR-4 *Safety Assessment for Facilities and Activities*, SSG-20 *Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report*, and SSG-22 *Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors*, as well as the Department of Energy standard DOE-STD-3009-94 *Preparation Guide for U.S. Department of Energy Nonreactor Facility Documented Safety Analyses* that may be used as guidance in preparing the safety analyses for CRL facilities.	Technical
10.1	Added new CVC requiring the use of CSA standard N288.6, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills*, when performing environmental risk assessment for CRL facilities.	Technical

Section	Description of change	Revision type
Appendix B	Updated the information on CRL facilities.	Administrative
Appendix D	Updated the information on licensing basis documents for CRL facilities.	Administrative
Appendix K	Updated the information to record AECL's progress to closing transitional provisions.	Administrative
Appendix M	Updated the information to record new approvals granted by the Commission or CNSC staff under various licence conditions.	Administrative

H-2: AECL's WL CHANGES TO LICENCE AND LICENCE CONDITIONS HANDBOOK

Licence

The WL decommissioning licence NRTEDL-08.02/2018 [10] has been amended twice since its issuance in 2008.

In April 2010, the licence was amended to:

- change the submission dates for the annual reports to align with the AECL Chalk River Laboratories (CRL) operating licence
- correct two errata in the appendices of the licence, as they were outdated and not representative of the facility and its conduct of operations

In July 2012, the licence was amended to:

- update the licensee's address
- update editions of codes and standards listed in licence condition
- make minor changes to three licence conditions
- update the reference to the revised action levels
- update appendices

Licence Conditions Handbook

Currently, there is not an LCH for WL. CNSC staff are presently developing one for WL.

H-3: AECL's PHP CHANGES TO LICENCE AND LICENCE CONDITIONS HANDBOOK

Licence

The Port Hope long-term low-level radioactive waste management project licence WNSL-W1-2310.00/2022 [13] was issued in November 2012. There have been no amendments to this licence since it was issued.

Licence Conditions Handbook

No changes to the PHP LCH [14] have taken place since licensing in November 2012. Documents listed within the LCH are currently being revised. The LCH will be updated to reflect the new versions in the fall of 2014.

H-4: AECL's PGP CHANGES TO LICENCE AND LICENCE CONDITIONS HANDBOOK

Licence

The Port Granby long-term low-level radioactive waste management project licence WNSL-W1-2310.00/2021 [16] was issued in November 2011. There have been no amendments to this licence since it was issued.

Licence Conditions Handbook

No changes to the PGP LCH [17] have taken place since licensing in November 2012. Documents listed within the LCH are currently being revised. The LCH will be updated to reflect the new version in the fall of 2014.

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APPENDIX I: LINKS TO LICENSEE WEBSITES

AECL Chalk River Laboratories

aecl.ca/en/home/about/locations/

AECL Whiteshell Laboratories

aecl.ca/en/home/environmental-stewardship/whiteshell

PHAI Port Hope Project:

phai.ca/en/port-hope-project

PHAI Port Granby Project:

phai.ca/en/port-graby-project-2

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APPENDIX J: ACRONYMS AND ABBREVIATIONS

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable
BE	Below Expectations
Bq	Becquerel
CMD	Commission Member Document
CNLL	Canadian Nuclear Laboratories Limited
CNSC	Canadian Nuclear Safety Commission
CPDP	Comprehensive Preliminary Decommissioning Plan
CRL	Chalk River Laboratories
CSA	Canadian Standards Association, now called the CSA Group
CVC	Compliance Verification Criteria
DDP	Detailed Decommissioning Plan
DFO	Department of Fisheries and Oceans
DRL	Derived Release Limits
EIR	Event Initial Report
FISST	Fissile Solution Storage Tank
FPS	Fuel Packaging and Storage Facility
FS	Fully Satisfactory
IAEA	International Atomic Energy Agency
IIP	Integrated Implementation Plan
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
LLRW	Low-Level Radioactive Waste
LTWMF	Long-Term Waste Management Facility
MLW	Medium-Level Waste
mSv	millisievert
MPF	Molybdenum Production Facility
NLLP	Nuclear Legacy Liabilities Program
NRCan	Natural Resources Canada
NRF	Nuclear Response Force
NRU	National Research Universal
NRX	National Research Experimental
NSCA	*Nuclear Safety and Control Act*
NWMO	Nuclear Waste Management Organization
OPEX	Operating Experience
OSH	Occupational Safety and Health
PGP	Port Granby Project
PHAI	Port Hope Area Initiative
PHP	Port Hope Project
PIP	Public Information Program
PSA	Probabilistic Safety Analysis
PWGSC	Public Works and Government Services Canada
RCMP	Royal Canadian Mounted Police
RD	Regulatory Document

RLTI	Recordable Lost-Time Injuries
SA	Satisfactory
SAMP	Severe Accident Management Program
SAR	Safety Analysis Report
SAT	Systematic Approach to Training
SCA	Safety and Control Areas
SLWC	Stored Liquid Waste and Cementation project
SMAGS	Shielded Modular Above Ground Storage
SSCs	Systems, Structures and Components
TLD	Thermo Luminescent Dosimeters
UA	Unacceptable
USL	Upper Sub-critical Limits
VLLW	Very Low-Level Waste facility
WL	Whiteshell Laboratories
WMA	Waste Management Area
WMF	Waste Management facility
WR-1	Whiteshell Reactor -1
WTP	Water Treatment Plant

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD:16-M12

Date signed / signé le : MARCH 22, 2016

Status Update

Mise à jour

Canadian Nuclear Laboratories

Status Update for CNL Prototype Waste Facilities and Whiteshell Nuclear Laboratories

Laboratoires Nucléaires Canadiens

Mise à jour au sujet des installations de gestion des déchets des réacteurs prototypes et des Laboratoires nucléaires de Whiteshell appartenant aux LNC

Public Meeting

Réunion publique

Scheduled for:

April 6, 2016

Prévue pour :

Le 6 avril 2016

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

e-Doc 4908461 (WORD)
e-Doc 4952931 (PDF)

Summary

This Commission Member Document (CMD) provides information on the status of CNL's three shut down power reactors: Douglas Point, Gentilly-1 and Nuclear Power Demonstration.

The CMD also presents an update on the progress of decommissioning at CNL's Whiteshell Nuclear Laboratories.

There are no actions requested of the Commission. This CMD is for information only.

Résumé

Le présent document à l'intention des commissaires fournit de l'information sur l'état des trois réacteurs nucléaires arrêtés des Laboratoires nucléaires canadiens : celui de Douglas Point, celui de Gentilly-1 et le réacteur nucléaire de démonstration.

Le document à l'intention des commissaires présente aussi une mise à jour des progrès du déclassement des Laboratoires nucléaires de Whiteshell.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

Signed/signé le

March 22, 2016

David Newland

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directeur général

Direction de la réglementation du cycle et des installations nucléaires

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

As part of CNSC staff's commitment to keep the Commission informed on the status of major projects, this CMD provides an update on the Canadian Nuclear Laboratories Limited (CNL) facilities that are undergoing decommissioning. These facilities are the three shut down power reactors, Douglas Point in Tiverton, ON, Gentilly-1 in Bécancour, QC, Nuclear Power Demonstration in Rolphton, ON and the Whiteshell Laboratories (WL), a nuclear research and test facility located near Pinawa, Manitoba.

The three shut down power reactors (also known as the prototype waste facilities) ceased operations in the 1980s and were placed in a safe storage state with surveillance, in accordance with their approved decommissioning plans. In addition to surveillance, CNL updates programs to reflect modern standards, maintains the facilities and reduces hazards and liabilities to improve safety and to prepare for final decommissioning and site closure.

WL consists of research and support facilities, the Whiteshell Reactor No. 1 (WR-1) and the SLOWPOKE demonstration reactor. WR-1 was shut down in 1985, and in the late 1990s, AECL decided to discontinue most research programs and operations at WL. A CNSC decommissioning licence was issued in 2003, and in 2008, the Commission approved accelerated decommissioning, as requested by AECL under the Government of Canada's Nuclear Legacy Liabilities Program. CNL's current decommissioning plan anticipates site closure by 2037.

CNSC staff confirm through inspections and desktop reviews that CNL is maintaining these facilities safely, in compliance with the requirements of the *Nuclear Safety and Control Act* and their respective licences, and is making progress on the accelerated decommissioning of the Whiteshell Laboratories.

1 OVERVIEW

As authorized by the Commission, Canadian Nuclear Laboratories (CNL) is decommissioning a number of facilities, including three shut down power reactors, Douglas Point (DP), Gentilly-1 (G-1) and Nuclear Power Demonstration (NPD), and the Whiteshell Laboratories (WL), a nuclear research and test facility that consists of two shut down reactors: Whiteshell Reactor No. 1 (WR-1) and the SLOWPOKE demonstration reactor (SDR). The three shut down power reactors, which ceased operating in the 1980s, are in a storage with surveillance state, while CNL is proceeding with dismantling WL in accordance with their approved decommissioning plans.

All of these facilities hold CNSC decommissioning licences. Decommissioning encompasses a wide variety of different activities to retire a licensed facility or site permanently from service and render it to a predetermined end-state. It may include for example, de-energizing and emptying circuits, dismantling equipment and facilities, segregating and transferring wastes, recycling materials, developing waste storage or work facilities and areas, or maintaining facilities in a storage with surveillance state. Decommissioning end points are documented in the decommissioning plans that are associated with each facility and form part of the approved licensing basis. Appendix A provides a summary of the status of the shut down reactor facilities.

Atomic Energy of Canada Limited (AECL) was the licensee of these facilities until November 3, 2014, when CNL became the licence holder due to the Government moving to a government-owned, contractor-operated model. CNL now operates the facilities while AECL retains ownership of the assets and liabilities. The Commission authorized the licence transfer to CNL in October 2014 (CMD 14-H117).

AECL developed a three-phase approach to reactor decommissioning. The decommissioning plans and interim end-state reports for each facility describe this approach. The three phases are:

- Phase 1 - bring the facility to a safe sustainable shutdown state suitable for storage with surveillance;
- Phase 2 - the storage with surveillance period; and
- Phase 3 - final decommissioning where the facility achieves its final end state.

While the decommissioning phases are the same for these reactor facilities, the period of each phase may vary. The decommissioning plans state that used fuel will remain on site at G-1, DP and WL until a long term management facility for used fuel is available in Canada. The Government of Canada has mandated the Nuclear Waste Management Organization (NWMO) to implement the long term management approach for Canada’s used nuclear fuel. If a long term management facility for used fuel is not available at the time when final dismantlement occurs, CNL’s plans are to place the fuel into on-site or off-site storage facilities, whichever is the most suitable at the time.

According to the decommissioning plans approved by the CNSC, the shut down power reactors are to be maintained in storage with surveillance with final dismantlement planned to begin in 2053-2103 (G-1), 2056-2106 (NPD) and 2103 (DP).

The currently approved decommissioning strategy for the shut down power reactors is the eventual removal of used fuel, (G-1, DP), removal of radioactive components/wastes and demolition of the buildings and structures with return of the land for unrestricted use. Long-term institutional controls after decommissioning will not be required.

For WL, decommissioning was originally planned to be completed by 2062 following a 60 year decommissioning program. In 2008, the Commission approved an accelerated decommissioning schedule as requested by AECL under the Government of Canada’s Nuclear Legacy Liability Program. At that time, the expectation for site closure was advanced to 2037 from 2062.

The currently approved decommissioning strategy for WL is based on the complete removal of radioactive materials from the site with the exception of contaminated river sediments and the low-level radioactive waste (LLW) trenches located in the Waste Management Area (WMA) that will be disposed of in-situ. A long-term institutional control period of 200 years after the cessation of physical decommissioning activities is planned. It should be noted that the final safety case for in-situ disposal of was not fully developed for this proposal and still needs to be provided and assessed by the CNSC prior to CNL proceeding.

The currently approved decommissioning strategy for the WR-1 reactor is to fully remove and package all activated and contaminated components for disposal in offsite facilities, to decontaminate the facility structure and then to demolish the building to achieve unrestricted release criteria.

In a letter dated October 23, 2015, CNL notified the CNSC of its intent to accelerate and change the decommissioning strategy for NPD and WL.

The letter makes reference to the submission of initial regulatory applications by March 31, 2016 for NPD and March 31, 2017 for WL. This letter also provided advance notice of a new project at Chalk River Laboratories that is required to advance decommissioning of WL and NPD. In a subsequent letter dated February 9, 2016, CNL informed the CNSC that it intends to advance the submission of the initial regulatory application for WL by ten months to May 2016.

CNSC staff note that if the proposed decommissioning strategy and end state for these projects vary from what has been previously approved by the Commission, CNL will be required to seek the Commissions approval through a licence amendment process, considering that the current licences only authorize pre-assessed and pre-approved activities. Additionally, CNL would also need to revise, update and reassess key planning tools for the proposals, such as the detailed decommissioning plans, the work plans/work instructions and the environmental assessment.

CNL states that it now plans to complete the decommissioning of WL by 2025, and the decommissioning of NPD by 2021. The timelines for final decommissioning of DP and G-1 remain unchanged at this time.

2 REGULATORY OVERSIGHT

In order to ensure compliance with the NSCA, its regulations and the licences, CNSC staff have established a compliance program for each facility. The compliance program consists of inspections, desktop reviews of reports, plans or other submissions and reviews of events that CNL reports to the CNSC.

The baseline inspection program is tailored to the specific risks of each facility and to its compliance record. Consequently, the number of baseline inspections in any given year may vary depending on conditions and activities occurring on site, and on the compliance record of the licensee. CNSC staff may also conduct other inspections, such as those related to security and safeguards to verify that the licensee is operating in compliance with CNSC regulatory requirements.

For the shut down power reactors, CNSC staff currently conducts annual baseline compliance inspections. For the Whiteshell Laboratories, CNSC staff currently conducts semi-annual baseline compliance inspections.

Table 1 provides a summary of the CNSC compliance effort associated with these facilities from 2011/12 to December 2015.

Table 1: CNSC Compliance Effort 2011/12 to December 2015

Shut Down Power Reactors	2011/12	2012/13	2013/14	2014/15	2015/16 (Q1-Q3)
Inspections	3	3	3	3	3
Desktop Reviews	3	7	4	5	11
Total Person Days of Compliance Effort (Actual)	71	64	53	44	47
Whiteshell Laboratories	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16 (Q1-Q3)**
Inspections	2	2	3	2	3
Desktop Reviews	4	30	18	11	22
Total Person Days of Compliance Effort (Actual)	240	221	175	120	142

The CNSC expects that each facility, including those that are in storage with surveillance, be maintained safely and that physical systems and programs that are required for surveillance, inspection, servicing and maintenance be maintained.

Physical systems include for example: electrical power, emergency lighting, drainage, heating/ventilation, security, fire alarm and remote monitoring systems. Programs to be maintained include for example: radiation protection, environmental protection, occupational health and safety, training and aging management.

The CNSC requires that CNL submit an annual report for each facility. The purpose of the report is to demonstrate compliance with the terms and conditions of the licence and applicable regulations. CNL's annual compliance reports provide information on:

- operating experience of the facility,
- waste inventory and any changes to it,
- effluent treatment and waste processing,
- modifications to the facility,
- radiation protection program and the health and safety program performance,
- results of facility monitoring and environmental monitoring,
- new discoveries,
- compliance with other Federal or Provincial legislation,
- training conducted,
- public information program changes, and
- reports submitted to the CNSC during the year.

CNSC staff assess these reports and assess the licensee's implementation of their programs when conducting compliance inspections.

CNL reports regularly to CNSC staff on the status of activities at these facilities and based upon site inspections and desktop reviews, CNSC staff are satisfied that CNL takes adequate measures to ensure that these sites remain safe as required by the licences.

Fukushima Action Plan

Since the last update to the Commission on the shut down power reactors was provided just prior to the Fukushima accident, CNSC staff is including an update in this CMD. CNSC staff note that these facilities were included in the overall updates to the Commission on the CNSC Fukushima Action Plan in CMD 12-M56.

In March 2011, the CNSC issued requests pursuant to subsection 12(2) of the *General Nuclear Safety and Control Regulations* to all Class I facility licensees, including CNL, to confirm the safety case for each facility and to address the lessons learned from the Fukushima nuclear accident.

After assessing the licensees' responses and examining its own regulatory framework, the CNSC developed the Fukushima Action Plan with clear deliverables in the short, medium and long terms for both licensees and the CNSC. As part of the action plan, the CNSC requested that CNL re-examine the safety cases for these facilities with a focus on:

- External hazards such as seismic, flooding, fire and extreme weather events;
- Measures for the prevention and mitigation of severe accidents; and
- Emergency preparedness.

As has been previously reported to the Commission, CNL completed the actions and reported that no significant issues were identified for these facilities that required immediate corrective or compensatory measures.

However, CNL did identify opportunities to improve safety case documentation and emergency response procedures at WL. These activities were completed and the information was submitted to CNSC staff. CNSC staff reviewed the information and concluded that it met regulatory requirements.

CNSC staff report to the Commission that CNL has completed all of the identified improvements arising from the subsection 12(2) request and that all actions associated with these facilities have been closed.

3 PROJECT STATUS/PROGRESS

3.1 Shut Down Power Reactors

Licensing

The Atomic Energy Control Board (AECB), the Commission's predecessor until 2000, licensed DP, G-1 and NPD in the 1980's under individual waste facility operating licences. In 2014, AECL requested that these three facilities be consolidated together under a single prototype waste facilities decommissioning licence for a 20 year period (CMD 14-H107). The Commission issued this licence in the updated licence format with an associated Licence Conditions Handbook in July 2014.

In October 2014, the Commission approved the transfer of the prototype waste facilities decommissioning licence from AECL to CNL (CMD 14-H117), with an expiry date of December 31, 2034. CNL became the licence holder due to the Government moving to a government-owned, contractor-operated model. CNL is now responsible for these facilities while the Federal Government, through AECL, retains ownership of the assets and liabilities.

In addition to the previous licensing actions, CNSC staff last updated the Commission on the status of the shut down power reactors on January 20, 2011 in CMD 11-M11, as requested by the Commission.

3.1.1 Douglas Point

Background

The DP power reactor is located on the Bruce Power site, between Kincardine and Port Elgin, in Tiverton, Ontario (Figure 1). DP is a 200 MW CANDU power reactor that was put into service in 1968 and permanently shut down in May 1984.

The main components of the facility are the reactor building, the service building, the turbine building/administration wing, the concrete canister storage area for used nuclear fuel and several outbuildings.

Phase 1 (preparation for safe storage) activities were conducted from 1984 to 1988 and since that time, the facility has been maintained in a Phase 2 (storage with surveillance) state.

Figure 1: Douglas Point Reactor

Radioactive wastes on-site consist of used nuclear fuel and low and intermediate-level radioactive waste. Appendix B provides the inventory of stored wastes as reported in *Canada's Fifth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Oct 2014).*

Progress Update

As a result of CNL's assessment of radiation protection practices, CNL has relocated and reconfigured the transition areas between nuclear and non-nuclear areas to improve access through these areas and to improve the application and removal of personal protective equipment at the zone boundary. In the area of fire protection, CNL has achieved a significant reduction in combustibles at DP and is upgrading fire detection systems.

As part of projects to reduce hazards and liabilities, CNL has reduced the inventory of LLW being stored at DP in the reactor and service buildings. CNL has also removed most of the contents of the turbine building. This includes the non-radioactive unused office areas on the second floor, where a substantial number of office cubicles and furniture had remained. Under CNL's waste management program, waste that is likely not radioactive (i.e. clean) is monitored and segregated at the source for disposal by conventional means, minimizing the quantity of radioactive waste generated.

CNL has also initiated a procurement process to issue a contract for the transfer of ion exchange resins stored at DP to Chalk River Laboratories. Until the resins are moved, CNL continues to monitor and verify the integrity of the storage tanks, which continue to perform well.

3.1.2 Gentilly-1

Background

The G-1 power reactor (Figure 2) is located adjacent to the Gentilly-2 Nuclear Generating Station in Bécancour, Québec, on the shores of the St. Lawrence River, 15 km east of Trois-Rivières. G-1 is a 250 MW boiling light water reactor put into service in May 1972. The reactor operated for 183 effective full power days until 1978 when it was concluded that significant modifications would be required if it were to remain in operation. In 1982, AECL decided to not modify the reactor and the following year it was permanently shut down.

Figure 2: Gentilly 1

The main components of the facility are the reactor building, the service building and the turbine building. A concrete canister storage facility was constructed inside the turbine building in 1986 to house the used nuclear fuel.

Phase 1 (preparation for safe storage) activities were conducted from 1984 to 1986 and since that time, the facility has been maintained in a Phase 2 (storage with surveillance) state.

Radioactive wastes on-site consist of used nuclear fuel and low and intermediate-level radioactive waste. Appendix B provides the inventory of stored wastes as reported in *Canada's Fifth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Oct 2014).*

Progress Update

As part of the improvements identified by the assessment of their radiation protection practices, CNL has installed new hand and foot monitors and a new whole body monitor at G-1. In the area of fire protection, CNL has achieved a significant reduction in combustibles and is upgrading fire detection systems.

CNL conducts projects to reduce hazards and liabilities, and as a result, has reduced the inventory of LLW being stored at G-1 in the turbine building. In addition, asbestos evaluations conducted at G-1 have resulted in projects to address asbestos hazards. Tenting has been installed to protect workers entering the reactor building and additional safety requirements have been put in place with the requirement for additional personal protective equipment when entering hazardous areas. CNL plans to continue with asbestos abatement projects in the reactor building in 2016.

CNL has also initiated a procurement process to issue a contract for the transfer of ion exchange resins stored at G-1 to Chalk River Laboratories. Until the resins are moved, CNL continues to monitor and verify the integrity of the storage tanks which, to date, continue to perform well.

3.1.3 Nuclear Power Demonstration

Background

The shut down NPD power reactor (Figure 3) is located in Rolphton, Ontario, adjacent to the Ottawa River, approximately 25 kilometers upstream from Chalk River Laboratories.

NPD is a 20 MW CANDU reactor that was put into service in 1962 providing power to the grid and serving as a power reactor training facility.

The main components of the facility were the reactor building, the training centre and several support buildings. Currently, only the reactor building, ventilation stack and gatehouse remain.

Phase 1 (preparation for safe storage) activities were conducted from 1984 to 1986 and since that time, the facility has been maintained in a Phase 2 (storage with surveillance) state.

Figure 3: Nuclear Power Demonstration Facility

On-site radioactive waste is classified as LLW. Due to its proximity to CRL, most operational and decommissioning waste, including the used nuclear fuel were moved to CRL during Phase 1 (preparation for safe storage) activities. Appendix B provides the inventory of stored wastes as reported in *Canada's Fifth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2014).*

Progress Update

As a result of CNL’s assessment of radiation protection practices, CNL installed new hand and foot monitors and a self-contained decontamination/emergency shower at NPD. Also, the transition areas between nuclear and non-nuclear areas were relocated and reconfigured to improve access through these areas and to improve the application and removal of personal protective equipment at the zone boundary.

In the area of fire protection and emergency management, CNL has significantly reduced combustibles at NPD. Other improvements related to fire detection and mitigation include road upgrading to enable access to river water for first responders. In addition, fire detection upgrades have been completed. Also associated with emergency management, CNL installed diesel generators at NPD to provide an independent source of stand-by power.

CNL has conducted projects to reduce hazards and liabilities and has removed most of the LLW that was stored at NPD.

CNL has conducted asbestos evaluations at NPD resulting in projects to address the hazard. For the protection of workers on site, CNL has installed tenting to allow access to the boiler room, along with requiring the use of additional personal protective equipment when staff need to access hazardous areas. CNL plans to proceed with asbestos abatement projects in the NPD boiler room in 2016.

3.2 Whiteshell Laboratories

Licensing

The Whiteshell Laboratories was established by AECL in the early 1960s to carry out nuclear research and development activities. In 1997, AECL decided to discontinue most research programs and operations. The WR-1 reactor had previously been shut down in 1985.

The Commission originally issued WL a decommissioning licence in January 2003 for a six-year period (CMD 02-H19). The Commission then renewed the licence in November 2008 for a ten-year period (CMD 08-H24) and approved amendments requested by AECL in April 2010 (CMD 10-H109) and in October 2012 (CMD 12-H120). These amendments had no impact on the safety of the facility; they pertained to changes in report submission dates, references and action levels.

In October 2014 (CMD 14-H117), the Commission approved the transfer of the licence from AECL to CNL. Subsequently, in January 2016, the Commission approved an administrative amendment to issue the licence in the updated format with an associated Licence Conditions Handbook (CMD 16-H100).

CNSC staff presented WL interim status reports to the Commission on September 13, 2012 in CMD 12-M47 and on December 18, 2014 in CMD 14-M79.

Background

WL is a large site with an area of 4,375 hectares, although only about one third of that is associated with nuclear activities. It was established in the early 1960s to carry out research and development of higher temperature versions of the CANDU reactor and to conduct reactor fuel research.

An early focus of WL was WR-1, a 60 MW organically cooled research reactor that operated from 1965 to 1985. While WR-1 was initially the main focus of WL, other significant programs were later added, including the nuclear fuel waste management program, various research programs including environmental and radiation studies, and technology demonstration programs including accelerator projects and the SDR.

The main campus of WL (Figure 4) consists of offices, laboratories, hot cell facilities, the WR-1 research reactor, the SDR, radioactive liquid waste treatment facilities and numerous support buildings. A large WMA which contains LLW, intermediate-level radioactive waste (ILW) and high-level radioactive waste (HLW), including spent nuclear fuel, is located approximately 2.7 km north-east of the main campus.

Progress Update

Since the decommissioning licence was issued in 2003, there has been a gradual progression in the number of decommissioning activities being performed. The facility continues to operate laboratories, conduct research, conduct surveillance and maintain facilities but the overall focus is on decommissioning.

Figure 4: Whiteshell Laboratories

Some areas of the facility support surveillance (environmental laboratories) while some areas of the facility are not used but remain available to support future decommissioning (such as hot cells). Support services and supporting facilities need to be maintained while decommissioning planning and decommissioning activities continue. As parts of the facility are decommissioned, reconfiguring services and infrastructure must be conducted.

CNL is planning, implementing and completing decommissioning activities, in accordance with CNSC approved decommissioning plans. Associated with their waste management program, CNL is segregating, packaging, storing and reusing or recycling radioactive, hazardous and conventional wastes. Additionally, CNL is maintaining the WR-1 reactor in a Phase 2 (storage with surveillance) state while preparing for Phase 3 (final decommissioning).

For wastes in the WMA, CNL is conducting repackaging activities (WR-1 wastes) and implementing serviceability assessments and investigations to the condition and contents of some of the subsurface containment structures (bunkers and in-ground containers).

As with CNL's other facilities, improvements to programs such as radiation protection, occupational health and safety, security and fire detection are conducted to reflect updated standards. CNL must maintain and ensure that facility structures remain accessible for inspection and maintenance and they must also maintain monitoring and surveillance programs.

Following is a list of activities that are being conducted at WL associated with the decommissioning program.

Building B300: Building B300 is the central research complex that contained more than 170 laboratories and approximately 400 offices, mechanical rooms, and areas for large-scale engineering projects. The building was constructed in seven separate stages, and decommissioning will be conducted in stages as well. This is because certain areas must remain in service to support activities and dismantlement occurring in other areas of WL. The first two stages to be dismantled are stages 4 and 7, as shown in Figure 5.

Dismantling began with the removal of the office interiors, mechanical rooms and laboratories. Building services, such as ventilation, electrical and water systems were de-energized, capped and isolated, areas of contamination removed and other services were rerouted as necessary (the LLW liquid waste line which is still needed had to be rerouted as it passed though the stage 4 crawl space). In addition, a new access road was developed to support demolition.

CNL expects that the dismantlement of stages 4 and 7 of Building B300 will be completed by the end of March 2016.

Figure 5: B300, Stages 4 & 7

Active Liquid Waste Treatment Centre & Decontamination Centre: Constructed of reinforced concrete, the active liquid waste treatment centre (Building B200, Figure 6) contains two floors, a crawl space and an external underground concrete vault. The building houses 12 storage tanks, glove boxes, piping, and other related equipment.

The active liquid waste treatment centre was originally built to manage liquid ILW and liquid LLW streams. The ILW circuit was shut down in 2001 while the LLW circuit continues to operate.

The decontamination centre (Building B411, Figure 7) originally housed a laundry for contaminated clothing and equipment, decontamination services for tools and items and respirator cleaning and maintenance services. It contains aqueous and solvent cleaning areas, holding tanks, a respirator maintenance area, offices and washrooms.

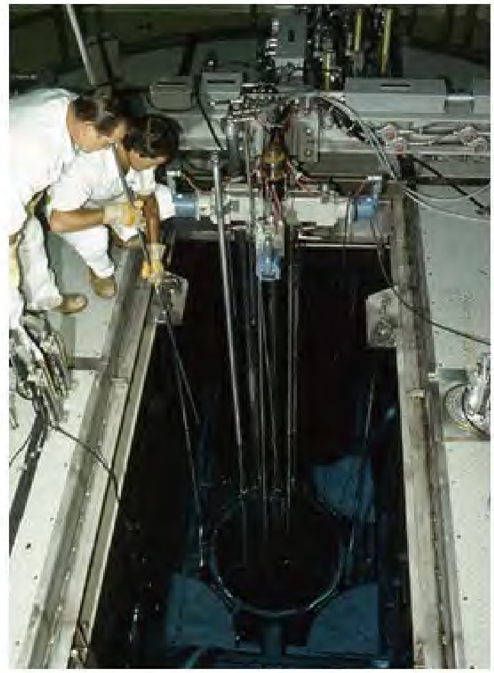
In order to prepare for decommissioning, CNL has transferred some of these services to alternative locations on the site. An active laundry was no longer required as disposable coveralls are now used for radiological work.

Figures 6 and 7: B200 (left) and B411 (Right)

A conventional laundry facility was still required and was developed in Building B300. Decontamination services and respirator cleaning and maintenance services were also transferred to reconfigured areas of Building B300. Decommissioning planning continues for Buildings B200 and B411.

SLOWPOKE Demonstration Reactor: The SDR (Figures 8 and 9) located in Building B100 was developed to demonstrate the viability of using it for heating communities and commercial establishments. AECL operated the SDR for 614 hours between 1989 and 1990.

After shutdown, fuel was removed as was the reactor control system. The pool water level was lowered, and in 1996, the remainder of the pool and piping were drained. LLW (activated reactor components such as shim plates, beryllium blocks and lower support brackets) were then removed and transferred to the WMA.



Figures 8 and 9: SLOWPOKE Demonstration Reactor circa 1990

Final dismantlement includes the removal of the remaining systems, including the cooling and shutdown systems, the remaining control system, instrumentation, auxiliary systems and the stainless steel pool liner. The end state is complete removal of the reactor components with the concrete pool vault remaining intact and covered. CNL expects to complete dismantlement of the SDR by March 2016.

WR-1 Reactor: Activities associated with decommissioning of the WR-1 reactor located in Building B100 (Figure 10) are focussed on planning and documenting the various steps associated with the detailed decommissioning plan.

Figure 10: B100

The removal of asbestos and clearing space for dismantlement activities (SDR decommissioning) has been a recent focus and decommissioning planning continues.

CNL has completed asbestos abatement in the non-restricted areas and as noted previously, CNL is proposing that decommissioning be completed by 2025.

Waste Management Area: WL's WMA (Figure 11) was developed when the facility was first opened. CNL conducts projects to re-characterize the performance and condition of structures, assess waste conditions, assess environmental conditions and assess the potential for environmental impacts. CNL is also conducting projects to improve access to the area and to reduce and repackage existing waste. Projects include:

- continuing waste characterization studies and condition assessments in standpipes, evaluating remediation options, and developing future strategies;
- continuing studies in the ILW storage bunkers and developing approaches for future management, including gathering information on ground conditions, radionuclide inventories, waste characteristics and condition assessments;
- developing a modular workspace complex; a support pad has been constructed, however the project is currently on hold pending completion of a needs analysis;
- reconfiguring Building B421 as a waste repackaging facility for wastes from the early decommissioning of WR-1. Wastes are being sorted and repackaged to reduce fire loading and to reduce waste volumes. Currently, the project is well underway and radioactive wastes are being repackaged into steel containers for placement in the Shielded Modular Above Ground Storage Building.

Figure 11: Waste Management Area including the concrete canister storage facility

Other Activities: As the number of buildings on site has reduced, CNL has reconfigured WL's heating system to convert it from a centralized oil system to a localized electrical/propane heating system. As part of this project, the oil storage tanks from the power house were decommissioned and removed. The power house remains in operation as it provides water services to the site.

CNL is conducting other projects including:

- the removal of storage sheds;
- the remediation of the meteorological tower area and the removal of associated sheds, electrical panels, communication equipment and tower sections;
- the relocation of the truck monitor, the removal of the gate house and the construction of a new entry gate system;
- ongoing maintenance and evaluations (reroofing projects, aging management inspections, fire protection system testing and maintenance and facility and support systems safety reviews.

4 OVERALL CONCLUSIONS

CNSC staff conclude that:

- CNL is maintaining Douglas Point, Gentilly-1, Nuclear Power Demonstration and the Whiteshell Laboratories safely in compliance with the requirements of the *Nuclear Safety and Control Act* and their licences; and
- CNL is making progress on the decommissioning of Whiteshell Laboratories in accordance with their approved decommissioning plans.

GLOSSARY

AECL	Atomic Energy of Canada Limited
CNL	Canadian Nuclear Laboratories Limited
CMD	Commission Member Document
DP	Douglas Point
G-1	Gentilly-1
HLW	High-Level Radioactive Waste
ILW	Intermediate-Level Radioactive Waste
LLW	Low-Level Radioactive Waste
NPD	Nuclear Power Demonstration
SDR	SLOWPOKE Demonstration Reactor
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactor 1

APPENDIX A – REACTOR FACILITIES

Reactor	Operations		Decommissioning			Estimated Decommissioning Waste	
	Start	Duration (years)	Phase 1	Current Status	Begin Phase 3 (Duration)	Radiological (m^3)	Clean (m^3)
Douglas Point 200 MW power reactor	1968	16	1984-1988	Phase 2 (storage with surveillance)	2103 (6 Years)	7,400	34,000
Gentilly-1 250 MW power reactor	1972	8 0.5 full-power	Laid up 1980-1984, 1984-1986	Phase 2 (storage with surveillance)	2053-2103 (5 Years)	11,300	7,600
Nuclear Power Demonstration 20 MW power reactor	1962	25	1987-1988	Phase 2 (storage with surveillance)	2056-2106 (4-6 Years)	2,200	9,900
WR-1 60 MW research reactor	1965	20	1989-1995	Phase 2 (storage with surveillance)	2025-2030 (6 Years)	500	510
Slowpoke 2 MW Demonstration Reactor	1989	1	1990 - 1996	Phase 3 (final decommissioning)	Began 2015 (1 year)	0	189

APPENDIX B – WASTE INVENTORY TABLES

Location	Classification of Waste	Description of Waste	Storage Method	Number of Bundles or Volume	Activity (TBq)
Douglas Point	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	22,256 bundles	na
	Intermediate-level waste	Waste from reactor decommissioning	Reactor building	61 m^3	6.9
	Low-level waste	Contaminated soils	205-litre drums	66 m^3	na
	Low-level waste	Waste from reactor decommissioning	Reactor building	85 m^3	0.009
Gentilly-1	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	3,213 bundles	na
	Intermediate-level waste	Waste from reactor decommissioning	Reactor building	27 m^3	0.3
	Low-level waste	Contaminated soils	205-litre drums	1 m^3	na
	Low-level waste	Waste from reactor decommissioning	Reactor building	927 m^3	0.09
Nuclear Power Demonstration	Low-level waste	Waste from reactor decommissioning	Reactor building	23.4 m^3	0.002
Whiteshell Laboratories	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	2,268 bundles	na
	Intermediate-level waste	Research reactor waste and waste from reactor decommissioning	In-ground concrete bunkers	863 m^3	2,942
	Intermediate-level waste	Waste from decommissioning activities	In-ground concrete bunkers	22 m^3	0.018
	Low-level waste	Research reactor waste and waste from reactor decommissioning	Above-ground concrete bunkers	19,885 m^3	333
	Low-level waste	Waste from decommissioning activities	Above-ground concrete bunkers	738 m^3	0.080

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 18-M30

Date signed/Signé le : JUNE 22, 2018

Reference CMDs/CMDs de référence : 16-M12, 16-M44

Technical Briefing

Exposé technique

Canadian Nuclear Laboratories (CNL)

Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative

Laboratoires Nucléaires Canadiens (LNC)

Rapport d'étape sur les installations prototypes de gestion des déchets, les Laboratoires de Whiteshell et l'Initiative dans la région de Port Hope des LNC

Public Meeting

Réunion publique

Scheduled for:

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Prévue pour :

Le 22 août 2018

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

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Summary

This Commission Member Document (CMD) provides the Commission with a progress update on licensed activities as of April 1, 2018 at Canadian Nuclear Laboratories' prototype waste facilities (Douglas Point, Gentilly-1, Nuclear Power Demonstration), Whiteshell Laboratories, as well as remediation activities under the Port Hope Area Initiative.

Canadian Nuclear Laboratories is the licence holder for all of these sites.

There are no actions requested of the Commission. This CMD is for information only.

Résumé

Le présent document à l'intention des commissaires (CMD) fournit à la Commission un rapport d'étape sur les activités autorisées au 1er avril 2018 aux installations prototypes de gestion des déchets (à Douglas Point, Gentilly-1 et au réacteur nucléaire de démonstration) et aux Laboratoires de Whiteshell, ainsi que sur les activités du projet de remise en état prévues dans le cadre de l'Initiative dans la région de Port Hope des Laboratoires Nucléaires Canadiens.

Laboratoires Nucléaires Canadiens sont le titulaire de permis pour chacun de ces sites.

Aucune mesure n'est requise de la Commission. Ce CMD est fourni à titre d'information seulement.

Signed/Signé le

June 22, 2018

Haidy Tadros

Director General

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EXECUTIVE SUMMARY

This CMD provides a progress update on Canadian Nuclear Laboratories' (CNL) licensed decommissioning activities at three shut down power reactors (Douglas Point, Gentilly-1 and Nuclear Power Demonstration, also known as prototype waste facilities) and Whiteshell Laboratories, as well as licensed remediation activities under the Port Hope Area Initiative (PHAI). This CMD is provided in response to the Commission's requests of October 24, 2012 and April 6, 2016 to receive periodic updates on the status of these projects.

The three shut down power reactors are Douglas Point (DP) in Tiverton, ON, Gentilly-1 in Bécancour, QC and Nuclear Power Demonstration in Rolphton, ON. These facilities ceased operations in the 1980s and were placed in safe shut down states. Since that time, the facilities have been in storage-with-surveillance phase. This is a planned phase of a deferred decommissioning strategy for nuclear reactors. As part of storage-with-surveillance, CNL continues to carry out care and maintenance activities, reduces hazards and liabilities, and undertakes decommissioning planning activities for final decommissioning and site closure.

Whiteshell Laboratories (WL) is a nuclear research and test facility located near Pinawa, Manitoba, which was originally operated by Atomic Energy of Canada Limited (AECL). It consists of the Whiteshell Reactor No. 1 (WR-1), a SLOWPOKE demonstration reactor, and other research and support facilities; WR-1 was shut down in 1985. In the late 1990s, AECL discontinued most research programs and operations at WL. A CNSC decommissioning licence was issued in 2003, renewed in 2008 and amended in 2016 to include a Licence Conditions Handbook. CNL continues to decommission the Whiteshell site under the current decommissioning licence, which expires in December 2018. In 2016, CNL submitted to the CNSC a project description to change the CNSC-approved decommissioning approach (full dismantling) to a new proposed approach for the WR-1 reactor (*in-situ* decommissioning). In order to have time to disposition comments received on the new proposed approach, in 2018, CNL applied for a licence renewal for a one-year term.

The PHAI represents the Government of Canada's commitment to the development and implementation of a safe, local, long-term management solution for historic low-level radioactive waste in the municipalities of Port Hope and Clarington, Ontario. The PHAI is being carried out as two separate projects, the Port Hope Project and Port Granby Project, under separate CNSC licences. At Port Granby, the long-term waste management facility (LTWMF) base liner construction was completed in 2016 and the excavation and emplacement of legacy wastes in the LTWMF is nearing completion. At Port Hope, the construction of the first of three cells of the LTWMF has been completed and emplacement of wastes has begun. CNL continues to conduct surveys of residential and commercial properties in Port Hope, aimed at identifying and remediating those that have historic low-level radioactive waste.

CNSC staff confirmed through inspections and desktop reviews that CNL continued carrying out work at these sites safely, and in compliance with the requirements of the *Nuclear Safety and Control Act* and their respective licences.

Referenced documents in this CMD are available to the public upon request.

1 OVERVIEW

During a Commission Meeting held on April 6, 2016 CNSC staff committed to provide periodic progress updates for the three CNL shut down power reactors, and Whiteshell Laboratories (WL), a shut down nuclear research and test facility. The shut down power reactors are Douglas Point in Tiverton, ON, Gentilly-1 (G-1) in Bécancour, QC and Nuclear Power Demonstration (NPD) in Rolphton, ON. These three facilities are also known as prototype waste facilities. CNSC staff's previous update to the Commission on these sites was included in CMD 16-M12. During a Commission Meeting held on October 24, 2012 CNSC staff committed to provide progress updates on the Port Hope Area Initiative (PHAI), a clean-up of historic wastes in the region of Port Hope, ON. CNSC staff's last update to the Commission on the PHAI was delivered on November 9, 2016 as CMD 16-M44. CNSC staff have combined these two commitments to provide progress updates into this Commission Member Document (CMD).

The information presented in this CMD covers the period from January 1, 2016 to April 1, 2018 for the three shut down power reactors and WL, and from July 1, 2016 to April 1, 2018 for the PHAI. The start dates of these periods correspond to the end dates in the previous progress updates to the Commission.

2 REGULATORY OVERSIGHT

The Commission authorized CNL to conduct the activities related to decommissioning and remediation at the project sites that are covered by this report following the CNSC's public hearing process. Table 1 lists the licences, their expiration dates, and makes reference to Commission Records of Decision for CNL's licence projects covered by this report.

Table 1: Licences covered by this CMD

Licence Number	Facility/Site	Expiry	Record of Decision
WFDL-W4-332.01/2034	Douglas Point Gentilly-1 Nuclear Power Demonstration	December 31, 2034	e-Doc 4471304
NRTEDL-W5-8.04/2018	Whiteshell Laboratories	December 31, 2018	e-Doc 3008086
WNSL-W1-2310.02/2022	Port Hope Long-Term Low-Level Radioactive Waste Management Project	December 31, 2022	e-Doc 4083842
WNSL-W1-2311.01/2021	Port Granby Long-Term Low-Level Radioactive Waste Management Project	December 31, 2021	e-Doc 3846017
WNSL-W1-182.0/2021	Pine Street Extension Temporary Storage Site	December 31, 2021	e-Doc 4535241
WNSL-W1-344-1.8/ind.	Port Hope Radioactive Waste Management Facility	Indefinite	e-Doc 5067125
WFDL = Waste Facility Decommissioning Licence NRTEDL = Nuclear Research and Test Establishment Decommissioning Licence WNSL = Waste Nuclear Substance Licence			

CNSC staff evaluate and confirm compliance with the licence and the licensing basis through verification, enforcement and reporting activities. CNSC staff develop compliance plans for each site, commensurate with the risk associated with the licensed activities at each site. Compliance verification activities conducted by CNSC staff include inspections, review of reports submitted by the licensee on a broad range of technical assessments, and the review and assessment of licensee programs and processes.

A summary of CNSC staff's compliance and licensing efforts associated with the shut down power reactors, WL and PHAI can be found in tables 2 and 3.

Table 2: CNSC regulatory effort on CNL's shut down power reactors and Whiteshell Laboratories, from January 1, 2016 to March 31, 2018

<table>
<tr><th>Facility</th><th>Number of onsite inspections</th><th>Person days for compliance</th><th>Person days for licensing activities</th></tr>
<tr><td>Douglas Point</td><td>4</td><td rowspan="3">573</td><td rowspan="3">707</td></tr>
<tr><td>Gentilly-1</td><td>3</td></tr>
<tr><td>Nuclear Power Demonstration</td><td>2</td></tr>
<tr><td>Whiteshell Laboratories</td><td>6</td><td>575</td><td>527</td></tr>
</table>

Table 3: CNSC regulatory effort on Port Hope Area Initiative licences, from July 1, 2016 to March 31, 2018

Facility	Number of onsite inspections	Person days for compliance	Person days for Licensing activities
Port Hope Project	10	582	148
Port Granby Project	11	413	38
Radioactive waste management facility	2	31	5
Pine Street Extension Temporary Storage site	2	43	3

Based on all the regulatory oversight activities that CNSC staff have conducted, CNSC staff are satisfied that CNL takes adequate measures to ensure that the public, workers and the environment are protected, and that these sites remain safe.

CNSC Independent Environmental Monitoring Program

The CNSC carries out its Independent Environmental Monitoring Program (IEMP) to verify and confirm that the public and the environment around licensed nuclear facilities remain safe. The IEMP is a regulatory tool that complements the CNSC's ongoing compliance verification program. The IEMP involves CNSC staff taking samples from publically accessible areas around nuclear sites, and measuring and analyzing the level of relevant contaminants in those samples.

Samples may be taken for air, water, soil, sediment, vegetation, and some food, such as locally-grown produce. Samples are analyzed at the CNSC's laboratory for both radiological and non-radiological contaminants related to the activities of the nuclear site. CNSC staff compare contaminant levels in samples to applicable guidelines and/or natural background levels. All IEMP sample results and associated standards are posted on the CNSC's IEMP website.

In 2016 and 2017, CNSC staff conducted independent environmental monitoring around the sites covered by this CMD as shown in table 4. Detailed IEMP results for the areas surrounding these sites are available on the CNSC's IEMP website and indicate that the public and the environment, in the vicinity of these sites, are protected. Independent environmental monitoring is scheduled to occur in 2018 around the NPD site in Rolphton, ON.

Table 4: IEMP activities around sites covered by this report, January 1, 2016 to April 1, 2018

Site	Date(s)
Gentilly-2 Nuclear Facility (including the Gentilly-1 Waste Facility)	October 2016
Bruce Nuclear Generating Station (including the Douglas Point Waste Facility)	October 2016
Whiteshell Laboratories	July/August 2017
Welcome (Port Hope) and Port Granby Waste Management Facilities	May 2017 and August 2017

Waste Inventories

Radioactive wastes stored on the sites covered by this report consist of high-intermediate and low-level radioactive waste. Appendix A provides the inventory of wastes stored as reported in *Canada's Sixth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2017)*. The report can be found on the CNSC's website.

3 PROJECT UPDATE

3.1 Decommissioning Projects

3.1.1 Background

CNL is currently decommissioning three shut down power reactors and a shut down nuclear research and test facility. Decommissioning encompasses a wide variety of activities to retire a licensed facility or site permanently from service and render it to a predetermined end-state. It may include any or all of the following activities: de-energizing and emptying systems, dismantling equipment and facilities, segregating and transferring wastes to waste storage areas, or maintaining facilities in a storage-with-surveillance state. The decommissioning strategy and end point are documented in the decommissioning plans that are associated with each site and form part of the approved licensing basis. CNL has developed decommissioning plans that include final end-state objectives and provided associated financial guarantees (FG) to assure the CNSC that it can access adequate funding upon demand, should the licensee not be able to fulfill its obligations. A FG must be sufficient to cover decommissioning work resulting from licensed activities or activities that will take place under the current licence.

As described in the decommissioning plans for DP, G-1, NPD and WL, CNL is employing a deferred decommissioning strategy. The three phases of deferred decommissioning are:

- Phase 1 – bring the facility to a safe sustainable shut down state suitable for storage with surveillance
- Phase 2 – the storage with surveillance period
- Phase 3 – final decommissioning where the facility achieves its final end state

While the decommissioning phases are the same for all facilities, the duration of each phase may vary depending on the specific CNSC-approved decommissioning plan for each of the facilities.

Shut Down Power Reactors

DP, G-1 and NPD, are in Phase 2 – storage-with-surveillance. The current licence for these facilities authorizes only Phase 2 activities.

As part of Phase 2 activities for decommissioning, the CNSC licence requires that CNL implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection. CNL must ensure that facility structures that have yet to be finally decommissioned remain accessible for inspection and maintenance and they must also maintain monitoring and surveillance programs.

As described in the shut down power reactor preliminary decommissioning plans (PDPs), by the end of final decommissioning phase (i.e., decontamination, the dismantling, disposal, and site restoration), the shut down power reactor sites will be free of industrial hazards. The used fuel, radioactive wastes and all radioactive contamination in excess of the clearance levels established in CNSC Regulations and all other hazardous materials will have been removed from the sites. All of the systems will have been dismantled and all of the buildings demolished. Subsurface structures will have been drained, de-energized and decontaminated. The proposed end-states for the sites are brown field restored for industrial use.

According to the current PDPs, these facilities are to be maintained in storage-with - surveillance with Phase 3 activities planned to begin in 2053-2103 (G-1), 2030-2043 (NPD) and 2103 (DP). Prior to performing Phase 3 activities, CNL will have to submit Detailed Decommissioning Plans (DDPs) to the Commission for acceptance.

Whiteshell Laboratories

The WL site is currently in Phase 3 – final decommissioning, with the exception of the WR-1 reactor, which remains in Phase 2-storage with surveillance. The current CNSC-approved decommissioning approach for the WR-1 reactor is to fully remove and package all activated and contaminated components for disposal in licensed offsite facilities, to decontaminate the facility structure and then to demolish the building to achieve unrestricted release criteria.

As described in WL's CNSC-approved DDP, the end-state is the complete removal of radioactive materials from the site, with the exception of contaminated river sediments and the low-level radioactive waste (LLW) trenches that will be disposed of *in-situ*. CNL's current CNSC-approved decommissioning plan foresees that decommissioning will be completed by 2050. CNL plans a long-term institutional control period of 200 years after the cessation of physical decommissioning activities. It should be noted that the final safety case for the *in-situ* disposal of the LLW trenches was not fully developed for this plan and still needs to be provided to and assessed by CNSC staff prior to CNL proceeding.

3.1.1.1 CNL's Proposed Accelerated Decommissioning Approach

In a letter dated October 23, 2015 CNL notified CNSC staff of its intent to accelerate and change the decommissioning approach for NPD and WL. Under this proposed accelerated schedule, CNL expects to complete the final decommissioning of WL in 2024, and the decommissioning of NPD in 2020. CNSC staff note that the proposed decommissioning approach and end-state for these projects vary from what has been previously approved by the Commission. CNL is required to seek the Commissions' approval to amend the current licences. CNL is further required to revise, update and reassess key planning tools for the new approaches, such as the DDPs. Additionally, new environmental assessments (EA) for NPD and WL are required under CEAA 2012; these new EAs have begun. Licensing for NPD and WL are further discussed in sections 3.1.4.2 and 3.1.5.2, respectively.

3.1.2 Douglas Point

The Douglas Point Waste Facility is located on the Bruce nuclear site near Kincardine, Ontario (figure 1). It is comprised of a reactor building, service building, turbine building/administration wing, an area for the storage of concrete canisters filled with used nuclear fuel and several outbuildings.

Figure 1: Douglas Point Waste Facility *(Source: CNL*)

The 200 megawatt electric (MWe) prototype CANDU power reactor was put into service in 1968 and permanently shut down in May 1984. Following the shut down of the reactor, the primary heat transport and moderator medium (heavy water) were safely drained and shipped to other licensed operating sites. The booster rods were safely removed and shipped to Chalk River Laboratories (CRL) for storage in February 1985. Non-radioactive hazardous materials, such as combustible and flammable materials, laboratory supplies and oils, were identified and safely disposed. The transfer of spent fuel from wet storage in the reactor pool to a dedicated licensed dry storage facility was completed in 1988.

Disassembly and decontamination of equipment, and consolidation of wastes, were completed as required. All radioactive or radioactively contaminated components that were not shipped to other facilities were consolidated onsite.

Since that time, the facility has been maintained in Phase 2 – storage-with-surveillance as part of deferred decommissioning. As part of Phase 2, the CNSC licence requires that CNL implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection. CNL must ensure that facility structures remain accessible for inspection and maintenance. Hazard reduction activities can also form part of Phase 2, such as CNL's plans to reduce the footprint of the DP facility by demolishing some non-nuclear facilities over the next seven years, such as the Emergency Cooling Injection System Tank and Bunker, the Turbine Building and the Service Building, among others.

CNL anticipates beginning final decommissioning in 2059. The current CNSC-approved approach and end-state for DP is the eventual removal of used fuel and of radioactive components/wastes to licensed storage and/or disposal facilities, followed by the demolition of the buildings and structures. The proposed end-state for the site is a brown field restored for industrial use consistent with the rest of the Bruce Site.

3.1.2.1 Progress Update

CNL has been carrying out hazard reduction work at DP over the period covered by this report. CNL continues to provide CNSC staff with plans and progress updates for the activities they are carrying out under the programs approved by their CNSC licence and in accordance with the PDP. Since the last update to the Commission, CNL safely transferred approximately 35,000 gallons of lightly contaminated water that was stored in tanks at the DP site to CRL for treatment. In addition, CNL has characterized ion exchange resins stored at DP. The resins will be recovered and packaged in containers for storage at CRL following the resins retrieval at G-1 (described in section 1.1.1). Until the resins are moved, CNL continues to monitor and verify the integrity of the storage tanks which, to date, continue to perform well.

With approval from CNSC staff, CNL carried out the following non-nuclear decommissioning activities at DP in the period covered by this report:

- Demolition of the guard house, machine shop, plate shop and tool crib, according to DDPs approved by CNSC staff. All waste was proven non-radioactive and cleared from the site for recycling or disposal in municipal landfills.
- Characterization of the Emergency Cooling Injection System (ECIS) Tank in support of a DDP approved by CNSC staff. The ECIS tank is planned to be removed in 2018.

CNSC staff verified CNL's compliance with regulatory requirements through inspections and by review of relevant CNL documentation. CNSC staff have confirmed that all actions raised during this reporting period have been closed.

3.1.3 Gentilly-1

The G-1 Waste Facility is situated within Hydro-Québec's Gentilly-2 nuclear power plant boundary in Bécancour, Québec (figure 2). The facility consists of a permanently shut down, partially decommissioned prototype reactor and associated structures and ancillaries.

Figure 2: Gentilly-1 Waste Facility *(Source: CNL)*

The G-1 reactor was a 250 MWe boiling light water reactor put into service in May 1972. It was operated intermittently for a total of 183 effective full-power days until 1978, when it was determined that some modifications and considerable repairs would be required. In 1984, a decommissioning program was initiated to bring the G-1 station to a safe sustainable shut down state that permitted storage-with-surveillance.

The moderator (heavy water) was safely drained and shipped to other licensed operating sites. Non-radioactive hazardous materials, such as combustible and flammable materials, laboratory supplies and oils, were identified and safely disposed of. The transfer of spent fuel from wet storage to dry storage in the purpose-built canister storage area was completed in 1986. Disassembly and decontamination of equipment, and consolidation of wastes, were completed as required. All radioactive or radioactively contaminated components that were not shipped to other facilities were consolidated onsite in either the reactor building or turbine building.

Since 1986, the facility has been maintained in Phase 2 – storage-with-surveillance as part of deferred decommissioning. As part of Phase 2, the CNSC licence requires that CNL implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection. CNL must ensure that facility structures remain accessible for inspection and maintenance. Hazard reduction activities can also form part of Phase 2.

CNL anticipates beginning final decommissioning in 2064. The current CNSC-approved approach and end-state for G-1 is the eventual removal of used fuel and of radioactive components/wastes to licensed storage and/or disposal facilities, followed by the demolition of the buildings and structures. The proposed end-state for the site is a brown field restored for industrial use.

3.1.3.1 Progress Update

CNSC staff continue to receive plans and progress updates from CNL for the activities they are carrying out under the programs approved by their CNSC licence and in accordance with the PDP.

In the early spring of 2018, a system was designed and deployed to retrieve the Heat Transport Purification System (HTPS) resins from the underground vaults in which they have been stored for the last 30 years; approximately 90 m^3 of the total 126 m^3 of resins have been safely retrieved and transferred to CRL for interim storage. A separate system has been designed and successfully tested to retrieve the Moderator Purification System (MPS) resins; this system will be deployed following completion of the HTPS retrievals. In March of 2018, CNSC staff conducted an inspection at the G-1 site and observed the resin retrieval process. CNSC staff noted a number of good practices by the licensee in the fields of radiation protection, conventional health and safety, and management systems.

CNL is progressively dispositioning low-level waste stored in the reactor building. 45,000 kg of wastes have been safely transferred to a licensed waste processing facility and a contract is in place to retrieve and transfer an additional 250,000 kg of waste. Processing residues will be sent to CRL for interim storage. In addition, asbestos abatement work has been carried out in both the Turbine Building and the Reactor Building. Further abatement will be carried out in the reactor building to enable the removal of the low-level waste.

CNSC staff verified CNL's compliance with regulatory requirements through inspections and by review of relevant CNL documentation. CNSC staff have confirmed that all actions raised during this reporting period have been closed.

3.1.4 Nuclear Power Demonstration

The NPD site (figure 3) is located in Rolphton, ON, adjacent to the Ottawa River and approximatively 25 km upstream of the CRL site.

Figure 3: Nuclear Power Demonstration Facility *(Source: CNL)*

NPD was a 20 MWe prototype CANDU power reactor that was placed in service in October 1962, and operated until May 1987. It was then permanently shut down; all process systems not required were drained and removed from service, including the heavy water moderator and heat transport system. The spent fuel was safely transferred to the CRL site, and the facility was placed in a state of storage-with-surveillance.

The current CNSC staff-approved PDP for NPD indicates that final decommissioning will begin in the 2030-2043 timeframe. The deferred decommissioning approach and end-state includes the removal of radioactive components/wastes and demolition of the buildings and structures, with wastes sent to a licensed storage/disposal facility. This will allow return of the land to unrestricted use. CNL has requested an amendment to the current licence covering NPD (see section 3.1.4.2).

3.1.4.1 Progress Update

Under its current licence, CNL continues to maintain the NPD site in Phase 2 – storage-with-surveillance. As part of Phase 2, the CNSC licence requires that CNL implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection. During this phase, routine inspections, housekeeping and continuous monitoring of the facility are performed regularly by CNL. CNL is also currently carrying out a number of CNSC-authorized preparatory activities (e.g., hazard reduction, characterization) for final decommissioning. For example, CNL completed the removal of accessible asbestos from the site's boiler room in June 2017. Safety improvements completed by CNL during this period include repairs to ladders, railings and platforms throughout the facility, along with relocating the personal protective equipment change room and radiation protection storage area to a more appropriate location. CNL also re-established access and maintained contamination control between the NPD Reactor Hall (a non-nuclear area) and NPD's Stairwell 21 (a nuclear area) with removal of a previously blocked up access way and installation of a fire door.

In preparation for decommissioning, CNL has completed several characterization activities of the facility structure and systems during the reporting period, this includes: the primary heat transport and moderator system, the reactor system and the building structure.

CNSC staff verified CNL's compliance with regulatory requirements through inspections and by review of relevant CNL documentation. CNSC staff have confirmed that all actions arising during this reporting period have been closed with the exception of one low-risk item related to CNL's internal inspection documentation for the NPD site. This item is anticipated to be closed in the summer of 2018.

3.1.4.2 Licensing

In March 2016, CNL submitted to the CNSC a Project Description to change the CNSC-approved decommissioning approach (full dismantling of NPD) to a new proposed approach, that is, *in-situ* decommissioning of the NPD reactor (also known as entombment). *In-situ* decommissioning is an approach in which the remaining radioactive material is permanently encapsulated in place, effectively creating a waste repository.

CNSC staff have determined that, in accordance with the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) and the *Nuclear Safety and Control Act* (NSCA) and their associated Regulations, an environmental assessment (EA), conducted under CEAA 2012, and an amendment to the current licence, are required for the new proposed NPD Closure Project. Under CEAA 2012, CNSC staff are the Responsible Authority to ensure an EA for the project is conducted in accordance with requirements. In September 2017, CNL submitted a draft environmental impact statement (EIS) in support of the EA and an application to amend the current licence for review by CNSC staff. CNSC staff are leading the review and comment on the draft EIS by federal and provincial authorities (Environment and Climate Change Canada, Health Canada, Government of Quebec, and the Ontario Ministry of Environment and Climate Change), Indigenous groups and the public.

As part of the CEAA 2012 process, CNL has determined they need additional time to address the large number of comments raised by the public, First Nations, Métis communities and regulators in relation to the draft EIS. Consequently, on June 6, 2018, CNL informed the Commission that the final EIS, originally expected in June 2018, and the public hearing, which had been tentatively planned for December 2018, will be delayed. Both the EA and the licence amendment application will be subject to decisions made by the Commission at a future date through a public hearing process.

3.1.5 Whiteshell Laboratories

The Whiteshell Laboratories was established by AECL in the early 1960s to carry out nuclear research and development activities. In 1997, AECL decided to discontinue most research programs and operations at Whiteshell and applied to the CNSC for a decommissioning licence.

The WL site is 4,375 hectares in size and consists of a main campus area and a waste management area. The main campus includes the WR-1, a 60 megawatt thermal (MWth) research reactor, which operated from 1965 to 1985.

While the WR-1 reactor was initially the main focus of the facility, other programs were added, including the nuclear fuel waste management program, various research programs including environmental and radiation studies, and technology demonstration programs including accelerator projects and a SLOWPOKE demonstration reactor (SDR).

Figure 4: Whiteshell Laboratories Main Campus *(Source: CNL)*

The main campus of WL (figure 4) consists of offices, laboratories, hot cell facilities, the WR-1 research reactor and numerous support buildings. Located approximately 2.7 km north-east of the main campus, the waste management area (figure 5) contains Low-Level (LLW), Intermediate-Level (ILW) and High-Level (HLW) radioactive waste.

Figure 5: Whiteshell Laboratories Waste Management Area *(Source: CNL)*

3.1.5.1 Progress Update

Since the last update to the Commission in 2016, there has been continued progress made in decommissioning activities being performed at the Whiteshell site. CNL is planning, implementing and completing decommissioning activities, in accordance with CNSC approved decommissioning plans. CNL is also maintaining the WR-1 reactor in a state of storage-with-surveillance, while preparing for final decommissioning. As part of ongoing work, the CNSC licence for WL requires that CNL implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection. CNL must ensure that facility structures that have yet to be decommissioned or are undergoing decommissioning remain accessible for inspection and maintenance.

The following are some of the WL decommissioning program activities that have been conducted by CNL, since the last update to the Commission in 2016.

Research Building B300

Building B300 was a central research complex that originally contained numerous laboratories, offices, mechanical rooms and areas for large-scale engineering projects. B300 was constructed in seven separate stages, and decommissioning is being conducted according to those stages. The first two stages dismantled were stages 4 and 7, as shown in figure 6. CNL completed demolition of stages 4 and 7 of Building B300 in 2016 as shown in figure 7.

Figure 6: Whiteshell Laboratories B300, stages 4 & 7 *(Source: CNL)*

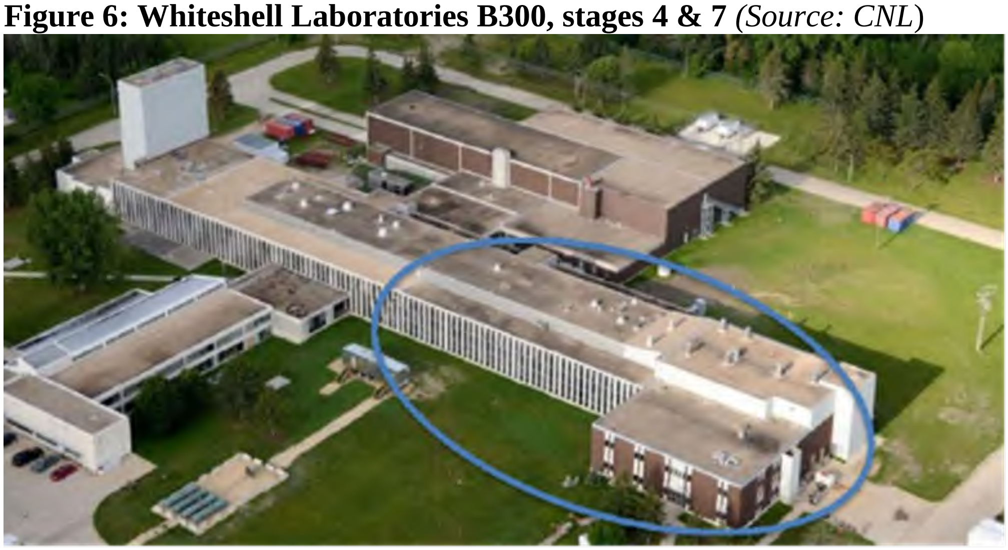


Figure 7: Whiteshell Laboratories B300 after removal of stages 4 & 7 *(Source: CNL)*

Decontamination Centre

Building B411, the WL decontamination centre (figure 8) originally housed a laundry for contaminated clothing, decontamination services for tools and items and respirator cleaning and maintenance services. The building was shut down in 2016, with decommissioning/demolition complete in 2017.

Figure 8: Whiteshell Laboratories B411 Decontamination Centre *(Source: CNL)*

Active Liquid Waste Treatment Centre

The active liquid waste treatment centre (building B200, figure 9) was originally constructed to manage both ILW and LLW liquid waste streams from buildings B411, B100 and B300. Constructed of concrete, the active liquid waste treatment centre is an indoor tank farm consisting of 12 storage tanks, glove boxes, piping, and other related equipment.

The ILW circuit was shut down in 2001 while the LLW circuit was shut down in 2017. Any liquid waste currently being generated within B300 or B100 is now collected and treated with new, independent systems located in each building.

Decommissioning activities have begun in B200, including characterization and hazard reduction in preparation for building demolition. Hazard reduction activities have included asbestos remediation, application of fixatives on the interior of tanks, the removal of active drain lines, the drum filling station and fume hoods. Building demolition is planned for 2019.

Figure 9: Whiteshell Laboratories B200 Active Liquid Waste Treatment Centre *(Source: CNL)*

SLOWPOKE Demonstration Reactor (SDR)

The SDR was developed in Building B100 to demonstrate the potential of using SLOWPOKE reactors for heating communities and commercial establishments. AECL operated the SDR for 614 hours between 1989 and 1990.

After shut down, fuel was removed and shipped to CRL. The pool water level was lowered, and in 1996, the remainder of the pool and piping was drained. Final dismantlement of the reactor, with the exception of the stainless steel pool liner, was completed in 2016. The pool liner will be decommissioned as part of the B100 building structure demolition, planned for 2022.

WR-1 Reactor

The WR-1 reactor is located in building B100 (figure 10). Recent decommissioning activities in this building have included the relocation of office areas, the removal of asbestos in accessible areas and characterization of reactor components.

Figure 10: Whiteshell Laboratories Building B100 *(Source: CNL)*

CNL's current CNSC-approved decommissioning plan foresees that decommissioning will be completed by 2050, while CNL's new proposed accelerated decommissioning approach would lead to WR-1 being decommissioned *in-situ* by 2025.

Waste Management Area

WL's Waste Management Area (WMA, figure 5) was developed when the facility was first opened. CNL conducts projects to re-characterize the performance and condition of structures, assess waste conditions, assess environmental conditions and assess the potential for environmental impacts. As part of the CNSC approved decommissioning plans, CNL is conducting projects to improve access to the area, reduce and repackage existing waste, and prepare facilities to be decommissioned.

CNSC staff have evaluated CNL's compliance during inspections of the waste management areas and are satisfied that CNL is carrying out decommissioning work in accordance with the licensing basis.

Some of the WL decommissioning activities that have been conducted by CNL at the Waste Management Area since the last update to the Commission are listed below:

- Preparing for the extraction of waste from the ILW bunkers and standpipes. This work began in 2017 and includes contracting out the design/build of systems for remediating these facilities (60% design complete).
- Construction work for expansion of the protected area in the WMA that surrounds the standpipes. This is required to allow space for the extraction of wastes noted above. The expanded protected area encompasses the standpipes and the ILW bunkers and will be activated in 2018.
- Developing a modular workspace complex at the entrance of the WMA to control and coordinate worker access to the WMA.

- Completing waste segregation and repackaging. Since 2016, most WR-1 and some other WMA wastes have been sorted and repackaged, in order to reduce fire loading in storage buildings and to reduce waste volumes. Repackaged wastes have been placed into steel containers and transferred to storage in the Shielded Modular Above Ground Storage building.

- Shipping to CRL of over sixty Cs-137 and Cf-252 sources and approximately 1500 m^3 of soil waste from the former Experimental Cesium Pond.

Other Activities

- The decommissioning/demolition of several non-nuclear buildings, totaling more than 4700 m^2 of floor space dispositioned to licensed disposal facility.

- Ongoing inspections maintenance (aging management inspections, fire protection system testing and maintenance, and facility and support systems safety reviews).

3.1.5.2 Licensing

The first decommissioning licence for WL was issued by the Commission following a public hearing in January 2003 (CMD 02-H19). This licence was subsequently renewed for a 10-year period in November 2008 (CMD 08-H24).

In September 2017, CNL submitted its renewal application for the WL licence for a 10-year period to the CNSC. As part of the application, CNL proposed a new decommissioning approach for the WR-1 reactor, moving from the original deferred dismantling strategy to *in-situ* decommissioning. CNSC staff have reviewed the licensing basis documentation and provided comments to CNL.

Under the NSCA, CNL's proposal requires an amendment to its existing licence issued by the Commission. CNL's proposal also requires an EA be conducted under CEAA 2012 and EA decision affirming that the proposed activities will not cause significant adverse environmental effects. Under CEAA 2012, CNSC staff are the Responsible Authority to ensure an EA for the project is conducted in accordance with requirements. In September 2017, CNL submitted a draft environmental impact statement (EIS) in support of the EA for review by CNSC staff. CNSC staff are leading the review and comment on the draft EIS by federal and provincial authorities (Environment and Climate Change Canada, Health Canada, Natural Resources Canada and Manitoba Sustainable Development), Indigenous groups and the public.

As part of the CEAA 2012 process, CNL has determined they need additional time to address the large number of comments raised by the public, First Nations, Métis communities and regulators in relation to the draft EIS. Consequently, on March 13, 2018, CNL requested that the Commission renew their current licence for a one-year period with no changes, with a requested expiry date of December 31, 2019. CNL plans to use this time to address comments and provide documentation to support their safety case.

3.1.6 Public Information Program for CNL Decommissioning Projects

To ensure licensees provide open and transparent information to the public, in 2012, the CNSC published RD/GD 99.3, *Public Information and Disclosure*. CNL's public information program for the decommissioning projects has been developed in accordance with CNSC regulatory guide RD/GD 99.3 and allows members of the public to obtain information on all aspects of these projects, for instance CNL's website on decommissioning projects, as well as ensuring appropriate disclosure following the occurrence of unplanned events.

In May 2018, the CNSC published REGDOC-3.2.1 *Public Information and Disclosure.* A transition plan will be developed to incorporate requirements of this updated standard into licensing basis documents for CNL projects.

Indigenous Engagement

CNSC staff confirm that CNL performs outreach with Indigenous groups that have expressed interest in the decommissioning projects covered by this CMD. CNL's approach to Indigenous engagement follows the guidance found in CNSC REGDOC-3.2.2 *Aboriginal Engagement*. These efforts have included emails, letters, meetings, site visits and tours, and community visits, among others. CNL has stated that the Indigenous groups included in these efforts were Sagkeeng First Nation, Black River First Nation, Brokenhead Ojibway Nation, Hollow Water First Nation, Wabaseemoong Independent Nations, the Manitoba Métis Federation, Algonquins of Ontario, the Métis Nation of Ontario, the Algonquins of Pikwàkanagàn, the Algonquin Anishinabeg Nation Tribal Council, Eagle Village First Nation, Kitigan Zibi Anishinabeg First Nation, Williams Treaties First Nations, Alderville First Nation, Beausoleil First Nation, the Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation, Union of Ontario Indians, and the Algonquin Nation Secretariat.

3.2 Port Hope Area Initiative

3.2.1 Background

The historic low-level radioactive waste (LLW) contamination found in Port Hope and Port Granby is a result of the area's long involvement with the nuclear industry. This legacy extends back to the 1930s with the commencement of radium refining activities by Eldorado Gold Mines Ltd. In the 1940s, Eldorado switched its focus to uranium processing, and became a Crown Corporation (Eldorado Mining and Refining Limited, later renamed Eldorado Nuclear Limited). During those early years, wastes from radium and uranium production were stockpiled at various locations in the Port Hope area, and also used for fill material in construction and landscaping.

In 1948, Eldorado began placing process wastes in the Welcome Waste Management Facility (WMF) in the Township of Hope. The Welcome WMF continued to receive wastes until 1955, when Eldorado began operating the Port Granby WMF, located in nearby Clarington, Ontario. The Port Granby WMF received process wastes and other waste materials until 1988. Although these facilities represented an improvement over earlier practices, they do not provide for acceptable long-term management of LLW.

In the late 1990s, the Township of Hope, the Town of Port Hope and the Municipality of Clarington each developed a proposal for the establishment of long-term management facilities for the LLW found in their municipalities. These proposals formed the basis for what is now the PHAI, which represents the Government of Canada's commitment to the development and implementation of a safe, local, long-term solution for the management of historic LLW in the municipalities of Port Hope and Clarington.

The Port Hope Area Initiative

The PHAI is defined by "An Agreement for the Cleanup and the Long-Term Safe Management of Low-Level Radioactive Waste Situate in the Town of Port Hope, the Township of Hope, and the Municipality of Clarington", hereafter "the Legal Agreement". The Legal Agreement was signed in 2001[1] by the Government of Canada and the Municipalities of Port Hope and Clarington. In 2012, the Government of Canada, through Natural Resources Canada, made a financial commitment of $1.28 billion towards the clean-up of LLW and implementation of the PHAI.

The PHAI is comprised of two separate projects, each authorized under licences issued by the Commission to CNL as shown in table 1.

[1] The Legal Agreement was amended in 2003, 2006 and 2009.

Figure 11: The Port Hope area with insets showing the PGP and PHP sites
(Source: CNL)

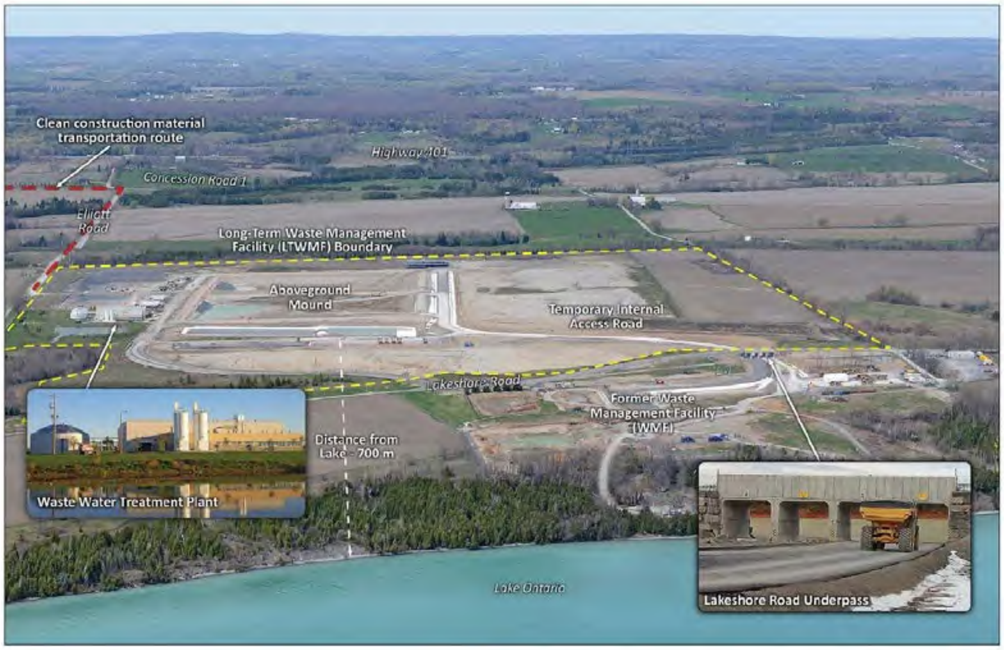
The Port Hope Project and the Port Granby Project each involves the construction of an engineered above-ground containment mound, which will safely isolate legacy LLW. In both cases, the project involves the excavation of waste from a legacy waste management facility, and its emplacement in a nearby modern long-term waste management facility (LTWMF). In Port Hope, the project further includes excavation of LLW from various sites in the urban area of the municipality.

CNL also holds two additional Designated Officer licences that have connection to the PHAI. These licences are for the care and maintenance of interim LLW storage locations in Port Hope that will be transferred to the new Port Hope LTWMF. Further details on these licences are discussed in section 3.2.4.

3.2.2 Port Granby Project

The objective of the Port Granby Project is to remediate and remove approximately 450,000 m^3 of historic LLW from the existing Port Granby WMF, and to consolidate and manage this waste at a new LTWMF. The Port Granby WMF is located in the Municipality of Clarington, Ontario, and it received wastes resulting from former radium and uranium refining operations at Eldorado Nuclear in Port Hope beginning in 1955 and continuing until 1988. The new LTWMF is an engineered above-ground mound which is located approximately 700 m north of the shoreline of Lake Ontario (see figure 12).

Figure 12: Location of the Port Granby WMF and new LTWMF. The LTWMF facility boundary is indicated by the dashed yellow line. *(Source: CNL)*



The Port Granby Project is currently in the second of three project phases. The first phase included ongoing operation, care and maintenance of the Port Granby WMF, and development of detailed technical information such as LTWMF design and other documentation to support licensing. CNSC staff reviewed and confirmed the information met all regulatory requirements. Following acceptance of this technical information, the Commission issued a licence amendment in November 2011 permitting the implementation phase, Phase 2, to commence.

Building on Phase 1 activities, the implementation phase includes the construction and operation of a new Waste Water Treatment Plant (WWTP); the construction and operation of a new LTWMF, including the excavation and emplacement of LLW; the capping of the LTWMF once complete; and the remediation and restoration of the existing Port Granby WMF site. CNSC staff continue to verify and evaluate compliance during the implementation phase.

The LTWMF base liner design consists of multiple layers of natural and synthetic materials which effectively prevents the release of contaminants to the environment. Within the base liner, a leachate collection system has been installed which directs contaminated water to the WWTP for treatment prior to discharge.

Following the completion of LLW placement on the LTWMF base liner, a cap consisting of a multi-layered cover system will be constructed to prevent water ingress and intrusion. Once complete, the Port Granby LTWMF will resemble a large grassy hill with radiation levels expected to be similar to natural background levels. CNL expects to begin capping the LTWMF in 2019.

Following completion of Phase 2, the Port Granby Project will enter into Phase 3, that is, long-term monitoring and maintenance of the LTWMF. CNL will install systems within and around the Port Granby LTWMF which will monitor the facility, and visual inspection and monitoring of WWTP influent will confirm the performance of the cover system. CNL will further monitor groundwater quality using a series of wells at the base of the mound and the perimeter of the site. CNSC regulatory oversight will continue for as long as the site is licensed.

3.2.2.1 Progress Update

Significant progress has been made at the Port Granby LTWMF, since the last update to the Commission in 2016. Construction of the base liner system in the waste cells, including the leachate collection system, was completed in 2016. CNSC staff carried out several inspections to confirm the integrity of the base liner system before the emplacement of waste began on November 1, 2016, and an additional inspection to verify that the base liner was being suitably winterized in December 2016. CNSC staff concluded that the base liner was properly installed and suitably winterized.

To facilitate the safe transfer of LLW from the existing WMF to the new LTWMF, a temporary underpass has been constructed to enable trucks carrying waste to travel beneath Lakeshore Road (see inset in figure 12). This underpass, completed in September of 2016, provides an internal haul road for use when travelling between the existing WMF and the LTWMF, thus eliminating the possibility of contaminating public roads.

As of April 1, 2018, CNL estimates that roughly 525,000 tonnes of the legacy LLW at the Port Granby WMF has been excavated and emplaced in the Port Granby LTWMF. In some areas of the WMF, CNL has progressed to verifying the effectiveness of the remediation by sampling soil in the remediated area and measuring the samples to ensure that excavations have been extensive enough to remove contamination in excess of the clean-up criteria specified in the licence. This stage will be followed by the final step in the remediation, backfilling, grading and seeding the remediated areas so as to achieve a natural end-state. CNSC staff's compliance activities related to remediation include inspections to verify the effectiveness of the remediation activities, collecting samples for analysis at the CNSC laboratory, and inspection of radiation protection, contamination control and worker health and safety measures. To facilitate these inspections, a CNSC inspector has been deployed to the Port Hope/Port Granby area.

Portions of the old Port Granby WMF site are quite steep leading down to Lake Ontario, and in 2017, CNL undertook significant work to ensure slope stability on the site, especially in the east and west gorge reservoirs (see figure 15). These undertakings to ensure worker safety were verified by CNSC staff during several inspections in 2017, with CNSC staff concluding that CNL has taken adequate measures to ensure slope stability on the Port Granby site.

As noted in table 4, in 2017, CNSC staff carried out independent environmental sampling in the area of the old Port Granby WMF under the CNSC's Independent Environmental Monitoring Program (IEMP).

Detailed IEMP results are available on the CNSC's IEMP website, and results from the Port Granby area indicate that the public and the environment in the vicinity of that site are protected.

CNL expects remediation of the old Port Granby WMF to continue into 2019, and capping of the new LTWMF mound to begin in 2019.

3.2.2.2 New Waste Water Treatment Plant

Construction of the new WWTP was completed for the Port Granby Project in 2014. On April 1, 2016, CNL shifted treatment of collected groundwater at the existing WMF from the previous system to the new WWTP, resulting in an immediate and marked improvement in the effluent quality being discharged to Lake Ontario. Commissioning of the new WWTP was completed in October 2016. The new WWTP will continue to operate for the foreseeable future during Phase 3 of the Port Granby Project. The old water treatment building was demolished in 2017.

Figure 13: Port Granby Waste Water Treatment Plant *(Source: CNL)*

As required by the Port Granby Project LCH, in 2017, CNL established action levels for the new WWTP, and further established release limits for the new WWTP as well. CNSC staff have assessed the adequacy of the limits and sampling frequencies proposed by CNL and have agreed that they are appropriate and should become part of the licensing basis for the Port Granby licence. These new action levels and release limits will be incorporated into the LCH for the Port Granby Project in the coming months.

In order to evaluate WWTP performance, weekly composite effluent samples are collected by CNL from the effluent stream and sent to an accredited external laboratory for analysis. CNL submits quarterly reports to CNSC staff which include the maximum weekly result for each month. CNSC staff review and verify these data to ensure they meet regulatory requirements and standards.

Effluent quality results available as of April 1, 2018 indicate that the WWTP is performing well within the regulatory release limits. CNSC staff's independent analysis of effluent samples taken from the Port Granby WWTP during inspections have confirmed the validity of the results provided by CNL. CNL's most recent effluent results as of the date of this report are presented in Appendix A.2.

3.2.2.3 Events of Regulatory Significance at Port Granby

There were no lost-time injury events at the Port Granby Project during the period covered by this report. The following is a summary of events that occurred at the Port Granby Project during the same period.

Hazardous Substances at the Port Granby WMF

There were two events related to hazardous materials encountered by workers during the process of waste excavation and emplacement. The presence of certain hazardous materials in the Port Granby WMF was known from historic records prior to the commencement of excavations.

- In December of 2016, a drum containing an ammonia-based chemical was excavated from the Port Granby WMF and was ruptured during emplacement at the Port Granby LTWMF. Two workers suffered temporary eye and respiratory irritation. Workers were not wearing elevated levels of Personal Protective Equipment (PPE) because hazardous substances had not been expected in that area of the Port Granby WMF where the drum was found. CNL halted waste excavation until revised procedures and engineering controls were put in place and workers trained. These included the use of PPE offering a high level of respiratory and skin protection, and the installation of air supply tanks and ballistic protection on key excavation equipment (see figure 14).

- In May of 2017, while a specialist contractor was performing excavations in an area known to contain cylinders of potentially hazardous chemicals, slightly elevated levels of hydrogen fluoride in air were measured next to a cylinder being unearthed. As per the protocols in place, workers evacuated the area and returned in a higher class of PPE to continue work. The cylinder was safely unearthed using a hydro-vac truck, which is less likely to cause mechanical damage than conventional excavation equipment.

CNL's implementation of corrective measures related to these events has been verified by CNSC staff through document review and inspection activities, with CNSC staff concluding that worker safety has been clearly enhanced.

Figure 14: A bulldozer on the Port Granby WMF site, fitted with steel gratings over windows and air tanks on the roof

Hydrogen Sulphide Exposure at the Port Granby WWTP

On January 13, 2017, hydrogen sulphide gas (H_2S) built up in the Port Granby WWTP, exposing several workers and triggering an alarm which caused the WWTP to be evacuated. Two workers exhibited symptoms such as mild headaches and nausea, but were cleared to return to work later the same day after medical evaluation. The H_2S gas was generated in stagnant solids in the WWTP's bioreactor, and released as workers disposed of that material. In response, CNL committed to put in place additional measures such as the mandatory use of personal H_2S monitors in specified areas of the WWTP, the provision of Self-Contained Breathing Apparatuses (SCBAs) for emergency use, and upgrades to building ventilation and the ambient H_2S monitoring system.

CNSC staff consider that CNL's H_2S corrective actions will result in increased worker safety. CNSC staff verified those corrective actions during a subsequent inspection and found upgrades to the ambient H_2S monitors were not yet complete. CNSC staff issued a compliance notice to CNL prohibiting the use of H_2S-generating portions of the WWTP until all corrective actions are complete. CNSC staff continue to monitor CNL's H_2S corrective actions.

Water Overflow Event at the East Gorge Reservoir

On June 23, 2017, heavy rains in the Port Granby area led to an unplanned discharge of untreated water from the East Gorge Reservoir (EGR) at the Port Granby WMF (see figure 15). The entire blue shaded area in figure 15 is under remediation; therefore, CNL must treat water from this area as being potentially contaminated. According to the Port Granby Project licensing basis, CNL is not authorized to release any untreated water from the site.

Figure 15: Partial layout of the Port Granby Project site *(Source: CNL)*

CNL determined that the overflow was due to valves having been incorrectly sequenced, which caused a restriction in the flow of water and resulted in an overflow. CNL estimated that up to 5 m^3 of untreated water was discharged over 20 minutes, before valves were properly reconfigured and the problem corrected. CNL staff performed radiation surveys and took soil samples which indicated that contaminant levels in the path of the overflow are less than the average initial contaminant concentrations for the Port Granby WMF site, as identified in the EA. There was no impact to the environment as a result of this event.

CNSC staff carried out a reactive inspection of the Port Granby and Port Hope sites on June 26 and 27, 2017, which included representatives from the Ontario Ministry of Environment and Climate Change (MOECC) and Environment and Climate Change Canada (ECCC). As a result, an Order was issued to CNL against the Port Hope Project licence, as discussed further in section 3.2.3.4. In response to the Order, CNL has made significant updates to their emergency water management strategy, obtained supplies and developed detailed water management plans for the Port Granby site.

CNL has also installed multiple 6,000 m^3 water tanks, two of which are shown on figure 15, to increase water storage capacity. CNSC staff have verified during inspections that emergency water management supplies as listed in CNL's Port Granby water management documents are present.

As a result of the same weather event, an unplanned discharge also occurred on the same day at the Port Hope LTWMF, and is discussed in section 3.2.3.4. An Event Initial Report on both events was presented to the Commission in August 2017 under CMD 17-M38.

Water Overflow Event at the West Gorge Reservoir

On January 23, 2018, there was an unplanned discharge of untreated water from the West Gorge Reservoir (WGR) at the Port Granby WMF (see figure 15). Upon observing the overflow, CNL ceased pumping water into the WGR and the overflow stopped shortly afterwards. CNL estimated the duration of the release to have been 30 to 45 minutes, and the volume of the release to be no more than 7 m^3. CNL has concluded that the overflow was due to a restriction in the pipe running from the WGR to the adjacent sump where the WGR pumps draw water. After the overflow, CNL staff performed radiation surveys and took soil samples which indicated that contaminant levels in the path of the overflow are less than the average initial contaminant concentrations for the Port Granby WMF site, as identified in the EA. There was no impact to the environment as a result of this event.

CNL carried out various corrective actions in response to this incident, most significantly moving the sump from adjacent to the WGR, to directly in the WGR. CNSC staff performed an inspection in February 2018 at the Port Granby site and verified that the corrective measures were in place. CNSC staff continue to monitor and assess CNL's water management measures at the Port Granby site.

3.2.3 Port Hope Project

The objective of the Port Hope Project (figure 16) is to remediate and remove historic LLW from various locations in the Municipality of Port Hope (MPH), and to consolidate and manage this waste at a new LTWMF. The site of the Port Hope LTWMF encompasses the Welcome Waste Management Facility (WMF), which until 1955 was used to manage radioactive wastes arising from the refining of uranium and radium (cells 2a and 2b in figure 16).

The Port Hope Project involves the remediation of LLW from a variety of locations throughout the municipality, including:

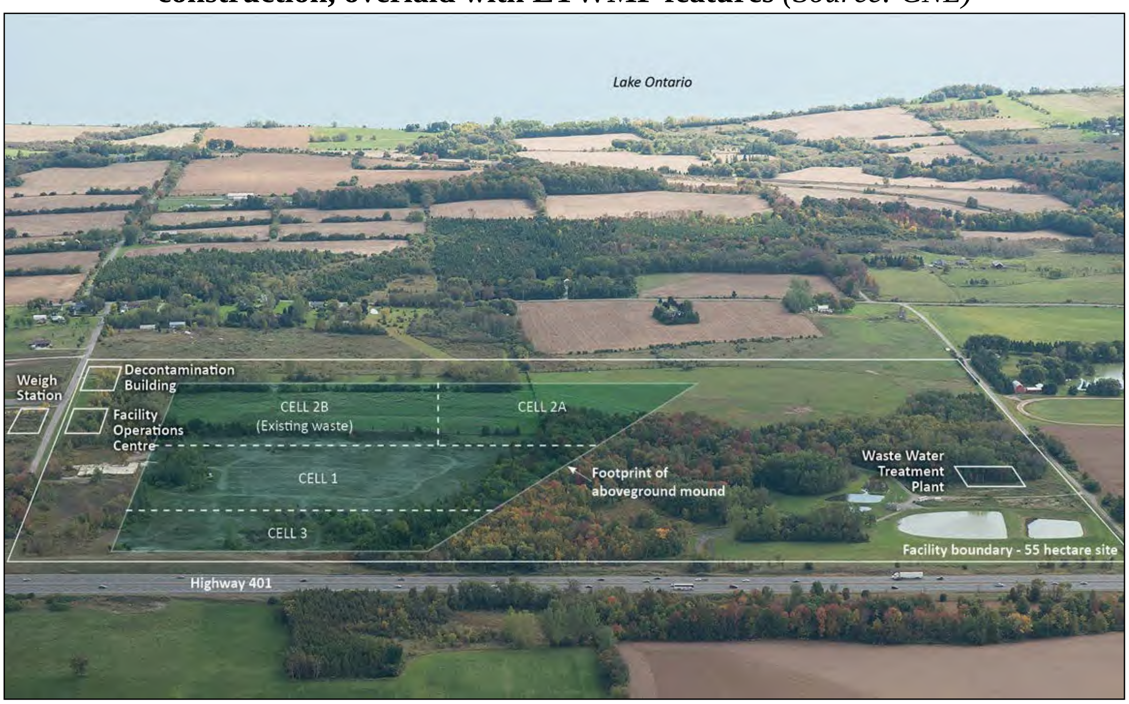
- 450,000 m^3 of LLW from the existing Welcome WMF
- 572,000 m^3 of waste from various remediation sites throughout Port Hope including the Port Hope Harbour, the closed-down Municipal Landfill on Highland Drive, and numerous residential properties

- 150,000 m^3 of Cameco-owned waste generated prior to 1988 and waste from building demolition associated with Cameco's Vision in Motion project
- 51,250 m^3 of waste from industrial waste contaminated sites (i.e., Port Hope Centre Pier, Lions Park, and the municipal sewage treatment plant)

The Port Hope Project is currently in the second of three project phases. The first phase included ongoing operation, care and maintenance of the Welcome WMF, and development of detailed technical information such as LTWMF design and other documentation to support licensing. CNSC staff reviewed and confirmed the information met all regulatory requirements. Following acceptance of this technical information, in November 2012, the Commission issued a licence amendment permitting the implementation phase, Phase 2, to commence. Building on Phase 1 activities, Phase 2 includes the construction and operation of a new WWTP; the construction and operation of the new Port Hope LTWMF, including the excavation and emplacement of LLW; the remediation and restoration of excavated areas; and the capping of the LTWMF once it is complete. CNSC staff continue to verify and evaluate compliance during Phase 2 activities.

The Port Hope Project LTWMF is designed for the safe long-term storage of LLW, and is conceived as an engineered above-ground mound with a design capacity of 1.9 million m^3 of LLW. The design allows for a 30% contingency on waste volume estimates.

Figure 16: An overview of the Welcome WMF site prior to Port Hope LTWMF construction, overlaid with LTWMF features *(Source: CNL)*



The LTWMF design comprises a single mound with four waste storage cells. These cells will be developed progressively to permit efficient construction and operation of the facility. The base liner design consists of multiple layers of natural and synthetic materials which will effectively prevent the release of contaminants to the environment. Within the base liner, a leachate collection system has been installed which will direct contaminated water to the WWTP for treatment prior to discharge. Excavation and emplacement of wastes is expected to continue to 2023.

As noted in table 4, in 2017, CNSC staff carried out independent environmental sampling in the area of the old Welcome WMF under the CNSC's Independent Environmental Monitoring Program (IEMP). Detailed IEMP results are available on the CNSC's IEMP website, and results from the Welcome WMF area indicate that the public and the environment in the vicinity of that site are protected.

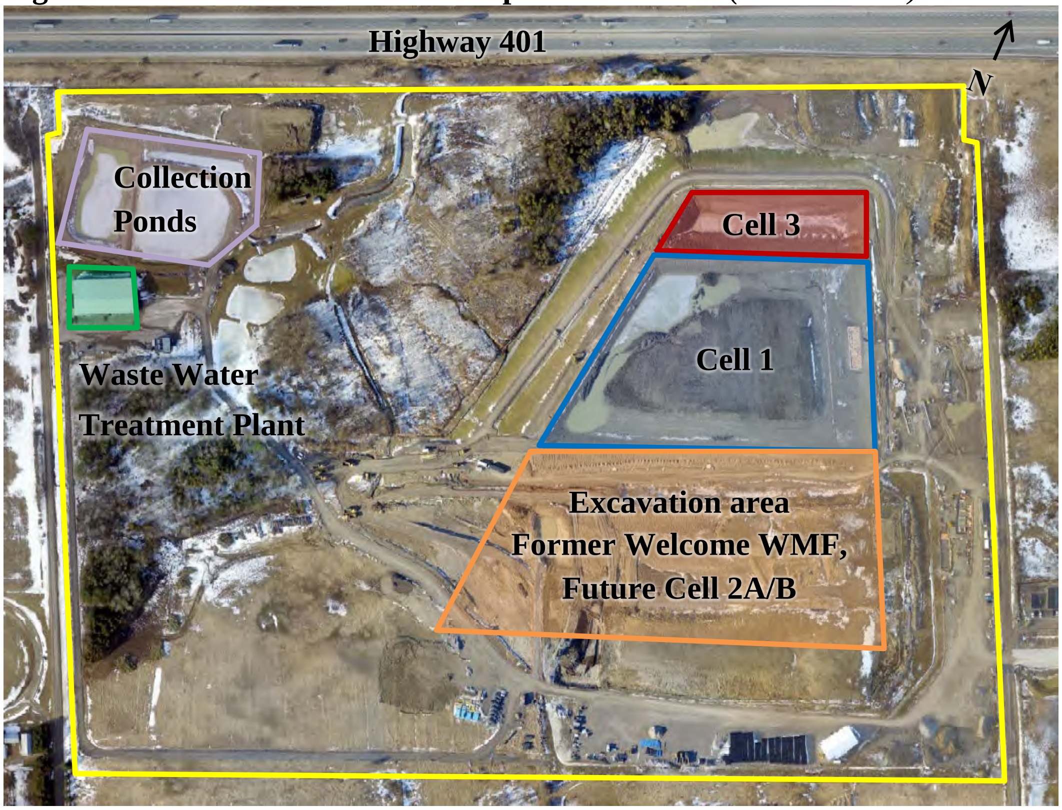
Following the completion of LLW placement on the LTWMF base liner, a cap consisting of a multi-layered cover system will be constructed to prevent water ingress and intrusion. Once capping is complete, the Port Hope LTWMF will resemble a large grassy hill. Radiation levels on the mound are expected to be similar to natural background levels. The final phase of the project, Phase 3, will involve long-term monitoring and maintenance of the LTWMF under continued CNSC regulatory oversight.

3.2.3.1 Progress Update

Significant progress has been made at the Port Hope LTWMF, since the last update to the Commission in 2016. Following completion of site preparation in the spring of 2016, contractors began construction of Cell 1. The base liner of that first cell was completed in 2017, and significant progress has also been made on the construction of Cell 3. CNSC staff carried out several inspections to confirm the integrity of the Cell 1 base liner system during its installation, and a further inspection to verify that the site was being suitably winterized in December 2017. No significant deficiencies were noted.

On December 1, 2017, CNL began excavation of onsite wastes from the Welcome WMF, and emplacement of those wastes in Cell 1 of the Port Hope LTWMF. As of April 1, 2018, CNL estimates that roughly 15% of onsite waste has been excavated from the Welcome WMF and emplaced in Cell 1.

Figure 17: An aerial view of Port Hope LTWMF site *(Source: CNL)*



As the extent of excavation grows, so too does the need to collect and treat the water from the site to ensure that no untreated water is released outside the boundary. The two collection ponds adjacent to the WWTP (figure 17) serve this purpose. In order to ensure that sufficient capacity exists to cover all probable water inflow scenarios, CNL is in the midst of an expansion of the collection ponds. The ponds, with an original capacity of roughly 18,000 m^3, have been expanded to 23,800 m^3, and will be expanded to a total capacity of 47,000 m^3 by October 2018.

CNL expects to begin receipt of offsite wastes in June 2018, beginning with contaminated soils and Cameco wastes from the Centre Pier at the Port Hope Harbour. Centre Pier remediation activities are discussed further under section 3.2.3.3.

3.2.3.2 New Waste Water Treatment Plant

CNL has constructed a new WWTP on the Port Hope LTWMF site, as shown in figure 18. In January 2017, CNL began discharging treated water from the new WWTP, resulting in an immediate and marked improvement in effluent quality. Commissioning of the new WWTP was completed in December 2017. The new WWTP will continue to operate for the foreseeable future during the long-term monitoring phase of the Port Hope Project.

Figure 18: The Port Hope Waste Water Treatment Plant *(Source: CNL)*

As required by the Port Hope Project LCH, in 2018, CNL established action levels for the new WWTP, which were accepted by CNSC staff in March 2018. CNL expects to have release limits in place for the Port Hope WWTP by mid-2018 and once accepted by CNSC staff, the action levels and release limits will be incorporated into the LCH for the Port Hope Project.

As part of routine operation of the WWTP, samples are collected from the effluent stream by CNL and sent to an accredited external laboratory for analysis. Effluent quality results obtained from CNL during commissioning and operation indicate that the WWTP is performing significantly better than the design objectives for the WWTP found in the Port Hope Project LCH. CNL's most recent effluent results as of the date of this report are presented in Appendix A.3.

CNSC staff have performed inspections related to the commissioning of the WWTP at the Port Hope LTWMF, and over the course of the inspections collected samples of influent and effluent for independent analysis at the CNSC laboratory. CNSC results were in agreement with CNL results.

The old Welcome WMF water treatment building remains in place and operable, as a part of CNL's contingency plan for water management at the Port Hope LTWMF.

3.2.3.3 Remediation Activities in Port Hope

CNL's Preparation for Remediation Activities in Port Hope

In preparation for remediation in the urban area of the Municipality of Port Hope, CNL is currently preparing key documents that will guide the work. Among those documents are the *Remediation Verification Standard Operating Procedures* (RVSOP) and the *Port Hope Special Circumstances Protocol*, both currently under development by CNL.

The RVSOP suite of procedures describe the approach that CNL will implement following remediation to demonstrate the cleanup has met the requirements of the licence.

The *Port Hope Special Circumstances Protocol* has been developed by CNL to address situations where property specific constraints make it impractical to meet the cleanup criteria prescribed in the licence for the Port Hope Project. Application of the special circumstance protocol will be managed by CNL and is expected for only a very small number of sites.

CNSC staff have reviewed and provided comments on drafts of these documents and CNL has been updating the documents accordingly. Representatives from the Municipality of Port Hope (MPH) have also been active participants in the review of these documents and have met collectively with CNL and CNSC staff on this topic, most recently in March 2018.

Remediation of Major Sites in Port Hope

CNL has defined the various major sites throughout Port Hope which are subject to remediation under the Port Hope Project. These are listed in table 5 below, including a brief update on their status. Interactive maps of these sites can be found on the [PHAI website.]

Table 5: Major Remediation Sites in Port Hope

Title	Description	Remediation Timeline
Temporary Storage Sites	These include the Centre Pier Temporary Storage Site (TSS), Pine Street Extension TSS, and Sewage Treatment Plant TSS. More detail is provided in Section 3.2.4 below.	Expected to begin in 2018
Waterfront Area	This includes the West Beach and former Waterworks site, the Alexander Street Ravine, the Centre Pier, Port Hope Harbour, the Mill Street South site, and the CN/CP Viaducts area. The waterfront area is complex and remediation work will be ongoing for some years.	Expected to begin at the former Waterworks site and the Port Hope Harbour in 2018
Highland Drive Area	This includes the Highland Drive landfill, roadbed, and south ravine; the Pine Street Extension Consolidation Site; and the Pine Street North Extension roadbed.	Expected to begin in 2019
Industrial Sites	This includes areas of the Centre Pier, Lions Recreation Centre Park, Former Coal Gasification Plant, Chemetron Lagoon, and Sewage Treatment Plant Storage Cell.	Expected to begin in 2019
Central Area and Known Sites	This includes the former St. Mary's School, Strachan Street Ravine Consolidation Site, Caroline Street Park, Abandoned Pipeline, and Peter Street Mound.	Expected to begin in 2018 or 2019

Figure 19 - The Port Hope waterfront area

Waste Arising from Cameco Decommissioning Activities

The Legal Agreement specifies the accommodation of up to 150,000 m^3 of defined "Cameco Decommissioning wastes" in the new Port Hope LTWMF. This includes stored legacy wastes that were generated as a consequence of uranium and radium refining at the site of the current conversion facility in Port Hope prior to 1988, and other historic LLW located at this facility, the Dorset Street warehousing facility, and the Centre Pier. Cameco has initiated the "Vision in Motion" project to transfer eligible wastes to the Port Hope LTWMF, in addition to other improvements to the Cameco site. In 2017, Cameco began preparing a variety of legacy Eldorado materials anticipation of their transfer to the Port Hope LTWMF.

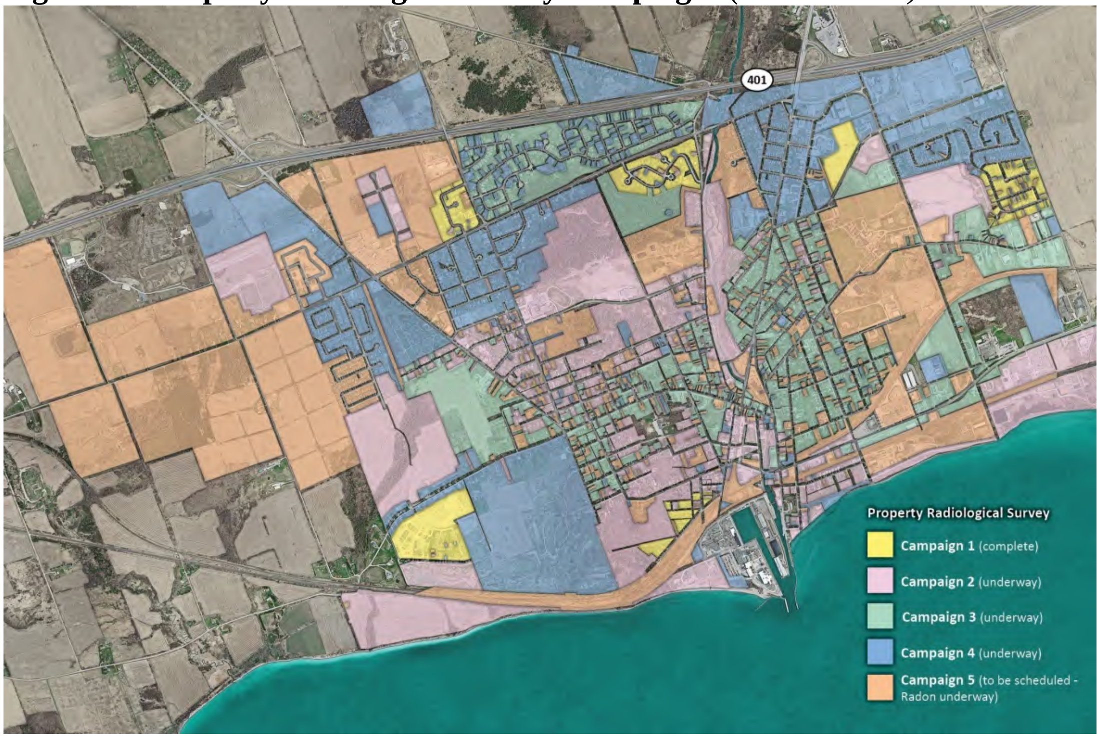
CNL and Cameco routinely meet to ensure agreement and understanding on logistics of these activities, and both CNL and Cameco keep CNSC staff informed of developments.

Small-Scale Sites

As previously indicated, the PHAI involves identification of LLW on residential and commercial properties in the Port Hope area. Surveys are being undertaken on all urban and some rural properties in the Port Hope area, for a total of roughly 4,800 properties. Through this program, properties will undergo four tests for detecting the presence of LLW: interior radon testing, interior gamma radiation surveys, exterior gamma radiation surveys, and subsurface soil sample analysis. This program was implemented in 2012 and is expected to be completed in 2023.

Port Hope properties have been organized into a series of five campaigns for the execution of property surveys, as shown in figure 20.

Figure 20: Property Radiological Survey Campaigns *(Source: CNL)*



Based on historic information, CNL initially estimated that at least 375 properties in Port Hope would have contamination at levels which require remediation, but as of April 1, 2018, has found LLW at 745 properties to date, and now estimates more than 800 properties will require remediation. The status of CNL's small-scale site sampling program, as of April 1, 2018 is summarized in Appendix B.

For each small-scale site requiring remediation, CNL is preparing a site-specific remediation plan which will serve to inform property owners of the extent of remediation activities on their property. CNL is currently working on roughly 45 such plans, and they form an important vehicle for consultation between CNL and property owners. Small-scale sites will temporarily become subject to the Port Hope Project licence during their respective remediation periods. During that time, CNSC staff may carry out inspections on these sites to verify CNL's compliance with their licensing basis.

3.2.3.4 Events of Regulatory Significance at Port Hope

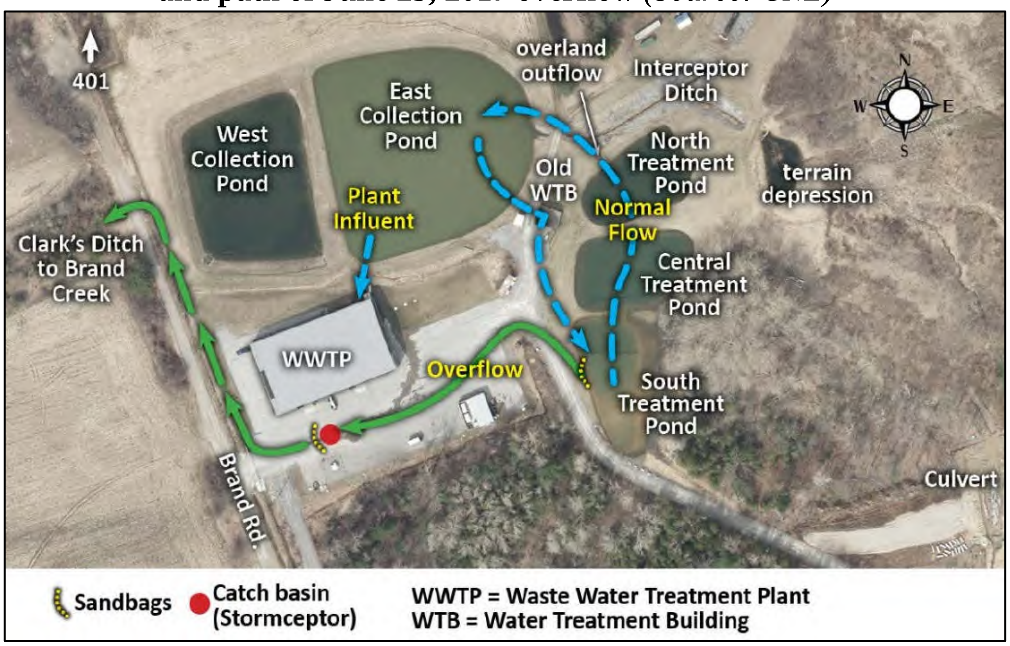
There were no lost-time injury events at the Port Hope Project during the period covered by this report. During the period covered by this report, one event occurred at the Port Hope Project which was of particular interest to CNSC staff. This event is summarized below.

Water Overflow Event at the South Treatment Pond

On June 23, 2017 sustained heavy rains (up to 70 mm) led to an unplanned discharge of untreated water from the Port Hope LTWMF site. An unplanned discharge also occurred on the same day at the Port Granby WMF site, as discussed above in section 3.2.2.3. An Event Initial Report was presented to the Commission in August 2017 under CMD 17-M38.

As shown in figure 21, the heavy rain event caused an overflow from the South Treatment Pond into the WWTP parking lot and then to Brand Creek and Lake Ontario (green lines). The normal flow of water is shown with blue lines. In response, CNL staff deployed sandbags at the point of overflow (yellow dots), and pumped water from the South Treatment Pond into the East Collection Pond. Sandbags were used to force most of the overflow into the Stormceptor drain (red dot), in order to minimize the sediment in the water being released. The overflow gradually lessened and was halted roughly 4-1/2 hours after its discovery.

Figure 21: Layout of water management features at the Port Hope LTWMF, and path of June 23, 2017 overflow *(Source: CNL)*



CNL conducted an extensive sampling campaign to determine whether there were any environmental impacts resulting from this event. Based on these results, CNL has concluded that there was no risk to the health and safety of workers or the public, and no lasting impact to the environment. CNSC staff reviewed CNL's sampling data and concurred with their conclusions.

CNSC staff carried out a reactive inspection of the Port Granby and Port Hope sites on June 26 and 27, 2017, which included representatives from the MOECC and ECCC. CNSC staff took various water samples from downstream of the LTWMF site and confirmed that there was no risk to public and the environment as a result of this overflow.

As a result of the inspection, CNSC staff identified the lack of a documented water contingency plan and the lack of emergency equipment and supplies were contributing factors to this overflow. Accordingly, CNSC staff issued an Order which required CNL to ensure its emergency preparedness measures are available to mitigate accidental releases of untreated water from the site and additionally to review and update its water management strategy to ensure that no further unauthorized releases would occur.

As of September 2017, CNSC staff have concluded that CNL has fulfilled the conditions of the Order through the submission of updated water management plans for the Port Hope Project. In subsequent inspections, CNSC staff verified that emergency water management supplies, as listed in CNL's water management documentation, are present. CNSC staff continue to monitor and assess CNL's water management measures at the Port Hope site.

3.2.3.5 Other Topics of Regulatory Significance

Licence Amendment related to *in-situ* Arsenic Management

On November 29, 2017 the Commission approved an amended licence for the PHP which includes revised requirements related to arsenic for specified portions of the Port Hope LTWMF site. Specifically, the amended licence exempts certain portions of the Port Hope LTWMF footprint from the clean-up criterion for arsenic of 40 parts per million, as specified in Appendix C of the Port Hope Project licence. This variance is acceptable because these areas are within the Port Hope LTWMF fence line, meaning that there will be no impact to the public or the environment resulting from this licensing change. The issuance of the amended licence allowed CNL to begin excavation of onsite wastes at the Port Hope LTWMF site, beginning with the high-arsenic wastes from the Welcome WMF, and emplacement of those wastes in the Port Hope LTWMF. As of January 31, 2018, all high-arsenic materials from the Welcome WMF have been excavated and emplaced in Cell 1 of the Port Hope LTWMF. Further information on this licence amendment is available in the Commission's Record of Decision, available on the CNSC's website.

IAEA Safeguards at the Port Hope LTWMF

Pursuant to the *Treaty on the Non-Proliferation of Nuclear Weapons*, Canada has entered into a Comprehensive Safeguards Agreement and an Additional Protocol with the International Atomic Energy Agency (IAEA) (hereafter, the safeguards agreements). The objective of the safeguards agreements is for the IAEA to provide annual assurance to Canada and to the international community that all declared nuclear material is in peaceful, nonexplosive uses and that there is no indication of undeclared material.

The CNSC provides the mechanism, through the NSCA and Regulations, for the IAEA to implement the safeguards agreements. Under these agreements, CNL is required to maintain and declare detailed accounting records of all transactions involving nuclear material, allow access to IAEA inspectors for inspections, accept the installation of IAEA equipment for remote verification or surveillance where necessary, and to provide relevant design and operational information to the IAEA periodically.

The waste inventory destined for the LTWMF includes 17,000 drums of historical uranium-bearing waste currently under safeguards at Cameco's Port Hope Conversion Facility (PHCF). This material was generated by historical uranium processing activities at PHCF and contains approximately 1,400 tons of uranium. The uranium-bearing waste transferred to the LTWMF is subject to IAEA safeguards.

The IAEA, the CNSC, CNL, and Cameco have developed practical arrangements which codify the safeguards expectations at the LTWMF. As part of these arrangements, CNL will facilitate the installation of an IAEA unattended monitoring system to verify the safeguarded uranium bearing waste as it arrives at the LTWMF. The LTWMF will also be subject to measures provided for under the safeguards agreements for the IAEA to verify the absence of undeclared nuclear activities and materials.

CNSC staff have concluded that the practical arrangements and the CNL's safeguards program will meet the safeguards obligations of the licensee with respect to this project.

3.2.4 Other PHAI-Related CNL Licences in Port Hope

In addition to the PHAI licences for the Port Hope Project and Port Granby Project, CNL holds two Designated Officer-issued licences as shown in table 1.

The purpose of both of these licences is for the interim management of LLW until the Port Hope LTWMF is ready to begin receiving wastes. The Pine Street Extension Temporary Storage Site continues to accept new wastes, as identified by CNL's Construction Monitoring Program (CMP), while the Port Hope Radioactive Waste Management Facility is not accepting any new wastes. Through the CMP, excavations in properties in the Municipality of Port Hope are monitored and if the presence of historical LLW is confirmed, the material is collected and safely transported to the Temporary Storage Site.

The materials stored under these licences are among the first in Port Hope that will be remediated, with work expected to begin in 2018. CNL may choose to keep the pads at the Pine Street Extension Temporary Storage Site open and active during wider remediation work in Port Hope, in order to support the Construction Monitoring Program.

The data from CNL's annual reports and the results of CNSC staff's most recent inspection of these sites (conducted in November 2017) leads CNSC staff to conclude that CNL continues to conduct activities at these sites safely, and in accordance with the requirements of its licences.

3.2.5 Public Information Program for PHAI

As per the licences for the Port Hope and Port Granby projects, CNL is required to have a public information program. CNL's public information program for the PHAI has been developed in accordance with CNSC regulatory guide RD/GD 99.3 *Public Information and Disclosure*, and allows members of the public to obtain information on all aspects of the PHAI, as well as ensuring appropriate disclosure following the occurrence of unplanned events. CNSC staff confirm through compliance activities that CNL has shown willingness to share project-related information freely with interested parties and taken proactive steps to build positive relationships with stakeholders. In May 2018, the CNSC published REGDOC-3.2.1 *Public Information and Disclosure* and CNSC staff will ensure that this updated standard is included in the LCHs for the Port Hope and Port Granby projects in the coming months.

A primary information source for the public is the Project Information Exchange (PIE) located at the PHAI management office at 115 Toronto Road in Port Hope, Ontario, where members of the public can obtain documents or speak directly to CNL staff about the projects, including plans for the remediation of their properties. CNL's website for the PHAI also provides interested parties up-to-date information on current project activities. CNSC staff have observed that CNL also engages the public through opinion surveys, presentations, information sessions, newsletters, resident notifications, site tours, open houses, Indigenous engagement sessions, citizen liaison groups, etc.

CNL informs CNSC staff of the dates of its meetings in the community, and CNSC staff have participated in the past to answer questions about the CNSC's mandate and role in regulating the PHAI. CNSC staff have also participated in community events such as the "Port Hope & District Agricultural Society Fair" in the past, and CNSC staff meet bilaterally with the Municipality of Port Hope on an as-needed basis. Given that both the Port Hope and Port Granby projects are currently in extremely active phases, a CNSC inspector has been seconded to live in the area, to allow a more flexible approach to CNSC staff's compliance verification activities. This staff member will be able to carry out more frequent and smaller-scale compliance activities which are adapted to CNL's current project activities, and will allow CNSC staff to be more engaged in community activities.

Evolution of Citizen Liaison Groups

Since 2013, CNL has maintained a Citizen Liaison Group (CLG) for each project. CLG meetings provide a mechanism for CNL to provide information and updates directly to local residents and also receive important feedback from the community.

Up to 2018, the CLGs met four times per year. Beginning in 2018, CNL has changed the frequency of CLG meetings for the Port Granby Project to twice annually. This reduced frequency is reflective of the fact that the Port Granby Project is nearing completion. CNL is also transitioning the Port Hope CLG away from a fixed-membership model to several new approaches designed to encourage participation from members of the community from areas in which remediation work is currently underway.

CNSC staff confirm that these updated strategies and approaches meet the objectives of REGDOC-3.2.1 and demonstrate that CNL is proactive in ensuring the Port Hope and Port Granby communities are in possession of up-to-date information on the PHAI.

Indigenous Engagement

CNSC staff confirm that CNL holds an information session for Indigenous groups that have expressed interest in the projects on an annual basis. The most recent session was held in June 2017, and was attended by Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation, and Alderville First Nation. As part of their public disclosure program, CNSC staff confirm that CNL provided updates on both the Port Granby and Port Hope Projects, with a focus on remediation at the Port Hope Waterfront, followed by a walking tour of waterfront sites.

4 OVERALL CONCLUSIONS

Through site inspections and desktop verifications, CNSC staff conclude that CNL is maintaining and operating the various facilities covered by this report in accordance with the requirements of the NSCA, CNSC Regulations and the terms of the applicable licences.

Since the last reports to the Commission on these licensed activities, CNL is making progress on the decommissioning of Whiteshell Laboratories in accordance with their approved decommissioning plans, and has made significant progress in the Port Hope Project and Port Granby Projects.

CNSC staff continue to provide oversight and monitoring of CNL’s adherence with regulatory requirements. Given the increasing activity at many of these sites, CNSC staff intend to provide another progress update to the Commission on these projects every two years.

CNSC staff conclude that:

- CNL is maintaining Douglas Point, Gentilly-1, Nuclear Power Demonstration and the Whiteshell Laboratories safely and in compliance with the requirements of the NSCA, CNSC Regulations and its licences.
- CNL is making progress on the decommissioning of Whiteshell Laboratories in accordance with their approved decommissioning plans.
- CNL is carrying out work under the Port Hope Area Initiative safely and in compliance with the requirements of the NSCA, CNSC Regulations and its licences.

LIST OF ACRONYMS

AECL	Atomic Energy of Canada Limited
CEAA	*Canadian Environmental Assessment Act*
CLG	Citizen Liaison Group
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CMD	Commission Member Document
CMP	Construction Monitoring Program
DDP	Detailed Decommissioning Plans
DP	Douglas Point
EA	Environmental assessment
ECCC	Environment and Climate Change Canada
ECIS	Emergency Cooling Injection System
EGR	East Gorge Reservoir
EIS	Environmental Impact Statement
FG	Financial guarantees
G-1	Gentilly-1
GoCo	Government-Owned Contractor-Operated
H_2S	Hydrogen sulphide gas
HLW	High-Level Radioactive Waste
HTPS	Heat Transport Purification System
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program
ILW	Intermediate-Level Radioactive Waste
LCH	Licence Conditions Handbook
LLW	Low-Level Radioactive Waste
LTWMF	Long-Term Waste Management Facility
MOECC	Ontario Ministry of Environment and Climate Change
MPH	Municipality of Port Hope
MPS	Moderator Purification System
MWe	Megawatt electric

MWth	Megawatt thermal
NPD	Nuclear Power Demonstration
NSCA	*Nuclear Safety and Control Act*
PHAI	Port Hope Area Initiative
PHCF	Port Hope Conversion Facility
PPE	Personal Protective Equipment
SCBAs	Self-Contained Breathing Apparatuses
SDR	SLOWPOKE Demonstration Reactor
TSS	Temporary Storage Site
WGR	West Gorge Reservoir
WL	Whiteshell Laboratories
WMA	Waste Management Area
WMF	Waste Management Facility
WR-1	Whiteshell Reactor No. 1
WWTP	Waste Water Treatment Plant

A.1 Waste Inventory Information[2]

Location	Classification of Waste	Description of Waste	Storage Method	Number of Bundles or Volume	Activity (TBq)
Douglas Point	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	22,252 bundles	N/A
	Intermediate-level waste	Waste from reactor decommissioning	Reactor building	60 m^3	N/A
	Low-level waste	Contaminated soils	205-litre drums	66 m^3	N/A
	Low-level waste	Waste from reactor decommissioning	Reactor building	35 m^3	<1
Gentilly-1	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	3,213 bundles	N/A
	Intermediate-level waste	Waste from reactor decommissioning	Reactor building	58 m^3	<1
	Low-level waste	Contaminated soils	205-litre drums	1 m^3	N/A
	Low-level waste	Waste from reactor decommissioning	Reactor building	607 m^3	N/A
Nuclear Power Demonstration	Low-level waste	Waste from reactor decommissioning	Reactor building	12 m^3	<1
Whiteshell Laboratories	High-level waste	Used nuclear fuel	Dry storage in concrete canisters	2,268 bundles	N/A
	Intermediate-level waste	Research reactor waste and waste from reactor decommissioning	In-ground concrete bunkers	863 m^3	2,794
	Intermediate-level waste	Waste from decommissioning activities	In-ground concrete bunkers	22 m^3	148
	Low-level waste	Research reactor waste and waste from reactor decommissioning	Above-ground concrete bunkers	19,700 m^3	325
	Low-level waste	Waste from decommissioning activities	Above-ground concrete bunkers	1,598 m^3	6
Port Hope	Low-level waste	Contaminated soils	*In-situ* and consolidated storage	720,000 m^3	N/A
Port Granby	Low-level waste	Waste and contaminated soils	Trench burial	438,200 m^3	N/A

[2] Waste inventory information from the *Canadian National Report For The Joint Convention On The Safety Of Spent Fuel Management And The Safety Of Radioactive Waste Management*, October 2017. Some radioactive waste at the NPD site is included in the CRL inventory as shown in Table D.5 of that report. The volume of LLW at Port Granby has increased over original estimates and will be larger than shown here.

A.2 Effluent Quality at the Port Granby Waste Water Treatment Plant

Parameter	Units	Maximum Weekly Results January 2018	February 2018	March 2018	Weekly Action Levels	Weekly Release Limits	Monthly Release Limits
Radium-226	Bq/L	<0.0050	<0.0050	<0.0050	0.05	0.74	0.37
pH	-	7.54	7.67	7.35	Between 6.5 and 8.5	Between 6.5 and 9.5	Between 6.5 and 9.5
Nitrite	mg/L	0.102	0.159	0.403	1.5	3	1.5
Nitrate	mg/L	4.36	3.64	1.76	75	150	75
Total Suspended Solids	mg/L	<1	<1	<1	15	30	15
Ammonia	µg/L	0.36	0.33	0.21	1	11.5	5.75
Phosphorus	mg/L	0.023	0.029	0.024	5.75	0.7	0.35
Arsenic	µg/L	14	14	6.7	50	200	100
Cadmium	µg/L	<0.10	<0.10	<0.10	1	2	1
Cobalt	µg/L	<0.50	<0.50	<0.50	5	10	5
Copper	µg/L	2	<1.0	<1.0	5	10	5
Molybdenum	µg/L	7.1	6	3.1	50	-	-
Selenium	µg/L	<2.0	<2.0	<2.0	20	60	30
Thallium	µg/L	<0.050	<0.050	<0.050	0.5	16	8
Vanadium	µg/L	<0.50	<0.50	<0.50	5	80	40
Uranium	µg/L	4	11	7.9	100	200	100
Acute Toxicity	-	Pass	Pass	Pass	-	-	Cannot be toxic

Notes:

Results prefixed by "<" indicate a result less than the minimum detection limit

A.3 Effluent Quality at the Port Hope Waste Water Treatment Plant

Parameter	Units	Maximum Weekly Results: January 2018	February 2018	March 2018	Weekly Action Levels
Radium-226	Bq/L	<0.0050	<0.0050	<0.0050	0.05
pH	-	7.30	7.53	7.83	Between 6.5 and 8.5
Total Suspended Solids	mg/L	<1	2	<1	7.5
Aluminum	µg/L	9.2	7.5	<5.0	100
Arsenic	µg/L	1.6	2	2	41
Boron	µg/L	21	20	19	175
Copper	µg/L	<1.0	<1.0	<1.0	5
Lead	µg/L	<0.50	<0.50	<0.50	5
Uranium	µg/L	1.7	2.1	2.6	100
Zinc	µg/L	<5.0	<5.0	<5.0	15
Acute Toxicity	-	Pass	Pass	Pass	-

Notes:
Results prefixed by “<” indicate a result less than the minimum detection limit

A.4 Status of Port Hope Project Small-Scale Sites Surveys as of April 1, 2018

Campaign	Number of Properties in Campaign	Interior Measurements			Exterior Measurements			Number of Properties Found to Have LLW
		Radon	Gamma	Delineation	Gamma	Subsurface	Delineation	
Trial Survey	23	100%	100%	100%	100%	100%	100%	2
1	430	100%	100%	100%	100%	100%	100%	44
2	806	100%	100%	95%	100%	100%	95%	337
3	1108	100%	100%	19%	100%	100%	59%	362
4	1349	100%	69%	0%	87%	53%	0%	Estimated 50
5	1150	100%	Fieldwork to commence in summer 2018					Estimated 40
Estimate at completion	4866						**Total forecast**	835

Notes

- In this table, '%' refers to percentage of measurements complete
- 'Delineation' refers to the process of determining the extent of LLW in a given property where it has been found

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CNL Management System Manual
REV 3.1

900-514100-MAN-001

Information Use

Approved by	Title	Date
Peter Stalker	Chief Operating Officer	2023/07/07

Effective Date: 2023/08/08
Expiry Date: 2026/08/08

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Management Commitment

As members of the Executive Team, we commit Canadian Nuclear Laboratories' management and staff to adhere to, implement, and continually improve the Management System described in this manual.

J. Griffin
Vice-President, Science & Technology

M. Steedman
Vice-President, Environmental Remediation Management and Stewardship and Renewal Group

R. Hendrickson
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President and Chief Executive Officer

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
3.1	2023/06/07	Issued as "Approved for Use". Minor revision to: 1) Address comments from CNSC letter 145-NOCN-22-0013-L 2) 2) Moved Grading and Risk Management to Section 7.1 and 7.2	A. Dash	A. Coulas P. Stalker	P. Stalker on behalf of J. McBrearty
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3	2022/06/22	Issued as "Approved for Use". Minor revision to incorporate:Appendix B, Management System Framework; 4) Minor additions to Appendix A; 5) Minor clarification of language and re-ordering of content in section 4; 6) Added definitions for Position, Role and Functional Support Area; 7) Updated Figure 2 to reflect Organizational Changes; 8) Updated Figure 3; 9) Updated Figure 5 to align with Information Management; 10) Removed Management Review and Assessment subsections with the	A. Dash	P. Boyle P. Stalker A. Coulas	J. McBrearty

		rewriting of the CAS section.				
3D1	2022/05/17	Issued for "Review and Comment".	A. Coulas	J. McBrearty P. Stalker P. Boyle B. Savage D. Cram D. Pilgrim Y. Dube K. Ibrahim D. Meldrum N. Chan B. Savage R. Mirault	T. Cook D. McIntyre T. Gazarek K. Leroux J. deRuiter K. Schruder D. Garrick D. Radford A. Rehman S. Cotnam S. Mistry S. Bessey	
2	2021/07/20	Issued as "Approved for Use". Minor revision to incorporate: 1) The three phase organizational structure transformation; 2) Adoption of new language from Vision 2030; 3) Clarification of roles and responsibilities in Section 4.3.3; and 4) Removal of Appendix B	A. Coulas	P. Boyle D. McIntyre	J. Willman D. Wood	J. McBrearty
2D1	2021/06/14	Issued for "Review and Comment".	A. Coulas	P. Boyle T. Gazerek M. Gull D. McIntyre L. Riccoboni M. Steedman D. Wood	T. Cook J. Griffin J. McBrearty R. Mullur B. Savage J. Willman K. York	
1	2020/07/01	Issued as "Approved for Use". 1) Minor revision to incorporate:	A. Coulas	P. Boyle		J. McBrearty

		2) Organizational changes to CNL Leadership Team; 3) Capturing improvements made to governance (updating the four part vision and updates to parent companies); and , 4) External audit observations (regarding alignment to requirements associated with grading, risk management, and principles).			
1D1	2020/02/14	Issued for “Review and Comment”.	A. Coulas	P. Boyle M. Lesinski J. McBrearty M. Steedman K. McCarthy C. Williams B. Savage M. Gull D. Wood	
0	2016/12/16	Issued as “Approved for Use”. Replaces Management System Manual, CW-514100-MAN-001, Rev 3	A. Coulas	K. Daniels	M. Lesinski
D1	2016/11/25	Issued for “Review and Comment”.	A. Coulas	F. Abulfazl C. Charbonneau F. Cowan K. Daniels A. Drom C. Fisher G. Garrett J. Gibb K. Leroux K. Lundie D. McIntyre D. Murphy P. Quinn D. Campbell S. Cotnam S. D’Eon G. Dolinar Y. Dubé L. Fleury D. Garrick L. Korkukluoglu M. Lesinski N. Mantifel B. Mumford T. Purcell	

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Table of Contents

Section **Page**

1. Introduction

Canadian Nuclear Laboratories Ltd. (CNL) has a management system comprised of an integrated set of documented policies, expectations, standards, procedures and responsibilities through which CNL is governed and managed, from the setting of direction through to day-to-day operations, all within a coherent control and accountability framework.

CNL's integrated management system demonstrates and documents commitment to maintaining a high-level of quality, strong customer service, and excellence in management within an environment that has safety as a first priority, is focused on the customers, and fosters continual improvement.

The management system provides the framework of processes, procedures and practices used to ensure that CNL can fulfill all tasks required to achieve our objectives safely and consistently. This foundational framework delivers quality in research & development; design engineering; procurement; manufacturing; qualification testing; construction; commissioning; operations; decommissioning; demolition; waste management; inspection; maintenance and plant life management; and project management; for nuclear power plants, research reactors, nuclear/non-nuclear facilities and installations.

A core prerequisite for CNL's success in consistently bringing high value to its customers and stakeholders is the effective and efficient governance and management. CNL is committed to excellence in management, thereby providing the foundation on which the Company and our employees can thrive.

1.1 Purpose

The CNL Management System Manual (Manual) sets the framework of policies, processes, and practices used to ensure that CNL can fulfill our mission and achieve our objectives. The top-tier reference document is this Manual. The Manual is complemented by learning materials, tools, and web-based products, which are accessible through the CNL intranet and Learning Management System. The Manual describes the relevant statutory, regulatory, contractual, and corporate frameworks within which CNL exists and operates. CNL's Management System is based on and complies to the requirements of CSA N286-12, ISO 9001:2015 and ISO 14001:2015; details of additional requirements informing the management system are identified in *Codes, Regulations, Standards, and Other Documents* [1].

1.2 Scope

The management system applies to all CNL management and execution activities. Management activities include setting expectations, enabling, planning and budgeting, and assessing all aspects of business, thereby ensuring delivery against commitments within appropriate accountabilities and controls. Execution activities include the safe, effective, and efficient conduct of work across all CNL lines of business.

The management system applies to all work performed by CNL employees, contractors and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL. It is expected that they are trained and competent, and have sufficient knowledge of the management system in order to conduct work according to CNL's expectations and requirements as reflected in policies and procedures. For more specific information regarding contractors and sub-contracts see *Supply Chain* [2].

CNL is comprised of organizational units at the following sites across several provinces of Canada:

- Chalk River Laboratories and Deep River offices (Chalk River and Deep River, Ontario);
- Historic Waste Program Management Office (Port Hope, Ontario);
- Nuclear Power Demonstration Reactor Waste Facility (Rolphton, Ontario);
- Douglas Point Waste Facility (Tiverton, Ontario);
- CNL Ottawa Office, (Ottawa, Ontario);
- Whiteshell Laboratories, (Pinawa, Manitoba);
- CNL Site Offices (Fredericton, New Brunswick);
- La Prade Heavy Water Storage Facility (Bécancour, Québec); and
- Gentilly-1 Waste Facility (Bécancour, Québec).

1.3 Principles

The CNL management system ensures that the following principles, as provided in Canadian Standards Association standard, *Management System Requirements for Nuclear facilities* [3], are applied and considered when executing all CNL work:

- Safety is the paramount consideration guiding decisions and actions;
- The business is defined, planned, and controlled;
- The organization is defined and understood;
- Resources are managed;
- Communication is effective;
- Information is managed;
- Work is managed;
- Problems are identified and resolved;
- Changes are controlled;
- Assessments are performed;
- Experience is sought, shared, and used; and
- The management system is continually improved.

2. Corporate Profile- Who We Are

2.1 Purpose

Advancing nuclear science and technology for a clean and secure world.

2.2 Vision 2030

At the heart of Vision 2030 is more than 70 years of pioneering research in nuclear science and technology. In planning its future, CNL has developed a strategy that harnesses this expertise, and realigns our priorities to match real-world opportunities. At CNL, we fulfill three strategic priorities on behalf of the Government of Canada – restoring and protecting the environment, clean energy for today and tomorrow, and contributing to the health of Canadians. That work is critically important to the future of this country, and to the health and well-being of Canadian citizens.

To achieve success in our current priorities for energy, health and environment, we work with our partners by applying CNL's world-class capability in managing the full-life cycle of nuclear materials. We underpin our core capability by integrating across a wide range of scientific and technical disciplines that include materials science, engineering, process modelling, robotics, artificial intelligence (AI), cyber security, biology, environmental science, and detection and forensics. Recognizing that science and technology are not static we continually invest in expanding and modernizing our capabilities while also exploring their application to new and emergent problem sets that are important to the safety and prosperity of Canadians.

Vision 2030 is enabled through a revitalized Chalk River Laboratories. The campus is being carefully restored through an integrated strategy of facility decommissioning and waste disposal, which are, in turn, coupled with the construction of new state-of–the-art research facilities. The decommissioning and waste disposal activities improve accessibility to the site and ensure the protection of the environment, our workforce and the public. These activities also create the space needed to accommodate cutting-edge research facilities and provide CNL with the necessary waste management, disposal and processing facilities to enable its scientific missions into the future. This process of renewal also extends to CNL's people. CNL has transformed its workplace policies and organizational structure to establish an innovative work environment that embraces flexibility. These changes will not only improve how our employees interact with one another, collaborate and innovate as a company – both in-person and remotely – but they will revitalize the tools, technologies and environment that we use to do so.

2.3 Mission

We will provide the world with sustainable energy solutions, including the extension of reactor operating lifetimes, hydrogen energy technologies and fuel development for the reactor designs of tomorrow.

We will restore and protect Canada's environment by reducing and effectively managing nuclear liabilities.

Together with partners, we will demonstrate the commercial viability of advanced reactor designs, including small modular reactors.

We will work collaboratively with medical/educational institutions and pharmaceutical companies to pioneer new Alpha therapies for cancer treatments that save countless lives.

We will leverage all of our capabilities for commercial success in Canadian and international markets.

2.4 Core Values- What We Believe In

An integrated framework of values set out the ethical standards, behaviours and foundations expected of every employee across the company. These values inform CNL's policies, processes, and practices, the conduct of work, and the professional conduct of all.

Safety - Safety is freedom from harm, danger, injury or loss to people and the environment. It is the foundation on which our decision-making stands. It is our primary focus, with no compromise.

Teamwork - Teamwork is the ability to work together, in a collaborative way, toward a common goal.

Accountability - Accountability is both an attitude and a set of actions that affect how we impact people, situations and results in a positive way.

Integrity - Integrity is adhering to high ethical standards and strong moral principles, even under pressure.

Respect - Respect is placing a high value on others, treating them fairly, and empathizing with their needs. It is the foundation of building relationships and trust.

Excellence - Excellence is striving to achieve an ever-rising standard of quality through continual improvement and innovation.

2.5 Vivid Description

CNL stands proud as a global leader advancing nuclear science and technology. The world comes to CNL to solve the toughest technological challenges. CNL has the most effective industrial partnerships of any national laboratory. Our campuses are home to a vibrant community of the world's brightest innovators. Our people know they are making a difference in the lives of people around the world. CNL is valued by the Canadian government and customers in industry.

2.6 Corporate Policies

CNL's corporate policies provide intentions and expectations to management and employees that inform all that we do and how we do it. The following corporate policies have been authorized by the Board of Directors and approved by the President and Chief Executive Officer (CEO).

Table 1: Corporate Policies

Corporate Policy	Functional Support Area
Nuclear Safety [4]	Conduct of Operations
Safety and Health [5]	Occupational Safety & Health
Environment [6]	Environmental Protection
Ethics and Business Conduct [7]	Legal Services
Quality [8]	Quality
People [9]	Human Resources
Security [10]	Security
Supply Chain [11]	Supply Chain
Asset Management [12]	Property (Asset) Management
Intellectual Property [13]	Legal Services

2.7 Strategic Overview and Funding

CNL is Canada's premier nuclear science and technology organization. CNL delivers science and technology solutions to meet current, and future, Canadian Government, public, and private commercial priorities in four program areas: Energy, Health, Environment, and Safety & Security. CNL is transforming its Chalk River Laboratories (CRL) through the revitalization of essential site infrastructure, the decommissioning of aging infrastructure, and a significant investment in new, world-class science facilities. This transformation will position CNL to remain a leader in developing peaceful and innovative solutions.

To achieve the strategic objective of a world-class, sustainable national nuclear laboratory, CNL will continue to transform into a high performing organization. CNL will build upon existing strengths, continuously improve delivery, and pursue new capabilities in response to Canada's and the world's challenges. Our diversified workforce will enable the safe and efficient execution of the missions in a constantly changing, competitive world. Further details can be found in *10-Year Integrated Plan Summary 2020-2030* [14].

2.7.1 Environmental Remediation Management

The Environmental Remediation Management mission supports a commitment to a clean and healthy environment for Canadians. Innovative technologies, modern facilities and technical expertise are provided in support of the safe storage and long-term management of radioactive waste. Redundant buildings and infrastructure are decommissioned in a prioritized manner reducing the legacy liability and associated risks and site operating costs. Environmental remediation processes apply systematic risk assessments, based on sound science and remediation solutions that help ensure all activities are protective of the environment and human health. Activities focus on addressing and managing health, safety, security, environment and quality risks.

2.7.2 Science and Technology

CNL is known and respected nationally and internationally for its scientific capabilities, which are used to progress Science and Technology (S&T) priorities. The expertise of staff, when coupled with our unique S&T facilities, positions CNL well to meet customers' current and emerging needs. CNL has been able to meet the needs of customers through collaborations with national and international companies and universities. CNL's reputation is a significant factor for attracting commercial customers who recognize that we can solve industry's toughest challenges.

Additionally, CNL is performing a broad program of work aimed at meeting the nuclear S&T needs of federal government departments and maintaining nuclear S&T capabilities. Under this program, CNL serves both individual federal departments and agencies and, as a whole, national priorities that meet the needs of Canadian citizens.

Alignment of this mission with federal needs is further enhanced through the recent establishment of the Federal Nuclear S&T Interdepartmental Committee that oversees the federally-funded S&T program.

2.7.3 Capital

As Canada's premier nuclear laboratories, infrastructure is being modernized and capabilities enhanced to provide vibrant, safe, and world class nuclear S&T facilities and supporting infrastructure that will support Canada's needs well into the future. Currently, priority is given to infrastructure upgrades that address immediate safety, environmental and regulatory requirements, and to new projects that will provide a high return on investment. These early investments at CNL's site at Chalk River will enable implementation of new infrastructure projects that will further enhance CNL's capabilities.

Chalk River Laboratories (CRL) assets include more than 50 unique facilities and laboratories. These facilities are enabled by radioactive material handling, processing and storage facilities; conventional municipal infrastructure as well as maintenance, manufacturing and engineering programs tailored to CNL's diverse needs.

2.7.4 General Services

CNL's General Services create the conditions that are required to achieve strong organizational performance, and management excellence in the delivery of effective programs and services. CNL's General Services include the programs and activities capturing corporate governance and management oversight, in Health, Safety, Security, and Environment (HSSE), Central Technical Authority, Business Management, Human Resources, Legal, Corporate Affairs, Infrastructure Development Group, and Business Development.

3. Corporate Governance- How We Are Controlled

CNL is a private corporation that exists for the purpose of performing work and other obligations under contract to Atomic Energy of Canada Limited (AECL). CNL's shares are wholly owned by Canadian National Energy Alliance Limited (CNEA) as part of a Government Owner Contractor Operated arrangement. CNL is obliged to operate lawfully as a Canadian corporation; comply with applicable licenses, registrations, certificates and permits; submit to the governance of the shareholder (CNEA), and fulfill obligations to AECL under the Prime Contracts.

The Corporate Governance Model is depicted in Figure 1: CNL Corporate Governance Model. Board of Directors membership is documented in an organizational chart (available on CNL intranet).

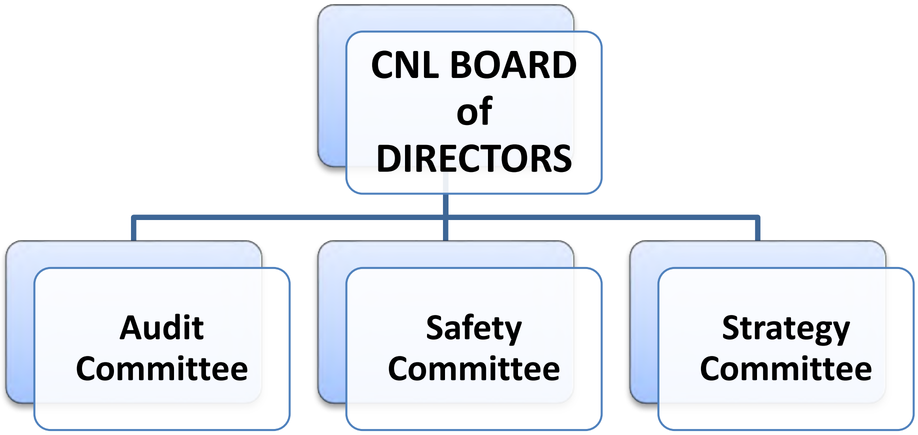

Figure 1: CNL Corporate Governance Model

The Board governance model provides active assurance to CNEA of the performance of CNL and is consistent with the requirements of the *CNEA Shareholder Declaration* [15]. The CNEA Board appoints from its members the Chair and two Directors of the CNL Board of Directors. This provides CNEA with direct involvement at the Board level of CNL. CNEA also appoints the directors, officers, and specific management positions of CNL. The CNL President & CEO and Chief Financial Officer (CFO) attend the CNEA Board meetings and report matters of interest to the Board, such as corporate performance and progress against the Annual Program of Work and Budget (APWB).

3.1 Integrated Decision Making

Without exercising any element of control in relation to the discharge of CNL's obligations as a nuclear site licence holder, the *CNEA Shareholder Declaration* [15] identifies:

- Those matters which the CNL Board of Directors need to refer to the CNEA Board for approval including those decisions to be taken unanimously by the CNEA Board; and
- Those decisions that are reserved to the CNEA Shareholders themselves.

This mechanism provides transparency, oversight and an integrated flow of information to the shareholder.

3.2 Contract and Corporate Governance

The CNL governance model is principally contained in the following documents:

- CNEA Governance: The *CNEA Shareholder Declaration* [15];
- The Prime Contracts [16], [17], [18], [19]; and

- CNL Governance: The constating documents, including Articles of incorporation and CNL By Law 1 and the Terms of Reference of the CNL Board of Directors [20] and Committees of the Board [21], [22], [23].

3.3 Licences and Regulatory Governance

CNL operates in a highly regulated environment, particularly with respect to its licensed nuclear activities. External regulators grant CNL licences that authorize the licence holder to undertake certain activities in accordance with defined expectations. These licences define reporting accountabilities and subject CNL to periodic regulatory inspections to confirm compliance with conditions imposed by the licence. These include the following licensed nuclear activities and are documented in *Site Licences, Certificates, Permits, Building/Facility Contacts, & Licence Representatives* [24], and authorized by the Canadian Nuclear Safety Commission (CNSC):

- Operate, wholly or in part, any nuclear facility;
- Maintain in storage with surveillance any nuclear facility, or any parts thereof;
- Decommission any nuclear facility, or any parts thereof;
- Construct, modify or abandon any nuclear facility;
- Produce, possess, process, refine, transfer, use, package, manage, store, dispose or abandon nuclear substances;
- Produce, possess, use, service, transfer or abandon prescribed equipment;
- Possess, use, transfer or abandon prescribed information;
- Operate dosimetry services;
- Export and import nuclear substances and prescribed equipment and information;
- Process, store or dispose of waste received from off-site clients; and
- Receive, repair, modify, store and return contaminated equipment from off-site clients.

A list of other Regulatory drivers can be found in *Codes, Regulations, Standards, and Other Documents* [1]. Licensing support and general regulatory compliance oversight of Canadian Nuclear Safety Commission (CNSC), Technical Standards and Safety Authority (TSSA), Environment and Climate Change Canada (ECCC), and Employment and Social Development Canada (ESDC) are managed according to the processes documented in *Compliance* [25].

4. Organizational Structure- How We Are Structured

CNL's organizational structure is approved by the CNL Board of Directors on recommendation of CNL's President & CEO. Responsibility for the management and operations of each element of its structure is assigned to executives and senior management reporting to the President & CEO. CNL's current organizational structure is depicted in Figure 2.

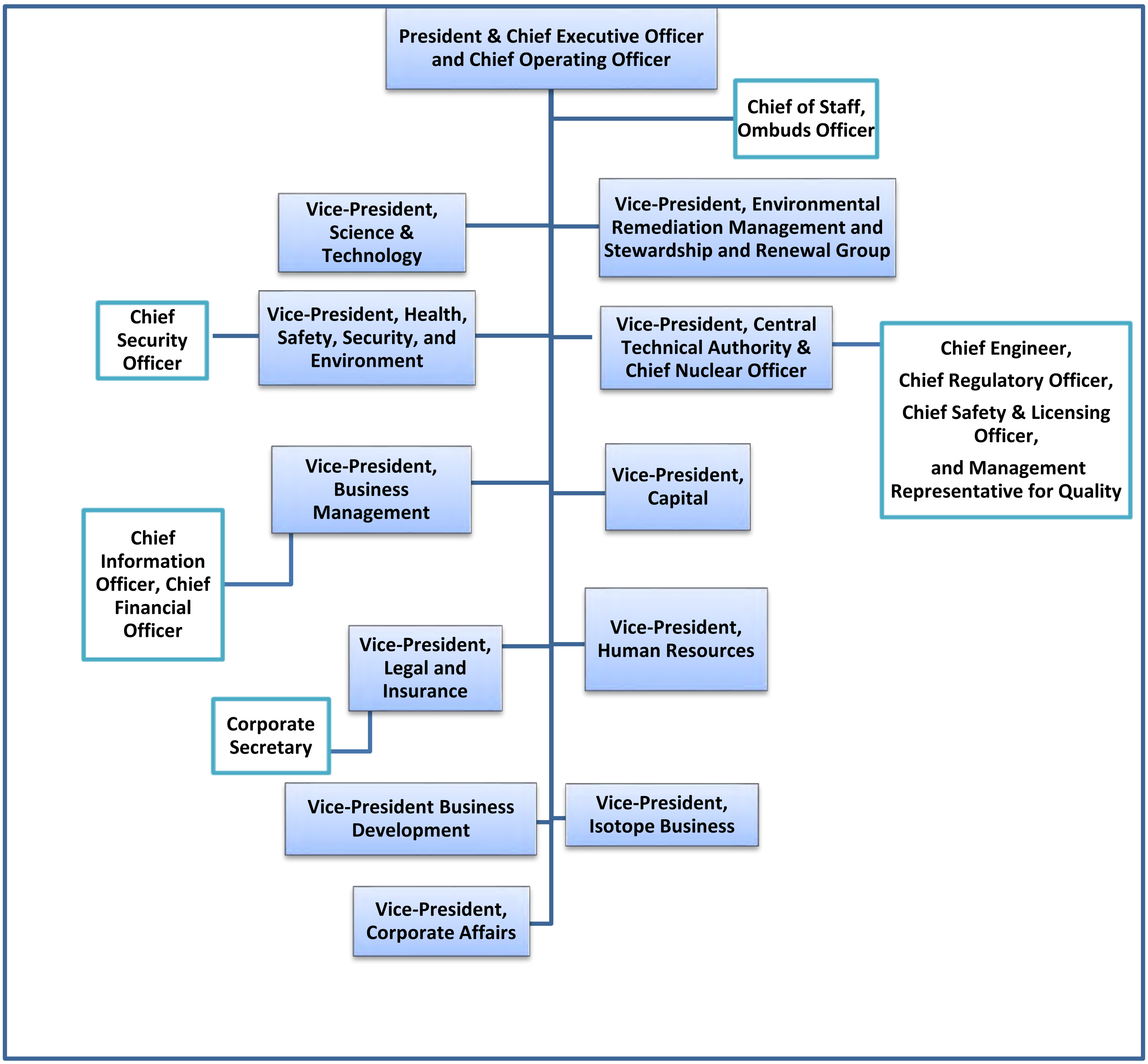

Figure 2: CNL Executive Team and Corporate Functional Authorities

Each member of CNL's Executive Team is accountable to the President & CEO for specific areas of CNL business and operations as recorded in Appendix A, individual position descriptions and current assignments are tracked in *Functional Authorities* [26].

CNL's organizational structure combines line management and functional authority designed to deliver work safely, ethically, and in compliance with requirements and in pursuit of achieving company goals.

All of CNL resources are assigned primarily as line management. Line management is any management level within the organization, which is responsible and accountable for directing and conducting work. The line management structure consists of the following hierarchical levels:

- Company: CNL as an entity comprised of all organizational units, divisions and departments. The President & CEO is responsible for the Company.
- Organizational Unit: The 2nd level within CNL's hierarchical structure. A Vice-President is responsible for the management of an organizational unit. An organizational unit is made-up of departments.
- Department: Sub-structures within an organization unit.

The line management structure is controlled, subject to *Organizational Change Control* [27], to ensure that any organizational changes are evaluated for impacts to CNL and is reflected in Appendix A.

A selected group of individuals are then, in addition to their line management role, assigned a functional authority role. A corporate functional authority spans horizontally across all organizations, and is an authority assigned by the President & CEO. This authority, operating on behalf of the President & CEO, includes providing associated direction and guidance, assessing whether activities meet expectations, and identifying gaps requiring further action.

Functional authorities have responsibility for defining, interpreting, and maintaining functional requirements, ensuring implementation of requirements are consistent company-wide, and for supporting line management in their implementation.

The functional authority structure is controlled, subject to *Functional Requirements and Framework Management* [28] to ensure that any changes are evaluated for impacts to CNL and reflected in Appendix B (which describes the functional authority structure), and *Functional Authorities* [26] (which describes the role assignment).

Figure 3 depicts how line management and functional authority interact.

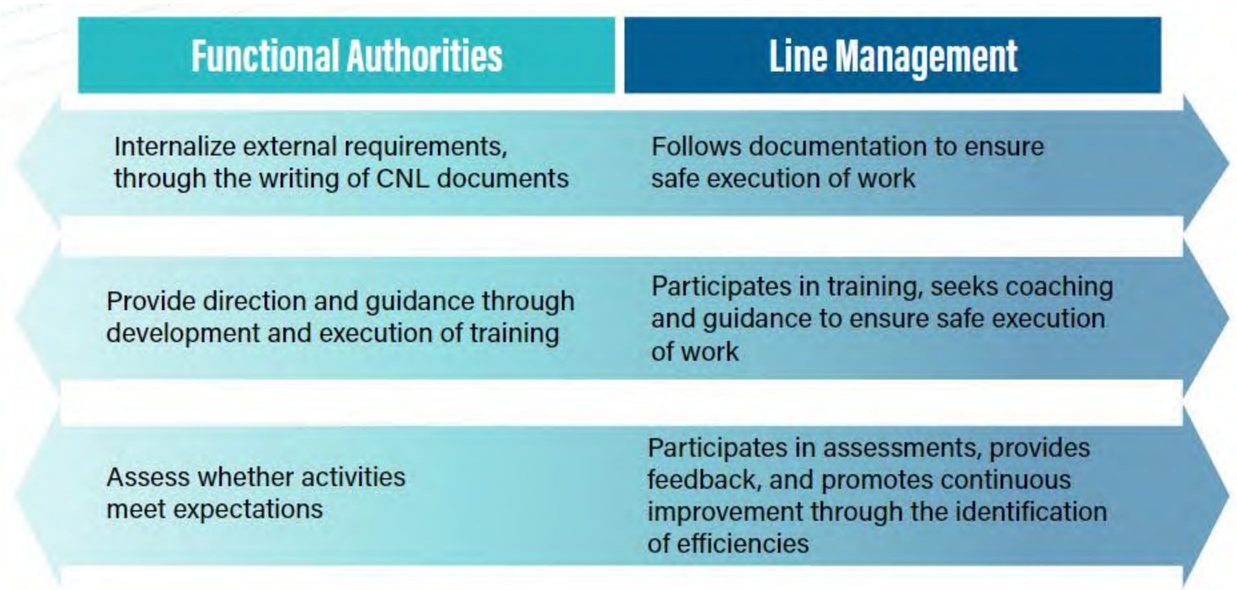

Figure 3: Examples of Interface between Line Management and Functional Authority

4.1 Line Management Structure

Line management consists of the CNL President & CEO, Line Management Executives, Department Managers, and First Line Supervisors.

4.1.1 Line Management Executives

Line Management Executives include job titles such as Vice-Presidents and Deputy Vice-Presidents. A Line Management Executive is assigned to organizational units as directed by the President & CEO. Line Management Executives are responsible for selecting and prioritizing projects within their assignments, defining the scope, establishing priorities, and requesting the funding to accomplish the scope in a safe, secure, cost effective, and compliant manner. In this capacity, Line Management Executives are responsible to:

- Be accountable and responsive to the President & CEO and CNL Board of Directors;
- Be appropriately knowledgeable of CNL's requirements, policies, processes, and practices;
- Support the company vision, strategic outcome and actions as defined in the 10 Year Strategic Plan;
- Establish an effective, balanced and transparent oversight framework to provide line of sight to important and emergent issues;
- Intervene to manage risks in their area of responsibility;
- Act as a role model for leadership and management excellence consistent with management system expectations;

- Provide strategic direction, leadership, and support to staff;
- Manage the assets, capabilities and human resources within their respective organizational unit;
- Contribute to the development and continual improvement of CNL's management system;
- Maintain effective communications and working relationships with all levels of line management and functional authority;
- Ensure, and take full accountability for, compliance with CNL policies and procedures and required legislations;
- Safely and compliantly complete activities within the approved scope, schedule, and budget;
- Ensure consideration for functional resource needs when establishing or changing budgets;
- Act as safety champions encouraging worker involvement in company safety programs;
- Ensure excellence in project team communication;
- Establish and maintain detailed work plans and the lifecycle baseline;
- Contribute to maximum operating efficiency through effective financial planning and monitoring, and the resolution of departmental issues to ensure responsible fiscal stewardship;
- Review and approve business cases for staff hiring, equipment, and facilities within the bounds of the budget;
- Support and maintain positive interactions with customers, stakeholders, and the public;
- Support and participate in continuous improvement and corrective action initiatives;
- Obtain and integrate feedback from employees concerning quality, health, safety, and environmental issues into facility and company lessons learned;
- Ensure that employees under their direction have requisite training and access to professional development opportunities consistent with corporate objectives and management system expectations;
- Ensure defined roles, responsibilities, and oversight are provided for workers;
- Functionally accountable to the Site Licence Holder for ensuring safety and compliance with all applicable codes, standards, legislation, regulations and site licence conditions when assigned responsibilities that directly or indirectly impact or involve the

management and/or execution of licensed activities. This includes the operation, maintenance and use of nuclear facilities, radioisotope laboratories and supporting facilities, as well as the provision of supporting corporate services;

- Support and implement assessment plans to evaluate implementation of programs appropriate to the projects; and
- Utilize appropriate project metrics to monitor, evaluate, and improve area project performance.

4.1.2 Department Managers

Department Managers implement the CNL goals and expectations for achieving safe, compliant, and efficient operations. Department Managers encompasses titles such as General Manager, Head of Directorates, Director, and Manager. Department Managers are responsible for ensuring that work is performed safely by implementing and ensuring operations are conducted within CNL's requirements (such as safety basis, rules, regulations and permits) in their respective department and facilities.

Principal responsibilities of the Department Manager include:

- Ensure work, performed by CNL employee or contractors, is done safely within the assigned area of responsibility;
- Manage the assets, capabilities and human resources within their respective department;
- Understand the full scope of accountabilities, authorities, and the associated expectations;
- Ensure effective implementation of the management system, including consistent adherence to functional support area requirements and procedures across assigned area of responsibility;
- Ensure that equipment is safe, meets all regulatory requirements and is suitable for the work, and that all necessary periodic inspections have been undertaken prior to use;
- Ensure work is directed through the appropriate department;
- Develop integrated schedules to accomplish the work according to project priorities and resolve priority conflicts between sub-projects;
- Ensure work, including that of subcontractors, is defined, hazards identified and analysed, controls developed and implemented, work executed within controls, and feedback provided and used to continuously improve;
- Ensure that commitments related to work are maintained and communicated regularly;

- Ensure that operations are conducted in compliance with facility requirements such as the authorization basis, license-required conditions, and environmental regulations and permits;
- Communicate risks to employees and ensure that appropriate controls are in place to mitigate and protect the worker from harm;
- Ensure that investigations are held for unusual events and near misses so that feedback is given to workers and lessons learned are captured and shared;
- Actively participate or lead required investigations; document root causes and findings; and implement corrective actions in a timely manner, securing the needed budget and resources;
- Obtain feedback from employees concerning issues and incorporate into lessons learned;
- Actively promote and support process improvement initiatives;
- Perform periodic monitoring and self-assessment of work and take action as needed to address issues and correct nonconformities;
- Prepare and manage business/project plans and supporting scorecards and metrics;
- Support the accomplishment of work and remove unnecessary obstacles;
- Interface with matrixed and embedded personnel to ensure all requirements are met within assigned area of responsibility;
- Ensure that training requirements are defined and implemented for each employee and support training as necessary;
- Participate in integration discussions and activities—as a team effort—to enhance the effectiveness of the organizational structures and processes in support of CNL goals;
- Foster an environment of respect, diversity, equity and inclusion, and overall engagement;
- Demonstrate appropriate workplace behaviour aligned to the code of conduct and workplace values and managing complaints and resolutions;
- Demonstrate due diligence to applicable laws, regulations and changing mandates;
- Functionally accountable to the Site Licence Holder for ensuring safety and compliance with all applicable codes, standards, legislation, regulations and site licence conditions when assigned responsibilities that directly or indirectly impact or involve the management and/or execution of licensed activities. This includes the operation, maintenance and use of nuclear facilities, radioisotope laboratories and supporting facilities, as well as the provision of supporting corporate services;

- Identify resource needs, and obtain and manage resources to accomplish project milestones and objectives;
- Manage resources, including recruiting, assigning, redeploying, and terminating; and
- Manage the performance of their employees by:
    - Ensuring that their employees understand their responsibilities under the CNL management system;
    - Ensuring their employees have the requisite competence, objectivity, knowledge and training to safely and effectively exercise their assigned roles and responsibilities;
    - Setting and reinforcing expectations and managing employee performance;
    - Evaluating overall performance of employees, and providing timely performance feedback;
    - Managing hours of work and attendance requirements, taking into consideration remote working arrangements;
    - Respecting collective agreements and terms and conditions of employment;
    - Providing professional development opportunities as part of succession planning; and
    - Providing specific feedback and assessing employee performance against expectations to develop and sustain performance.

4.1.3 First Line Supervisors

First Line Supervisors include titles such as Shift Supervisors, Foreperson, and Facility Managers. First Line Supervisors have direct authority over other workers or a specific work location. First Line Supervisors have the following responsibilities:

- Exercise departmental authorities that have been delegated to them;
- Carry out their activities with due regard for all areas of authority and any corresponding direction;
- Conduct all work consistently with CNL's processes and procedures;
- Promote safety as a priority throughout all work activities;
- Provide daily instruction and direction to workers;
- Serve as role models for employees under their supervision;
- Encourage workers to report violations, wrongdoings, and issues; and
- Resolve issues as they arise or escalate to departmental management for resolution.

4.1.4 Employees

In addition to items listed in sections 4.1.1, 4.1.2, and 4.1.3, Line Management Executives, Department Managers, and First Line Supervisors are also Employees and this section is applicable to them. All Employees are accountable to their management and supervision for the following:

- Perform duties safely, and to the expected level of quality, in accordance with instructions and training;
- Know their individual responsibilities and their employment expectations;
- Know and abide by requirements that include the Code of Conduct, workplace values how to work safely, rules regarding leave, procedures, and reporting;
- Know their collective agreements, if applicable;
- Monitor their employment information and immediately report changes, errors or concerns including personal information (e.g., pay matches salary, leave matches entitlement);
- Be compliant with all required training and attend training as scheduled;
- Support, operate, and maintain nuclear and non-nuclear facilities with a profound respect for safety and with an over-arching charge to preserve the health and safety of the general public and fellow employees as well as the environment;
- Adhere to CNL management system policies, process requirements and procedures, including safety protocols, in all activities;
- Report problems, deficiencies, incidents, accidents, and unsafe conditions immediately to supervisor or manager;
- Cooperate with investigations and with company processes;
- Understand their specific role and how it aligns with the overall mission;
- Understand how performance will be measured and expect and solicit feedback;
- Actively participate in the effort to develop and improve skills and performance;
- Carry out their duties ethically and with integrity, consistent with corporate policies; and
- Safeguard company information and assets.

4.2 Functional Authority Structure

The functional authority structure consists of Responsible Executives, Functional Support Managers, and Functional Support Manager Designates as listed in *Functional Authorities* [26].

4.2.1 Responsible Executives

Responsible Executives are appointed by, and accountable to, the President & CEO and are responsible for one or more Functional Support Area(s). Responsible Executives also identify Functional Support Managers and Functional Support Manager Designate(s) as needed to manage Functional Support Areas.

The role of the Responsible Executive is to ensure that the Functional Support Areas within their scope, meets external requirements; protects workers, the public, and the environment; and adequately addresses other vulnerabilities (e.g., financial, legal, reputational, or security). Responsible Executives ensure implementation of requirements of CNL as described in Program Requirements Documents for the Functional Support Area(s) within their scope.

Principal responsibilities common to all Responsible Executives include:

- Define and serve as ultimate CNL authority for applicable requirements for their grouping of Functional Support Areas;
- Approve any changes affecting the composition of the Functional Support Area(s) such as transfer or creation of new Functional Support Areas; and assignment or re-assignment of Functional Support Managers and Functional Support Manager Designate(s) (as per *Functional Requirements and Framework Management* [28] and *Authority Management* [29]);
- Establish programs and maintain effective systems, policies, and procedures in the assigned Functional Support Area(s);
- Ensure that commitments related to CNL projects are maintained and the status of the commitments is communicated regularly to employees;
- Promote a positive, collaborative work environment;
- Ensure effective and consistent implementation of functional programs across CNL;
- Interface with line management to improve processes through application of lessons learned and feedback;
- Ensure that assigned functional support workers are trained and qualified to perform their scope;
- Develop and implement a programmatic assessment plan to evaluate implementation of program elements in accordance with *Integrated Assessment Plan* [30];
- Perform assessments and oversight as per management review [31];
- Provide initiatives as part of continuous improvement; and
- Oversee and ensure compliance within other Functional Support Areas to the CNL management system.

4.2.2 Functional Support Managers

Functional Support Managers (FSM) are appointed by, and accountable to, their respective Responsible Executive, and are the single point of contact for their individual area of responsibility. Functional Support Managers are the document owners for documents listed in their respective Governing Document Index (GDI) which implement the requirements of their specific Functional Support Area(s). Additional responsibilities of Functional Support Managers include:

- Ensure that applicable requirements are implemented in an appropriate implementing document;
- Act as final authority for interpretation and applicability of their functional requirements to line management;
- Perform applicability reviews on new and revised requirements, including identification of required resources, impacts, and implementation schedules and strategies;
- Establish and implement the discipline-specific technical attributes and training expectations for the training and qualification of affected personnel;
- Ensure that the quality of standard equipment, hardware, software, and documentation that is under the direct purview of the Functional Support Area meets company and facility requirements;
- Establish and maintain effective relationships and coordination of CNL interfaces with AECL, regulators, and oversight organizations;
- Maintain effective communication and working relationships with line management and other Functional Support Managers; and
- Develop and perform programmatic assessment plan in accordance with *Integrated Assessment Plan* [30], to evaluate implementation of program elements to verify that Functional Support Area requirements have been adequately implemented across CNL.

4.2.3 Functional Support Manager Designate(s)

Functional Support Manager Designate(s) are accountable to a Functional Support Manager. Responsibilities of Functional Support Manager Designate(s) include:

- Assist Functional Support Managers to fulfill responsibilities listed above;
- Maintain effective communication and working relationships with line management and other Functional Support Manager Designates;
- Interface with facilities, projects, and other support organizations to ensure that the quality of standard equipment, hardware, software, and documentation meets site and facility requirements;

- Maintain proficient knowledge of assigned Functional Support Area requirements;
- Provide support to line management by identifying and interpreting the Functional Support Area requirements in assigned laws and regulations, contract clauses and language, and other contractual language as they apply to current contract work scope;
- Develop and submit documentation for implementation of the requirements of assigned Functional Support Area;
- Support and monitor training and qualification programs to ensure that requirements are implemented effectively and workers are trained and qualified to perform work;
- Participate in operational readiness reviews, readiness assessments, management assessments, third party audits, or other assessments and reviews, as requested;
- Be familiar with events and issues within facilities, projects, and other support organizations, assisting in developing corrective plans and lessons learned; and
- Support Functional Support Area programmatic assessment plan to evaluate implementation of program elements.

4.3 Interfaces

4.3.1 Line Management and Line Management Interface

To achieve objectives, line management will utilize resources from other line management organizations. Assignment on temporary basis of the employees to the work can be managed utilizing a variety of existing processes that clarify agreement between the management teams on topics such as safety of workers, budget, scope, timecard approvals, and work assignment. Project execution plans [32] are utilized to cover programmatic responsibility for work authorization and execution, notification and reporting, emergency preparedness, scope of work, budget and document control. Meanwhile, *Integrated Work Control* [33] process is utilized to manage the same topics for activity specific field work, with the fundamental principle of the line management responsible for authorizing the work is also responsible for safety of the workers.

4.3.2 Line Management and Functional Authority Interface

The success of the CNL management system depends on the integration and collaboration between line management and functional authority counterparts. Both must work together to develop and implement processes and procedures for the safe, compliant, and efficient conduct of work. Figure 3 above illustrates this interface.

Specifically, the following general expectations must be met:

- Line personnel are accountable for safety. This includes accomplishing work in a safe and compliant manner and being responsive to / complying with functional authority direction and guidance.
- Functional personnel define, interpret, and maintain functional requirements that support line personnel in consistent implementation company-wide, while at the same time assessing whether activities are meeting those expectations.
- All personnel will adhere to processes and procedures as written.
- When revisions to procedures are needed, the document owner will engage all relevant stakeholders for review and comment. The document may not be issued until all comments have been resolved per the guidance in *Creation, Capture, and Use of Information Assets* [34].
- Both line and functional personnel work together as a team to resolve implementation issues as they arise and in a timely manner.
- If timely resolution cannot be achieved at the working level, the issue is escalated to management. If necessary, respective Responsible Executive and Line Management Executive may be requested to support resolution.
- Both line and functional personnel are held accountable for their role in safely accomplishing the missions of CNL.

4.3.3 Functional Support Personnel Embedded Versus Matrixed within Line Management Structure

Functional personnel can either be ‘embedded’ or ‘matrixed’ to a line management structure as shown in Figure 4.

The responsibilities of both embedded and matrixed functional personnel include:

- Interface with the appropriate corporate functional authority on lessons learned, process initiatives, and technical difficulties.
- Implement the training and qualification process required by the Functional Support Area for functional personnel.
- Participate in the assessment process to ensure effective implementation.
- Implement procedures from respective Functional Support Area associated with the assigned work.

When functional support personnel are matrixed to a line organization they report directly (or hard lined) to their functional authority, while reporting (or dotted lined) to line management in support of the work. Matrixed functional personnel work in areas such as occupational safety and health, radiation protection, supply chain, and quality, and are responsible for implementing functional requirements, in a support role for a line organization. Matrixed personnel report to the functional authority and are responsible to implement functional authority requirements and standards. The line organization provides work assignment direction to matrixed personnel to support achievement of mission objectives. Line management provides input to performance evaluations and job rotations which are led by functional authority.

When functional support personnel are embedded within a line management, they are part of the line management organization, and report directly (hard lined) to line management. Embedded functional support personnel work in areas such as engineering and maintenance. Line management directs the day-to-day work of embedded functional support personnel to support achievement of mission objectives. Functional authority provides technical direction, guidance and technical training for embedded functional support personnel to achieve mission objectives. Both the line management and the embedded functional personnel are required to comply with functional requirements specified in the management system by the functional authority. Functional authority provides input to performance evaluations and job rotation which are led by line management.

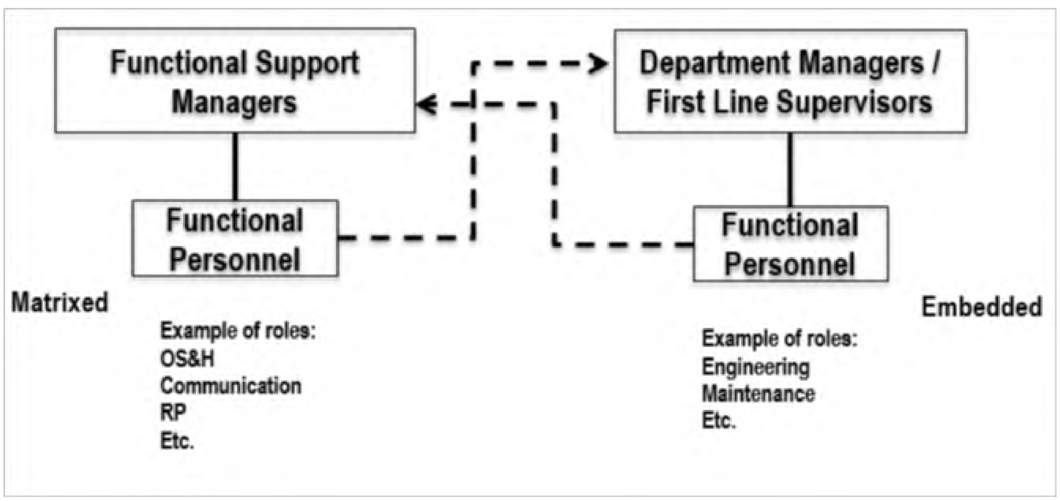

Figure 4: Reporting relationships of matrixed and embedded functional personnel

4.4 General Expectations

CNL recognizes leadership, safety, and collaborative teamwork expectations as important benchmarks to enable safety, execution, and innovation. The following behavioural expectations apply to all levels of CNL.

4.4.1 Leadership Expectations

The impact of management behavior on organizational performance is extensive. Compliance with CNL's *Code of Conduct* [35] is mandatory. The following leadership behaviors are critical to organizational success:

- Regularly communicate, model, and reinforce the CNL vision, values, standards, expectations, and strategies to align the organization to achieve excellence;
- Be visible, active, and engaged at job sites;
- Seek out and act on worker feedback;
- Demonstrate a firm and unwavering commitment to nuclear, radiological, industrial, and environmental safety; event-free conduct of work; and, effective emergency response;
- Demonstrate commitment to organizational learning and professional growth;
- Demonstrate a self-critical approach;
- Demonstrate a questioning attitude;
- Demonstrate ownership of requirements implementation;
- Demonstrate insistence on high standards;
- Hold themselves and employees accountable for performance; and
- Utilize employee recognition programs to increase desired behaviors.

4.4.2 Safety Expectations

Prevention of dangerous or hazardous situations and appropriate proactive strategies to positively impact and continuously improve all aspects of safety and health, are considered fundamental in everything CNL does. As such, the following safety behaviors are critical:

- Establish safety as an organizational value and a prerequisite for all work;
- Through processes such as assessment, worker feedback, and personal observation, ensure that a safe work environment is established and maintained;
- Take pre-emptive actions in response to degrading conditions. While prompt response to adverse occurrences and conditions is expected, management will ensure that processes such as critical assessment, performance metrics collection, and direct field observation of processes in progress, are available to aid in forming and executing pre-emptive actions; and
- Utilize response to adverse events for overall performance improvement. The emphasis in this response is on accurately determining causes, then properly responding, including response to underlying causes in management system processes. Management must ensure that adequate extent of condition considerations are utilized to preclude similar events elsewhere in the organization. Similarly, evaluation of information obtained from adverse events occurring in other organizations is required to preclude similar events.

4.4.3 Collaborative Teamwork

CNL promotes the overall successful accomplishment of mission objectives by sharing the same vision, trusting that all areas are capable of completing their portion of the mission, and being able to coordinate and communicate effectively across departments. The following behaviors are critical to ensuring that departmental goals align with the overall mission of CNL:

- Acknowledge collaboration as part of the value of teamwork and a prerequisite for all work;
- Actively sponsor teamwork and integration;
- Strive to eliminate the formation of silos within the organization;
- Encourage all departments to share information and knowledge to increase efficiency of the organization as a whole; and
- Promote a culture of coordination to achieve common goals for the organization.

4.5 Delegation of Authority

Authority may be delegated downward from the President & CEO, however, overall responsibility remains with the delegating individual. Accountability flows upwards from the working level to President & CEO. Authority is assigned throughout the CNL management system utilising management system documents such as job descriptions, controlled lists or processes like the *Financial Approvals and Delegation of Authority* standard [36]. The process for establishing or revoking temporary or permanent authority is in accordance with *Delegation of Authority* [37].

Those personnel with departmental or corporate functional authority may:

- Delegate to others the execution of duties associated with delegated authorities,
- Give direction on how those authorities are to be exercised, and;
- Hold delegates accountable for the exercise of these delegated authorities.

If delegation of authority is not documented/communicated, by default, authority will always revert upward.

5. Management System Document Hierarchy

CNL's document hierarchy is depicted in Figure 5 and is applicable company-wide. Site-specific nuisances related to scope or applicability of a process or document (based on graded approach or differing license conditions) is clearly defined within the applicable management system document. The management system documentation hierarchy cascades from the top downward. The Corporate Policies provide the direction and expectation to management and employees. The Manual defines the vision, mission, expectations, core values, roles, responsibilities, authorities, and accountabilities, the associated programs and processes, and interfaces.

Individual program description, requirements, and governing indices form the foundation of the management system internal control components and are referred to as "interpretation" documents.

The implementing documents flow from the interpretation documents. They describe the controlling activities required to implement the business processes and employees' day-to-day activities identifying the expectations and relevant procedural actions.

A complete list of functional areas and corresponding GDIs is available in *Functional Authorities* [26]. This document hierarchy serves to ensure that CNL policies and applicable program requirements are effectively implemented company-wide.

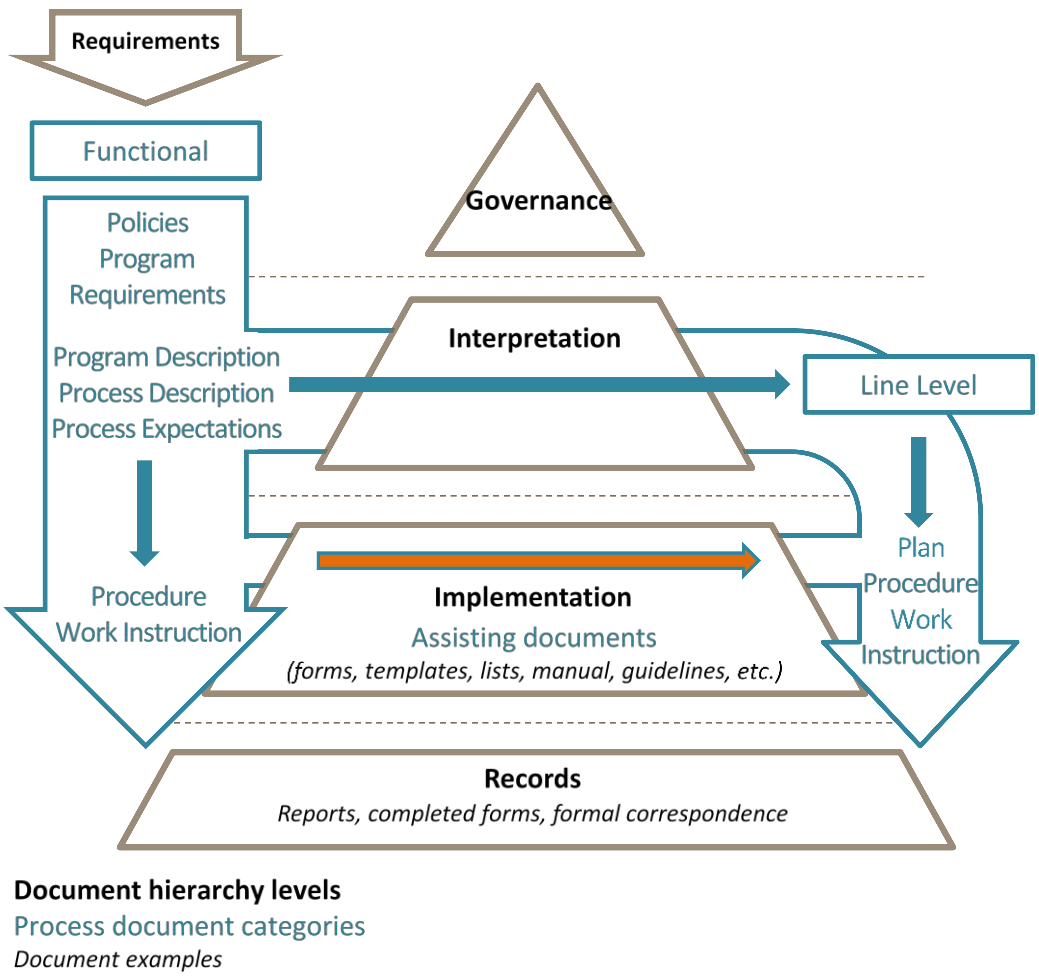

Figure 5: CNL Management System Document Hierarchy

These processes and procedures are concise, accessible, understood, and applied in a graded approach. The documents utilize best industry practices, leverage and integrate technology, and provide the basis for consistent implementation.

CNL's Management System is based on documentation, roles, responsibilities and authorities originated from CNL's predecessor AECL. Employees are responsible to ensure they are utilizing the most recent revision of implementing documents available within the electronic document records management system.

For more detailed information on the management system documentation hierarchy, see *Creation, Capture, and Use of Information Assets* [34].

6. Contractor Assurance System (CAS)

A *Contractor Assurance System* [38] is an integrated framework of assessment and oversight mechanisms employed to manage performance consistent with the Prime Contracts. It is used as a framework to assess performance, provide data to CNL's management decision-making process, and allows CNL to effectively manage processes, resources and outcomes. The system provides transparency between CNL, CNEA, and AECL to ensure alignment across the enterprise and to accomplish mission needs.

Integral elements of the CAS include assessment, management review, worker feedback, issue management, risk management, operating experience, continual improvement and performance measures. These programs and processes provide the means to identify and address program or performance deficiencies and opportunities for improvement. The CAS is implemented through operational and business systems using a graded approach based on risk, hazard and experience. This is done in accordance with requirements to ensure that CNL satisfies it's legal and contractual obligations, and to ensure that it is able to operate safely, securely, cost effectively and efficiently.

7. How We Operate

7.1 Risk Management

Risk (corporate, project, work package [39], task) management is the identification of barriers to achieving the corporation's strategic goals and objectives. By highlighting enterprise level risks [40], senior management can strategically position resources and funding to manage potential or upcoming risk events. Project and program risk management, as well as the management of safety risks, are embedded in the management system.

7.2 Grading

One objective of the management system is to ensure that the work being performed to meet requirements is both consistent and predictable. Where appropriate, the degree and level of rigor applied to program elements, items, or activities is based on a graded approach that takes into account the complexity of work to be performed and the magnitude of the hazards to maintain an acceptable level of risk. The level of analysis, extent of documentation, and degree of rigor of process control is applied commensurate with their significance; importance to safety; consequence of error; design complexity; process complexity; service characteristics; service conditions; or economics. The graded approach applies to both internal CNL activities as well as procurement of external products and services, and is documented within the associated procedural documents, or embedded in supporting forms and templates.

8. Ombuds Service

The leadership at CNL aims to engage in transparent communications and has created an independent mechanism – the Ombuds Service – through which stakeholders such as individuals, organizations, and leadership can share their concerns about a particular issue or provide general feedback and recommendations for improving the workplace at CNL. The Ombuds Service provides CNL stakeholders with an outlet to raise issues while encouraging positive dialogue and culture.

The mission of the Ombuds Service is to offer an informal, impartial and independent approach to conflicts raised by CNL stakeholders, providing a neutral and, to the extent permitted by law, confidential resource while advocating for fair, efficient, and transparent policies and procedures.

9. Definitions and Acronyms

9.1 Definitions

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [41] contains specific meanings for those words that require further clarification.

Accountability	The state of being responsible and answerable for an activity.
Authority	The degree of power vested in a worker by virtue of their role to demand performance and/or make decisions.
Functional authority	Management that has responsibility for defining, interpreting, and maintaining functional requirements, and for supporting the line management in their implementation.
Functional support area	A set of interrelated or interacting processes or programs that are characterized by a set of inputs and value added tasks that assure specific business outputs, products and services. The FSA's are a critical part of CNL's Management System Framework, and are driven by requirements to meet the objectives and goals of the

	organization such as safe workers, products, profit, good brand, customer satisfaction, industry leadership.
Line management	Any management level within the organization, which is responsible and accountable for directing and conducting work.
Position	A position is identified by a business title and is a worker's primary line job for which they were hired to perform.
Responsibility	A thing one is required to do as part of a job, role, or legal obligation.
Role	Functional duties and assignments, in addition to their existing position, that any CNL employee performs in order to facilitate delivery of a process.
Safety	The condition of being protected from or unlikely to cause danger, risk, or injury.
Worker	Someone who performs an occupational duty. Occupational duty is a term that describes the responsibilities that are a regular part of a person's job.

9.2 Acronyms and Abbreviations

AECL	Atomic Energy of Canada Limited
APWB	Annual Program of Work and Budget
CAS	Contractor Assurance System
CEO	Chief Executive Officer
CFO	Chief Financial Officer
CNEA	Canadian National Energy Alliance Limited
CNL	Canadian Nuclear Laboratories Limited
CNO	Chief Nuclear Officer
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners' Group
COO	Chief Operating Officer

CRL	Chalk River Laboratories
CTA	Central Technical Authority
ERM & SRG	Environmental Remediation Management and Stewardship and Renewal Group
FSA	Functional Support Area
FSM	Functional Support Manager
HSSE	Health, Safety, Security, and Environment
NPD	Nuclear Power Demonstration
S&T	Science & Technology
WL	Whiteshell

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Appendix A Roles, Responsibilities, Accountabilities, and Authorities

This appendix describes the role and responsibilities of the CNL Executive Team. The Executive Team of the Company comprise the following:

- President and Chief Executive Officer (CEO)
- Chief Operating Officer (COO)
- Vice-President, Science & Technology (S&T)
- Vice-President, Environmental Remediation Management and Stewardship and Renewal Group
- Vice-President, Capital
- Vice-President, Business Management
- Vice-President, Central Technical Authority (CTA) and Chief Nuclear Officer (CNO)
- Vice-President, Health, Safety, Security and Environment (HSSE)
- Vice-President, Human Resources
- Vice-President, Legal and Insurance
- Vice-President, Corporate Affairs
- Vice-President, Business Development
- Vice-President, Isotope Business

A.1 President and Chief Executive Officer (CEO)

The CNL President & Chief Executive Officer (CEO) provides overall leadership and direction. The President & CEO sets the mission, vision, direction, and strategy that create a cost-effective accomplishment of the scope of work. The President & CEO obtains the funding, manages the execution of work within the defined cost, scope, and schedule by ensuring the development of the integrated work schedule, and is ultimately responsible for the safe completion of work. The President & CEO maintains strategic relationships with regulatory agencies and oversight organizations, and with stakeholders and the public. The President & CEO is specifically responsible for:

- Ensuring high standards for HSSE and quality are clearly established and supported by a robust infrastructure of people, practices, and oversight mechanisms;
- Ensuring the scientific, technological and product developments necessary to enable CNL to serve Canada's objectives in nuclear and related areas while maximizing the return on the funds invested in S&T;
- Meeting CNL's policy objectives, commercial objectives, and financial targets;
- Ensuring the implementation and continual improvement of the management system;
- Developing the organization's managerial competence and culture with a view to continually improving CNL's performance;

- Maintaining and improving the credibility and support of CNL with the public, including creating public awareness of the value of the nuclear industry to Canada's future sustainable economic development;
- Meeting CNL's responsibilities for managing legacy liabilities; and
- Designating, in conjunction with the Site Licence Holder, Emergency Operations Centre Commanders for managing CNL and site emergency responses.

A.2 Chief Operating Officer (COO)

The Chief Operating Officer (COO) is the primary delegate of the President & CEO and supports the Executive Team in safe execution of the CNL mission, while being specifically responsible for:

- Executing CNL's Strategy on behalf of the President & CEO (internal facing);
- Developing operational plans as appropriate, setting out objectives and priorities for the Company;
- Developing and influencing corporate strategies, in particular transformational activities;
- Developing policies, processes, practices and strategies working with the relevant areas of the business;
- Building organizational competence and capacity;
- Briefing the President & CEO on performance, risk and opportunities for the Company gleaned from line and functional authority;
- Leading the organizational unit of Chief Operating Officer with the following departments: Site Planning and Asset Management, and Ombuds Service;
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Management System and Property (Asset) Management; and
- Acting as a key advisor to the President & CEO.

A.3 Vice-President, Science & Technology

The Vice-President, Science & Technology is responsible for:

- Ensuring the safe conduct of licensed activities associated with the nuclear facilities, and radioisotope laboratories at the LaPrade site;
- Ensuring the safe conduct of licensed activities associated with the operation of the radioisotope laboratories and nuclear facilities within Science & Technology;

- Ensuring the quality and effective, efficient and economical delivery of the products and services developed and delivered by S&T;
- Administering contracts between CNL and CANDU Owners' Group (COG), including the COG budget, business planning for COG programs, and related policy issues;
- Overseeing the development and management of the following technological areas: fuel channels, reactor chemistry and systems, hydrogen and heavy water technology, safety technology, fuel and fuel cycles, environmental technologies, health physics, software performance, and reactor core technology;
- Leading the organizational unit of Science & Technology with the following departments: Chief Scientist, and Deputy Vice-President Office S&T (S&T Business Management Office, S&T Facilities Operations Division, Reactor Fleet Sustainability Division, Isotopes, Radiobiology & Environment, Advanced Reactors Directorate, Safety & Security Directorate, Hydrogen & Tritium Technologies, Small Modular Reactors Project, and S&T Isotope Production Project); and,
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Conduct of Research Functional Support Area.

A.4 Vice-President, Environmental Remediation Management and Stewardship and Renewal Group (ERM & SRG)

The Vice-President, Environmental Remediation Management and Stewardship and Renewal Group is responsible for:

- Ensuring the safe conduct of licensed activities associated with the nuclear facilities, and radioisotope laboratories at Chalk River (under ERM control), Nuclear Power Demonstration, Douglas Point, Gentilly-1, Whiteshell Laboratories, and the Historic Waste Programme (HWP) at Port Hope;
- Managing decommissioning, waste management, and environmental remediation facilities and services, and related projects at company sites;
- Overseeing of the Liability Cost Estimate, which is the funding provided to address legacy responsibilities associated with the Government of Canada and CNL's operations;
- Overseeing the Low-Level Radioactive Waste Management Office, funded by the Government of Canada, to address historic wastes at specific sites in Canada;
- Overseeing the Port Hope Area Initiative Management Office, the federal operating agency declared by the Government of Canada to implement the Legal Agreement of the Port Hope Area Initiative on its behalf;
- Providing associated support resources to the CRL site, including maintenance trades, planning and assessment services, logistics, and fleet;

- Delivering site maintenance services that ensures high reliability and availability of nuclear facilities and site infrastructure facilities;
- Managing commercial waste management and decommissioning undertakings;
- Leading the organizational unit of Environmental Remediation Management and Stewardship and Renewal Group with the following departments: Historic Waste Program Management (HWP Health, Safety, Security, Environment & Quality, HWP Business Operations, HWP Major Sites, HWP Small-Scale Sites, and HWP Waste Management Operations), WL Restoration Project (WL Site & Nuclear Operations, WL Business Operations, WL Engineering, WL End-State Strategy , WL Decommissioning and Demolition, Waste Management Area Decommissioning and Demolition, WL Waste Management, WL Project Controls and Report), and Stewardship and Renewal Group (Fuel Programme & Project Division, ERM Program Management, Decommissioning & Environmental Remediation, Near Surface Disposal Facility, ERM Integrated Functional Support Services, Contractor Management, Waste Services, and Infrastructure Development Group); and
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Cleanup, Transportation of Dangerous Goods, and Waste Management.

A.5 Vice-President, Capital

The Vice-President, Capital, is responsible for:

- Leading the development, performance and management of capital infrastructure projects which includes operational plans, budgets, and schedules to ensure projects are within budget and on time, establishing challenging performance metrics, conducting operational reviews to ensure targets are being met;
- Delivering required budget documents to the Chief Financial Officer, the Executive Team and our shareholder (this includes key information to support the budget funding obligations);
- Serving as the intermediary among Finance, Executive Team and other stakeholders on all budget matters associated with capital investment;
- Evaluating overall APWB integration with project delivery, long and near-term strategies, and processes while continuing to deploy innovative enhancements and upgrades to improve efficiency and effectiveness;
- Leading the organizational unit of Capital with the following departments: New Builds, Capital Projects, and Capital Project Program;
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Construction Functional Support Area.

A.6 Vice-President, Business Management

The Vice-President, Business Management is responsible for the following:

- Developing and executing supply chain strategies and plans;
- Providing financial review, reporting, business decision support, business advice/strategies, financial modelling, negotiation support, billing, and routine project/product accounting activities for CNL;
- Overseeing the development and execution of a Business Continuity Program;
- Monitoring and controlling the APWB, planning and budget guidance, strategy development, associated risks, assumptions for future spending and use of performance measures to assess program performance;
- Managing processes to protect, manage, and safeguard records and information assets;
- Advising the CNL Board on Financial, IT and Supply Chain matters, and significant project investment justifications;
- Leading the organizational unit of Business Management with the following departments: Supply Chain, Program Management Office, Prime Contracts, Integrated Services, and Information Management and Technology;
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Supply Chain, Prime Contract, Information Management, Project Management Office, Information Technology, Nuclear Cyber Security, and Finance.

A.7 Vice-President, Central Technical Authority (CTA) and Chief Nuclear Officer (CNO)

In the role of Vice-President, Central Technical Authority, is responsible for the following:

- Setting and applying the standards necessary to achieve technical excellence in all aspects of the work performed by CNL;
- Providing CNL-wide processes and services to support the missions’ tasks and to recognize when, for whatever reason, CNL is falling short of technical excellence;
- Developing and implementing plans to address strategic business issues;
- Ensuring awareness of customer requirements are promoted throughout CNL;
- Promoting, measuring, and providing continual improvement for the site safety and security cultures;
- Reporting to the Executive Team on performance of the Management System and any need for improvement;

- Performing assessments of the implementation of regulatory requirements to ensure that they are being appropriately implemented in accordance with the graded approach allowed by the implementing documents;
- Ensuring the independent assessment program maintains its independence and is adequately performing its intended function;
- Leading the organizational unit of Central Technical Authority with the following departments: CTA Deputy VP, Engineering, Compliance, Quality and Operational Excellence; and
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Conduct of Operations, Fitness for Service, Design Authority and Design Engineering, Configuration Management, Pressure Boundary, Electrical Safety, Safety Analysis, Training & Development, Commissioning, Quality, Performance Assurance, Compliance, Nuclear Criticality Safety and Nuclear Materials & Safeguards Management.

In the role of CNO, is responsible for:

- Ensuring nuclear safety is an overriding priority at all CNL sites;
- Ensuring conditions and requirements of licences and certificates granted by the CNSC are communicated to CNL Management (for site licences, this is the responsibility of the site licence holder);
- Authorizing, where required, changes to programs and processes that support the site licences where such changes affect safe or compliant operation at more than one site;
- Representing CNL at CNSC meetings on matters relating to organization-wide licensing matters;
- Acting for CNL in dealings with the CNSC;
- Providing oversight of all CNL nuclear facilities and programs to ensure performance meets and/or exceeds regulatory expectations and industry best practices; and
- Ultimately responsible to ensure compliance with CNSC license requirements at all CNL sites. This does not relieve the individual site license holder from their responsibility as separately described in this Manual.

A.8 Vice-President, Health, Safety, Security and Environment (HSSE)

The Vice-President for Health, Safety, Security and Environment provides strategic direction and oversight to HSSE functional programs and services that meet site licence requirements, business operational needs and reflect industry best practices for CNL, and is responsible for:

- Promoting integration of HSSE requirements into all work activities, and assessing integration;

- Working with line organizations to implement actions to improve HSSE integration;
- Supporting and promoting worker involvement in CNL safety processes;
- Ensuring regulatory requirements for HSSE functions are properly documented, controlled and implemented;
- Interfacing with regulators and stakeholders on HSSE matters;
- Providing direction and guidance for proper implementation and improvement of the Radiation Protection program, Dosimetry program, Wellness program and Environmental Protection program;
- Leading the organizational unit of Health, Safety, Security and Environment with the following departments: Corporate Radiation Protection, Corporate Occupational Safety and Health, HSSE Business Operations, Corporate Environmental Protection, Deputy VP Office, Corporate Fire and Emergency Management, and Corporate Security; and
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the following Functional Support Areas: Environmental Protection, Radiation Protection, Occupational Safety & Health, Health Centre, Emergency Preparedness, Fire Protection, and Security.

A.9 Vice-President, Human Resources

The Vice-President, Human Resources is responsible for:

- Providing overall strategic human resources and labour relations direction and leadership to the organization;
- Overseeing the development, implementation and administration of human resource policies, programs and services, including employee and labour relations, employment practices, prevention of harassment and violence process, diversity, equity and inclusion program, compensation, benefits and pension, recruitment and orientation, talent management including engagement, retention and succession planning; and legislative and regulatory compliance relative to human resources and labour relations;
- Engaging in the strategic planning process by supporting the execution of organizational unit strategies and plans through the implementation of Human Resource and labour relations strategies and solutions that support short and long-term business objectives;
- Leading the organizational unit of Human Resources with the following departments: Talent Management, Labour Relations, and Total Rewards; and
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Human Resources Functional Support Area.

A.10 Vice-President, Legal & Insurance

The Vice-President, Legal & Insurance is responsible for:

- Providing legal advice and support in relation to all legal, commercial and regulatory matters at CNL;
- Managing and overseeing the performance of the Ethics and Business Conduct Office, Corporate Secretariat, Export & Import compliance, and the Internal Audit function at an organisational level;
- Leading the development and implementation of CNL Intellectual Property policy, plans, and procedures;
- Managing all legal claims that relate to the operations of CNL;
- Providing CNL with all necessary insurance and related risk management advice to enable CNL to meet its statutory and contractual obligations and to use insurance as a strategic risk management tool;
- Overseeing all engagements with outside legal counsel;
- Providing legal advice and support to support CNL intellectual property resources;
- Providing legal advice and support in relation to statutory and regulatory compliance, including operational elements of privacy requirements;
- Leading the organizational unit of Legal and Insurance Department with the following departments: Ethics and Business Conduct, and Legal Department;
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Legal Services Functional Support Area; and
- Providing a high level of assurance to CNL’s Executive and Board of Directors that:
    - The business activities and operations are being carried out to meet or exceed CNL’s regulatory and legal obligations and other applicable standards,
    - All employees know and understand their compliance roles and responsibilities; and
    - CNL’s employees, officers and directors of the company are acting ethically and with integrity.

A.11 Vice-President, Corporate Affairs

The Vice-President, Corporate Affairs leads a team responsible for developing and conducting communications, information dissemination, public engagements, and maintaining an overall public affairs program including internal and external communications; community involvement and outreach; interactions with the media, businesses, and the scientific and technical community and is responsible for:

- Delivering and lead the Public Information Program, a CNSC licence condition;
- Managing relationships with key stakeholders including industry associations and Indigenous communities;
- Liaising and consulting with indigenous groups, local, provincial, and federal levels of government with an overall goal to enhance the benefits of CNL to its host communities and Canada;
- Establishing and maintaining effective working relationships with community stakeholders in order to build awareness, understanding, and support for company activities and operations;
- Developing initiatives to bring benefits to the host communities, including, participation in community initiatives, fundraisers, and community service announcements, local events, while continuing to champion and encourage local development;
- Building constructive community engagement and support;
- Managing brand awareness including speeches, website, and conferences and tradeshows;
- Managing sponsorships, fundraisers, public tours, school programs, and special events and occasions;
- Supporting marketing and advertising;
- Acting as official corporate media spokesperson including receiving, responding to, and managing all media requests and press releases;
- Ensuring timely, open and transparent communications in response to issues or emergencies;
- Providing support to the Office of the President & CEO, CNL and CNEA Board of Directors, the Executive Team, Special Advisors, and special projects through Corporate Affairs;
- Building employee engagement and understanding of corporate plans, priorities and strategies;
- Supporting morale and employee recognition programs (i.e. Voyageur luncheon series, Awards Gala);
- Managing myCNL, All Staff engagements, and the CONTACT and Voyageur newsletters;
- Leading the organizational unit of Corporate Affairs with the following departments: Corporate Communications, and HWP Communications and Stakeholder Relations; and
- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Corporate Affairs Functional Support Area.

A.12 Vice-President, Business Development

The Vice-President, Business Development is responsible for the following commercial strategic and transactional activities:

- Leading the market analysis and commercial strategy development with respect to growing CNL's Energy, Health, Environment, and Safety/Security products and services business;
- Leading the marketing and market engagement/ongoing interaction with existing customers and leading market associations;
- Leading the interaction with primary client, AECL, to ensure endorsement of commercial strategies, and clear understanding and support for short, medium, and long term goals;
- Leading improvement initiatives required to achieve long term business development and organizational sustainability;
- Leading the development, review/analysis, and endorsement of business cases for potential public private partnerships and Make or Buy opportunities;
- Driving or assisting in the implementation of approved business cases;
- Structuring and managing the routine engagement with internal organizational areas to ensure strategy alignment, planning, and execution with respect to commercial work;
- Planning and coordinating all new sales, proposals, and account management activities that facilitate response to current and potential customers including scope development, risk assessment, cost estimating, pricing, terms and conditions, contractual structure, and legal/contracts review;
- Managing new and existing strategic customer relationships including external and internal interfaces (e.g. S&T Program Directors) as required in order to meet customer expectations and focus on improvements that increase customer satisfaction and potential revenue growth;
- Providing the interface between CNL's customer and line organizational units for the purpose of commercial sales planning and scheduling to ensure notifications, production, scheduling, and product delivery are coordinated;
- Ensuring Intellectual Property policy/protection/exploitation as applicable to performing federal work and negotiating commercial contracts;
- Leading the organizational unit of Business Development with the Business Development and Commercial department; and

- Establishing, maintaining, assessing, and continuously improving the company-wide processes and programs for the Business Development and Commercial Ventures Functional Support Area.

A.13 Vice-President, Isotope Business

The Vice-President, Isotope Business is responsible for the following commercial strategic and transactional activities:

- Providing the interface between CNL's customer and line organizational units for the purpose of Isotopes Sales planning and scheduling to ensure notifications, production, scheduling, and product delivery are coordinated; and
- Leading the organizational unit of Isotopes Business.

Corporate Functional Authority Roles

Additional corporate functional authority roles have been established in response to regulatory and other legislative requirements. These roles have an independent reporting relationship to the President & CEO:

- Chief of Staff
- Ombuds Officer
- Corporate Secretary
- Chief Information Officer
- Chief Financial Officer
- Chief Engineer
- Chief Safety & Licensing Officer
- Chief Regulatory Officer
- Chief Security Officer
- Management Representative for Quality
- Site Licence Holder

A.14 Chief of Staff

The Chief of Staff is accountable to the CEO/COO, representing them with internal and external stakeholders, while fulfilling the following responsibilities:

- Acting as the communication arm for the CEO/COO with other Executives, the Client, the Board, and other stakeholders as required. Facilitates communications with CEO/COO, ensuring wants, needs, concerns, and ideas are communicated effectively and efficiently in both directions;
- Acting as a strategic advisor and counsel for the CEO, COO and Executive Team;

- Improving current processes and coordinating organizational procedures for optimized efficiency and productivity, enabling the CEO/COO to focus on larger strategic organizational initiatives;
- Creating and maintaining strong cross-departmental relationships to enable collaborative leadership success;
- Preparing the CEO/COO for emerging issues and opportunities; and
- Delegating tasks/activities on behalf of the CEO/COO.

A.15 Ombuds Officer

The Ombuds Officer is accountable to the CEO/COO, representing them with internal and external stakeholders, while fulfilling the following responsibilities:

- Addressing concerns about transparency, fairness, and process consistency, as well as other issues of significance to the stakeholder community without sacrificing CNL’s mission;
- Improving CNL’s understanding of the workforce concerns and, more specifically, how the company can institute changes to address those concerns when appropriate;
- Being an accessible resource and actively participating in resolution processes, informal conversations, and neutral conflict coaching;
- Identifying areas for improvement, from a conflict resolution perspective, which might serve to benefit CNL processes;
- Evaluating and upgrading the efficiency of CNL’s conciliation and mediation processes, as necessary;
- Providing a confidential, to the extent permitted by law, and trustworthy channel for conflict resolution for CNL stakeholder community;
- Creating a climate in which CNL workforce feels comfortable contacting the Ombuds Service while dispelling the notion that raising issues or concerns with CNL will adversely impact employees in the future;
- Equipping CNL staff and the stakeholder community with conflict resolution skills;
- Ensuring that stakeholders and CNL staff understand the benefits of respectful, transparent, and efficient communications; and
- Remaining accessible and visible to CNL and external stakeholders through speaking engagements.

A.16 Corporate Secretary

The Corporate Secretary to the Board of Directors, is accountable to the Board of Directors and is responsible for:

- Advising on the appropriateness of CNL'S governance strategies and that its governance obligations are being met including those relating to ethics and business conduct;
- Ensuring the integrity of the corporate governance system, and compliance with statutory and regulatory board governance requirements;
- Acting as a trusted adviser to the Board of Directors;
- Tracking implementation of decisions made by the Board of Directors;
- Administering interactions with the Board of Directors including Board and Board committee meetings, minutes of meetings, and corporate records;
- Liaising with Directors and Corporate Officers, as well as with shareholders, auditors, and external advisor on board governance issues; and
- Supporting the Board of Directors in engaging the Shareholder and AECL on relevant governance issues.

A.17 Chief Information Officer

The Chief Information Officer (CIO) provides strategic direction and leadership in the efficient and effective use of information and information technology across CNL.

The Chief Information Officer (CIO) responsibilities are further described in the Program Description Document for *Information Technology* [42].

A.18 Chief Financial Officer

The Chief Financial Officer is responsible for:

- Ensuring the financial integrity and strategy of the business;
- Advising senior management on overall long- and short-term strategic issues, including matters related to financial management, performance management strategies, revenue/market growth strategies, and organization structure;
- Developing structure for internal financial controls;
- Developing accounting policies;
- Ensuring the integrity of CNL's financial systems and controls, and safeguarding and controlling the associated records; and
- Working closely with the Executive Team on their planning activities to ensure the plans support the profitability and continued financial viability of the company.

A.19 Chief Engineer

The Chief Engineer assumes professional responsibility for all engineering services provided by CNL to the public under CNL's Professional Engineering Certificate(s) of Authorization, and has authority for establishing and maintaining the design of CNL facilities.

The Chief Engineer is responsible for:

- Executing the design authority function for CNL facilities, design and licensing basis and engineering activities;
- Maintaining appropriate Professional Engineering Certificate(s) of Authorization;
- Conducting technical review and oversight of engineering activities to ensure compliance with design requirements, codes, standards, regulatory requirements, quality standards and engineering practices;
- Acting as the Functional Authority for Engineering processes including Configuration Management, Design Authority and Design Engineering; and
- Executing the owner's duties for CNL sites as defined by Pressure Boundary codes and standards.

A.20 Chief Safety & Licensing Officer

The Chief Safety & Licensing Officer responsibilities are further described in the Program Description Document for *Safety Analysis* [43].

A.21 Chief Regulatory Officer

The Chief Regulatory Officer responsibilities are further described in the Program Description Document for *Compliance* [25].

A.22 Chief Security Officer

The Chief Security Officer provides oversight to confirm that CNL meets its obligations under the Treasury Board Policy on Government Security in ensuring that information, assets and services are protected against compromise and individuals are protected against workplace violence.

The Chief Security Officer responsibilities are described in the Program Description Document for *Compliance* [25].

A.23 Management Representative for Quality

The Management Representative for Quality has organizational independence, functional responsibility and authority for:

- Ensuring that quality assurance processes needed for the management system are established, implemented and maintained;
- Ensuring awareness of customer requirements are promoted throughout CNL;
- Identifying and recording quality problems or conditions adverse to quality and compliance;
- Initiating, recommending, or providing solutions;
- Verifying implementation of solutions; and
- Ensuring that further processing, delivery, installation, or use of an identified nonconformity is controlled until corrective actions have occurred.

The Management Representative for Quality responsibilities are further described in the Program Description Document for *Quality* [44].

A.24 Site Licence Holders

Site Licence Holders are designated Executives and Senior Management responsible for the management and control of CNSC-licenced activities at their respective CNL-managed sites. Site Licence Holders are appointed by the President & CEO with the concurrence of the Chief Nuclear Officer and have the necessary functional authority to discharge responsibility for assuring the safe conduct and compliant operation of all licenced activities at their respective sites, including the authority for operating or shutting down nuclear facilities and radioisotope laboratories.

Specifically, the Site Licence Holder is responsible for:

- Ensuring no activity requiring a licence under the *Nuclear Safety Control Act* [45] is carried out on the site, other than those activities listed in the licence, as stated in the application for licence renewal, and as approved by the CNSC;
- Ensuring the management system is effective and implemented at the site, and that the senior management is committed to and meets its responsibility for reviewing and ensuring the success of the management system and safety management, including the ongoing proactive oversight and surveillance of nuclear safety activities and compliance with regulatory requirements;
- Ensuring site and facility operations meet health, safety, security, environmental, quality, and regulatory requirements, and take appropriate action for non-compliances up to and including ceasing operations;
- Taking site safety, quality, licensing, and technical issues to the Executive level for resolution where these cannot be resolved at the site;
- Representing CNL at CNSC meetings on matters relating to their respective site;

- Ensuring that conditions and requirements of site licences granted by the CNSC are communicated to site and facility management;
- Ensuring that "Obligations of Licensee" in the *General Nuclear Safety and Control Regulations* [46], where applicable, are met;
- Ensuring Facility Authorities are appointed for all nuclear facilities;
- Authorizing, where required, changes to programs and processes that support the site licences where such changes affect safe or compliant operation of the site;
- Ensuring adequate preparedness for responses to anticipated operational occurrences and emergency conditions and that appropriate actions have been taken to provide for the protection of site personnel, the public, and the environment;
- Ensuring that arrangements are in place to manage the situations that fall outside normal operating procedures at the site; these arrangements shall ensure that appropriate controls are maintained and due consideration is given to the safety implications of the situation; and
- As required, recommending to the CEO the appointment of Emergency Operations Centre Commanders for managing CNL and site emergency responses.

Appendix B Management System Framework Overview

The CNL Management System is based on a framework developed through benchmarking of industry standards, review and application of lessons learned from previous experience and systems, and alignment with the strategic direction of the corporation.

Functional Authorities have responsibility for defining, interpreting, and maintaining functional requirements, and for supporting the Missions in their implementation. The Functional Authority structure consists of Responsible Executives, Functional Support Managers, and Functional Support Manager Designates, as identified in the *Functional Authorities* list [26], who work closely together to ensure that implementation of standards and requirements specific to their Functional Support Area(s) are consistent company-wide.

Table 2: Management System Framework Overview

Responsible Executive	Functional Support Area	Purpose
President & CEO and Chief Operating Officer	**Management System**	Enables effective corporate governance and interfacing between the Board of Directors, Executive, and Management. Formalizes and institutionalizes the controls and accountabilities by which CNL manages and executes work, in conformance with legislative, regulatory, shareholder, and commercial requirements. Drives key improvement initiatives to address common opportunities and challenges to meet corporate objectives. Facilitates organizational transformation and provides assurance that action plans effect sustainable improvement through the application of effective change management principles.
	Property (Asset) Management	Ensures stewardship of AECL resources in accordance with CNL objectives. Ensures decisions regarding the acquisition, accounting for, control, utilization, maintenance, service, protection, preservation, and disposition of resources is based on defined service levels, informed by asset conditions and risks, considers whole life costs and is aligned with CNL business needs and strategic requirements.
VP Business Management	**Supply Chain**	Effectively establishes and builds integrated capabilities from the supply chain to support delivery of CNL's work scope and obligations to AECL. CNL's supply profile includes contracted

Responsible Executive	Functional Support Area	Purpose
		work and material requirements for decommissioning and waste management, science and technology, capital works, as well as general support to programs and operational activities. Drives best value for CNL and AECL, and includes a framework that enables the development of small and medium-sized enterprises in addition to local and indigenous businesses where capabilities exist.
	Prime Contract	Involves the management and administration of the Site Operating Company Agreement, the Whiteshell Laboratories Target Cost Agreement, and Nuclear Power Demonstration Reactor Target Cost Agreement between AECL and CNL. Establishes communication processes to support monitoring of the contracts, reporting on performance, and controlling any changes, variations, or amendments to the contracts.
	Information Management	Governs the creation, classification, capture, use, dissemination, retention, preservation, and disposition processes of information throughout the company. Develops, implements, and monitors controls that apply to all structured, unstructured, or transitory Information Assets to ensure the authenticity, reliability, and integrity of the records, and minimize the risk associated with disclosure and loss while allowing for inspection of records to ensure their continued preservation. Provides on-site information resources, and access to worldwide resources through online subscriptions and inter-library loans.
	Project Management Office	Ensures that CNL uses a standardized framework of processes, procedures, tools and systems to plan, control and monitor the strategic plan of CNL. The Project Management Office function provides guidelines; oversight and monitoring to ensure that projects, and site facility operations, are performed using CNL rules, follow industry best practices, and add value to the business.

Responsible Executive	Functional Support Area	Purpose
	Information Technology	Establishes effective governance practices, tools, and processes required to ensure the safety and security of information and technology assets falling within the mandate of CNL. Ensures industry best practices for IT services management and delivery and ensures a relevant and secure infrastructure for its continuing business.
	Nuclear Cyber Security	Facilitates compliance with all applicable requirements for the protection of nuclear cyber assets and information. Delivers nuclear cyber security services and solutions to the business and ensures confidentiality, availability, and integrity of all systems, information, data, and intellectual property under the control of CNL.
	Finance	Establishes a framework for all financial activities to ensure: financial resources are consumed in accordance with approved plans, budgets and/or allocated funding; financial transactions are undertaken in compliance with governing legislation, policies, and procedures; and financial reporting is timely, complete, accurate, and delivered in accordance with prescribed accounting and reporting standards. Provides financial stewardship and controllership for CNL and, supports the full scope of departmental and functional financial accountabilities including: sound financial policies, strong internal controls, accurate, responsive and timely financial reporting, and timely decision support.
VP Human Resources	**Human Resources**	Fosters a positive union-company relationship through management of Collective Agreements including: compliance, interpretation and negotiation. Optimizes organizational design, alignment, health, and change to support strategic workforce and business requirements. Enables competitive, cost effective benefits and compensation programs to attract, retain, motivate, align and reward employee performance.

Responsible Executive	Functional Support Area	Purpose
		Enables management to clearly set expectations in line with corporate culture and business objectives, and to support, recognize, and manage employee performance. Ensures awareness of each individual's responsibilities to ensure CNL's culture is inclusive, respectful, and supportive; ensures individuals are empowered to speak out when concerned with how they are being treated by another; and, ensures everyone has access to tools and resources to resolve conflict. Builds and sustains excellence in: securing top talent; developing talent; optimizing the application of capabilities across CNL; retaining and engaging talent employees; and managing the employee lifecycle.
VP Legal	**Legal Services**	Ensures the business' of CNL are executed in a strategic, legally compliant, risk informed, and ethical manner and assists and supports all CNL departments in the execution of their related legal and ethical responsibilities.
VP Corporate Affairs	**Corporate Affairs**	Ensures effective communications for engaging our employees, our Shareholder, Natural Resources Canada, and our key stakeholders that foster alignment with corporate objectives and strategies.
VP Business Development	**Business Development & Commercial Ventures**	Facilitates customer acquisition and retention, including the evaluation of investment in new capabilities to expand commercial offerings for CNL.
VP Science & Technology	**Conduct of Research**	Maintains integrity in research, and ensures research activities do not adversely affect the health and safety of the worker, the environment or the quality of data obtained, waste resources, or damage CNL's reputation or credibility with customers. Ensures adherence to good research practices leading to more attention to the details of scientific research including qualitative analysis, quantitative and statistical techniques, more thoughtful collaboration among investigators, performing work safely and cost effectively and complying

Responsible Executive	Functional Support Area	Purpose
		with all requirements while meeting the needs of the customer(s).
VP Health, Safety, Security, and Environment	**Environmental Protection**	Ensures protection of our natural environment in and around CNL sites. It provides the framework to implement CNL's Environment Policy [6]. The Environmental Protection (EnvP) requirements apply to operations and activities that may affect the environment in and around CNL sites. A graded approach to requirements is applied based upon environmental risks/events that could occur at any given location and considering the amount of control or influence that CNL has on the activity. The EnvP Program considers life cycle perspective for activities, products and services on and around CNL sites where CNL has control or influence and on products or services off site which the company has influence.
	Radiation Protection	Prescribes limits and requirements for safe work practices in a radiological environment and the monitoring required. Limits employee exposure and maintains doses to workers As Low As Reasonably Achievable (ALARA), social and economic factors taken into account.
	Occupational Safety & Health	Prevents accidents and injury to health arising out of, linked with or occurring to employees in the course of employment, and to all persons on sites or workplaces controlled by CNL. Supports industrial safety, industrial hygiene, and respiratory safety and the alignment of various safety programs.
	Health Centre	Ensures a safe and healthy workplace for employees. Enables employees to maintain, improve, and regain their health when needed.
	Emergency Preparedness	Enables the prevention and mitigation of, preparedness for, response to, and recovery from abnormal or emergent events.
	Fire Protection	Ensures an immediate coordinated response to fire and other incidents/emergencies.

<table>
<tr><th>Responsible Executive</th><th>Functional Support Area</th><th>Purpose</th></tr>
<tr><td rowspan="2"></td><td></td><td>Establishes a risk graded approach in conjunction with the defence-in-depth principles to its operations and activities in so far as they may affect fire protection.</td></tr>
<tr><td>Security</td><td>Ensures the physical protection of assets, safeguarding the public and personnel and resumption of business and ensuring the protection of CNL employees, assets, and operations.</td></tr>
<tr><td rowspan="3">VP Environmental Remediation Management and Stewardship and Renewal Group</td><td>Transportation of Dangerous Goods</td><td>Supports the protection of public and environment by ensuring dangerous goods are adequately packaged and controlled for company activities.</td></tr>
<tr><td>Waste Management</td><td>Ensures (a) activities involving planning for, handling, processing, transporting, storage and disposal of wastes are performed in a manner that protects workers, public, and environment, and are in compliance with applicable regulatory and licence requirements; and (b) waste hierarchy is effectively implemented across CNL sites.</td></tr>
<tr><td>Cleanup</td><td>Ensures a CNL wide approach to effective land use planning, decommissioning, demolition, and environmental remediation. The Function ensures there is adequate and appropriate Indigenous, public, and stakeholder engagement, which is conducted as part of the planning process and considered throughout the facility lifecycle. The facility lifecycle includes:
a) Design
b) Construction
c) Commissioning
d) Operation
e) Decommissioning & Demolition
f) Remediation.
This will enable a consistent approach to CNL sites with clear processes and guidance on key requirements. The Cleanup Function provides guidance to new builds on incorporating end state planning and next land use considerations as part of their project plans.</td></tr>
<tr><td>VP Capital</td><td>Construction</td><td>Manages, controls, and monitors construction and installation activities in accordance with the contract and compliant with requirements.</td></tr>
</table>

Responsible Executive	Functional Support Area	Purpose
VP Central Technical Authority & CNO	**Conduct of Operations**	Provides a framework which ensures facility operations are managed, organized, and conducted in a manner that results in high levels of safety, performance, and reliability, while maintaining compliance with requirements. Ensures Class I and Class II Nuclear Facilities are operated within their limiting conditions for safe operation.
	Fitness for Service	Ensures maintenance is carried out adequately and effectively. Decreases the likelihood, or impact of system, equipment, or component failures on nuclear safety, the health and safety of workers, public, security, environment, equipment, and property. Ensures safety-related systems function reliably in accordance with the relevant design and performance criteria, including any safety goals of the Facility and Canadian Nuclear Safety Commission. Enables evaluation of equipment, development, and implementation of long-term equipment improvement plans, monitoring of equipment performance and condition, and adjustment of preventive maintenance tasks and frequencies based on equipment performance.
	Design Authority & Design Engineering	Manages the organizational responsibility to ensure the technical integrity of designs and design processes, establishing the requirements for CNL design work. (Chief Engineer) Ensures design is planned, executed, verified and documented according to applicable codes, standards, regulatory, and design customer requirements. Controls the design basis of CNL within approved safety margins and regulatory requirements. (Design Authority)
	Configuration Management	Facilitates orderly management of system/facility information and system/facility changes for such beneficial purposes as to revise capability, improve performance, reliability or maintainability, extend life, reduce cost, risk and liability, or

Responsible Executive	Functional Support Area	Purpose
		correct defects within approved safety margins and regulatory requirements. Ensures changes are assessed, approved, designed, implemented, commissioned, and placed into service within the safety envelope at all CNL sites, in accordance with the design requirements.
	Pressure Boundary	Assures that pressure-retaining systems and components are designed, constructed and operated in full compliance with statutory and legislative requirements, while promoting and supporting performance excellence with a strong safety culture. The ultimate objective is “no pressure boundary failures”.
	Electrical Safety	Prevents electrical accidents and injury to health arising out of, linked with or occurring to employees in the course of employment, and to all persons on sites or workplaces controlled by CNL. Provides the framework to eliminate or reduce the risk of worker exposure to electrical hazards in the workplace. Ensures that electrical work executed at CNL is compliant to all applicable requirements.
	Safety Analysis	Conducts and maintains nuclear safety analysis to permit the successful completion of safe engineering design in support of new build, facility modification, facility operation, research and product development, decommissioning and disposal.
	Training & Development	Supports the Organization’s operational capabilities by ensuring that workers are effectively and efficiently trained to safely and competently perform their position or role.
	Commissioning	Ensure the as-constructed structures, systems, and components satisfy the functional, performance, and safety design requirements and meet the needs of the users. Provide a systematic and objective method that enables commissioning to proceed in a controlled manner, safely and to a high quality, and ensuring the necessary assurances and evidence are provided.

Responsible Executive	Functional Support Area	Purpose
	Quality	Ensures the efficient delivery of high-value, and quality products and services, and oversees that all activities and tasks are accomplished to maintain a desired level of excellence with alignment to requirements. Utilizes a combination of internal, second and third party audits and evaluations to provide performance oversight and reporting.
	Performance Assurance	Supports CNL's ability to improve operational performance, enhance safety, and reduce the occurrence of unplanned events. Provides an improvement framework to assist in decision making while promoting organizational learning, innovation, and continual improvement.
	Compliance	Ensures compliance with the verification criteria for each of the 14 Safety and Control Areas (SCA) established by the CNSC, consistent with CNL's licence obligations. Provides the regulatory and licensing framework, and independent technical reviews, for a coordinated and consistent approach in managing relationships with regulators throughout CNL.
	Nuclear Criticality Safety	Establishes the framework for ensuring that accidental nuclear criticality is prevented, and that the consequences of accidental nuclear criticality are mitigated during operations with fissionable material outside nuclear reactors.
	Nuclear Materials & Safeguards Management	Enables the tracking of our fissionable materials and supports international non-proliferation agreements.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Quality Assurance Plan

Quality Assurance Plan for Whiteshell Laboratories Decommissioning Project

WLD-508300-QAP-001

Revision 3

Prepared by:	Bruce Martini Quality Assurance Specialist/LQCR	2022/07/12 Date
Reviewed by:	Randall Swartz Manager, Licensing & Quality Management	2022/07/13 Date
Approved by:	Douglas Cram Director, CNL Quality Assurance	2022/07/13 Date
Accepted by:	Kerry Rod WL Site Head & General Manager, Whiteshell Closure Project	2022 July 13 Date

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
3	2022/08/31	Issued as "Approved for Use." Minor changes made to update content. Primary revision focus on updating all references to current versions and addition of ATOM numbers and links.	B. Martini	R. Swartz	K. Rod D. Cram (Acceptor)
3D1	2021/08/24	Issued for "Review and Comment."	B. Martini	R. Swartz L. Wojciechowski A. Caron S. Scott	
2	2018/07/23	Issued as "Approved for Use." Minor changes made, including alignment to N286-12 (in place of N286-05), updated and reordered references, and clarification on records inspection (Section 5.13).	N. Peitsch L. Wojciechowski	R. Swartz A. Caron	D. Coyne S. Sanders (Acceptor)
1	2018/01/05	Issued as "Approved for Use"	L. Wojciechowski	J. Thompson	D. Coyne S. Sanders (Acceptor)
1D1	2017/12/08	Issued for "Review and Comment." Addressed CNSC comments and updated the document due to changes in various management system documents.	L. Wojciechowski P. Patel	N. Peitsch J. Thompson R. Swartz J. Gibb S. Sanders B. Wilcox S. White	
0	2015/03/03	Issued as "Approved for Use"	J. Betteridge	D. Lemire	J. Miller A. Coulas (Acceptor)
D5	2014/11/19	Issued for "Review and Comment"	J. Betteridge	A. Coulas	
D4	2014/07/21	Issued for "Review and Comment"	J. Betteridge K. Mayoh	D. Lemire	

D3	2014/06/16	Issued for "Review and Comment" by additional WL Management and QA personnel.	K. Mayoh	D. Austin J. Betteridge P. Henschell	
D2	2013/08/28	Issued for "Review and Comment" by WL Management and QA personnel.	K. Mayoh	D. Fillion P. Henschell G. Koroll C. Michaluk D. Onagi A. Caron	D. Lemire B. Martini A. Radyastuti V. Steiner R. Swartz B. Wilcox
D1	2012/06/08	Major revision (from WLD-01913-QAP-001) including alignment to N286-05 Issued for peer "Review and Comment."	B. Martini	P. Henschell M. Attas	
REVISION HISTORY ASSOCIATED WITH WLD-01913-QAP-001					
3	2007/09	Issued for use	G. Cota-Sanchez	M. Stephens	J. Miller
3D3	2007/09	Revised to incorporate comments from reviewers: Major changes were performed on organizational structure. Responsibilities of WL C&RP Manager and WL RP Program Manager were added. Section 4.2.3 Work Plans was added. Sections 4.2.5, 4.9 and 4.9.1 were updated.	G. Cota-Sanchez	M. Attas M. Stephens C. Clavel J. Harding M. Rhodes P. Ingham P. Barnsdale L. Rasmussen R. Hamon M. Drynan J. Mallory R. McCamis G. Koroll	
3D2	2007/09	Revised to incorporate comments from reviewers: Major changes were performed on organizational structure. Responsibilities of WLD Fieldwork Coordinator and WLDP Control Coordinator were added. Sections 4.2.3, Environmental Assessment was added.	G. Cota-Sanchez	M. Attas M. Stephens C. Clavel J. Harding M. Rhodes P. Ingham P. Barnsdale L. Rasmussen R. Hamon	
3D1	2007/07	Revised to incorporate CNSC comments from 2006 June as well as organizational document updates, and issued for review.	G. Cota-Sanchez	M. Attas M. Stephens C. Clavel J. Harding M. Rhodes P. Ingham	

		Major Changes were performed on organizational structure, work planning, control of processes, verification, non-conformance, and corrective action, decommissioning documents, work control, turnovers, status of systems, communication, material control, worker safety and housekeeping.		P. Barnsdale L. Rasmussen R. Hamon M. Drynan J. Mallory R. McCamis G. Koroll	
2	2005/10	Issued for use.	E.M. Attas	M. Stephens	B. Kupferschmidt
2D1	2005/09	Revised to incorporate CNSC comments from 2005 Feb., and issued for review.	E.M. Attas	M. Stephens C.Colotelo E. Clavel J. Harding M. Rhodes R. McCamis G. Koroll	
1	2004/09	Released for use.	E.M. Attas	M. Stephens	B. Kupferschmidt
1D1	2004/07	Revised to incorporate CNSC comments; updated to reference latest AECL company-wide program documents; issued for review.	E.M. Attas	J. Garroni J. Harding R.H. McCamis G. Sotirov C. Colotelo M. Stephens C. Calve	
0	2002/12	Released for use.	E.M. Attas	M. Stephens	G. W. Koroll R.H. McCamis C.W. Zarecki W.C.H. Kupferschmidt
D3	2002/11	Revised to incorporate reviewers' comments and issued for discussion.	E.M. Attas	WL Decom. Review Team	
D2	2002/11	Revised to incorporate review comments.	E.M. Attas	M. Stephens M. Rhodes G. Koroll C. Colotelo R.H. McCamis G. Kharshafdjian C.W. Zarecki	

				M. Ryz P. Yuen	
D1	2002/09	Issued for review.			

Certification and Management Commitment

A) This document describes the Quality Assurance Program for the WL Decommissioning Project.

B) The document is supplementary to, and meets the requirements of, the *CNL Management System Manual*, 900-514100-MAN-001 [1] and the *CNL Quality Assurance Program Description Document*, 900-514200-PDD-001 [2].

C) The Quality Assurance Program for the WL Decommissioning Project satisfies the requirements of the CSA N286-12 Standard, *Management system requirements for nuclear facilities* [3] and CSA N286.6-98, *Decommissioning Quality Assurance for Nuclear Power Plants* [4].

D) Management is committed to the implementation and maintenance of the Quality Assurance Program described herein.

Kerry Rod, WL Site Head & General Manager	Matt King, WL Deputy General Manager
Allan Caron, Director, WL ERPL&Q	Douglas Cram, Director, CNL Quality Assurance
Brian Wilcox, Director, NPD & WR-1 Reactor Division	Bobby Gibson, WL Senior Project Manager, D&D
Jim Reynolds, Director, WL Waste Management	Gina Barnett, Director, WL Business Operations
David Gilson, Senior Manager, WL WMA D & D	Shane Richardson, Senior Manager, WL Project Controls

Table of Contents

Section **Page**

1. Scope and Applicability

This document describes the quality assurance program of the Whiteshell Laboratories Decommissioning Project (WLDP)[1] organization [5] within Canadian Nuclear Laboratories (CNL).

The WLDP provides integrated operational, compliance, and project services to Whiteshell Laboratories (WL) and carries out the decommissioning of the WL site including facilities, buildings, and clean-up of contaminated lands.

The quality assurance program outlined in this document applies to the nuclear and non-nuclear facilities being decommissioned, and the associated supporting activities at WL, as described in the WL Decommissioning Licence [6].

2. Purpose

This document describes the quality assurance program applied to decommissioning and supporting activities at WL. Compliance with the quality assurance program contributes to achieving the decommissioning objectives, protecting the health and safety of persons and the environment, and meeting the requirements of relevant codes, standards, regulations, and customers.

This document supplements the following documents:

- *CNL Management System Manual* [1], which describes the management system in place for CNL.
- *Quality Program Description Document* [2], which describes the policy for quality and expresses CNL's commitment to the Management System.
- *Cleanup Program Description Document* (PDD) [7] and the *Program Requirements Document* (PRD) [8], which describe the CNL decommissioning process that applies to CNL facilities.

The WL Site Head & General Manager, WLCP retains overall accountability for the implementation and effectiveness of the WL Decommissioning Project QA Plan. Comments or suggestions for improvement of this document should be communicated to the WL Site Head & General Manager, WLCP.

3. Definitions and Acronyms

Terms and acronyms specific to this Quality Plan are defined below. For all other terms, refer to the *Glossary of Controlled Terms and Acronyms* [9] on the CNL intranet or those found in common dictionaries.

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[1] Also referred to as the Whiteshell Laboratories Closure Project (WLCP).

3.1 Definitions

As Low As Reasonably Achievable	Defined by the International Commission on Radiological Protection to mean the optimization of protection so that the magnitude of individual doses, number of people exposed, and risk of unplanned exposures are as low as reasonably achievable, economic, and social factors taken into account.
Decommissioning	Those actions taken, in the interest of health, safety, security and protection of the environment, to retire a licensed activity/facility permanently from service and render it to a predetermined end-state condition.
Detailed Decommissioning Plan	A plan setting out the detailed work program, safety and environmental protection procedures and management systems that will be followed in the decommissioning of a licensed activity/facility.
Decommissioning Project	A set of activities undertaken to demolish a building, retire a facility permanently from service, prepare a building, facility, or site for reuse and/or to bring a building, facility, or site to a defined end-state.
End-state (final, interim)	The final end-state is the proposed physical, chemical, and radiological condition of the facility at the end of the decommissioning project for the facility. An interim end-state is a sustainable safe shutdown state into which the facility is put by one of the sub-projects that together constitute the project.
Facility Authority	The person accountable through the established line organization for health, safety, and environmental protection of a nuclear facility.
Facility Authorization	A document that sets out the key requirements, conditions, and limits for safe operation, in accordance with the WL Decommissioning Licence.
Facility Manager	The person who reports functionally to the Facility Authority and is responsible for the day-to-day operation and maintenance of a nuclear facility.
Landlord	The person accountable through the established line organization for health, safety, and environmental protection of a non-nuclear facility.
Preliminary Decommissioning Plan	An overview of the proposed approach to decommission a facility. The preliminary plan provides the structural outline of the subsequent detailed decommissioning plan(s) for the facility.

Procedure	A step-by-step detailed description of how a task or activity is to be carried out, including safety measures such as precautions before the work is started, personal protective equipment to be used, hold-points for safety checks and independent verifications to be carried out.
Project	A temporary endeavor undertaken to create a unique product.
Project Leader	A person responsible for executing one or more work plans.
Radiological Work Assessment	The assessment of requested work with the objective of assessing the radiological aspects, concern and significance of the work and determining the ALARA work package and approval requirements to allow the work to be executed.
Radiological Work Plan	Document describing the radiation protection requirements, procedures, limits, and back-out conditions for radiological work, as defined by the ALARA review and assessment process.
Shutdown (permanent, final)	No longer operating and not intended ever to be restored to operation.
Storage-with-Surveillance	A planned interval during the decommissioning of a facility when the remaining contaminated materials, equipment, structures, building, and site are maintained and are kept under planned surveillance in a sustainable safe shutdown state.
Surveillance	A planned evaluation to confirm that an activity or condition conforms to specified requirements at selected and identified points during the execution of activities.
Verification	The act of reviewing, inspecting, testing, checking or otherwise determining and documenting whether items, processes, services, or documents conform to specified requirements.
Work Plan	Document detailing the steps to follow to safely accomplish the objectives for a specific scope of work.

3.2 Acronyms and Abbreviations

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable, social, and economic factors being taken into account
ANSI	American National Standards Institute
ASI	AECL Subject Index

BSI	Basic Subject Index
CARB	Corrective Action Review Board
CMMS	Computer Maintenance Management System
CNSC	Canadian Nuclear Safety Commission
CW	Company-Wide
D&WM	Decommissioning & Waste Management (unit)
DDP	Detailed Decommissioning Plan
EmP	Emergency Preparedness (program)
EnvP	Environmental Protection (program)
EOC	Emergency Operations Centre
FA	Facility Authority (person)
FA	Facility Authorization (document)
FM	Facility Manager (person)
FSA	Functional Support Areas
GDI	Governing Documentation Index
GM	General Manager
HSSE	Health, Safety, Security & Environment
ImpAct	Improvement Action (process)
IWC	Integrated Work Control
LST	Controlled List
MRM	Management Review Meeting
MSD	Management System Document
MST	Management Screening Team
NPARB	Nuclear Performance Assurance Review Board
OPEX	Operating Experience (program)
ORG	Organization (document)
OSH	Occupational Safety & Health (program)
PDP	Preliminary Decommissioning Plan

PDD	Program Description Document
PRD	Program Requirement Document
QA	Quality Assurance
QAP	Quality Assurance Plan
RP	Radiation Protection (program)
RPM	Radiation Protection Manuals
RWA	Radiological Work Assessment
RWP	Radiological Work Plan
SAT	Systematic Approach to Training
SME	Subject Matter Expert
SRC	Safety Review Committee
SSHC	Site Safety & Health Committee
STD	Standard
SwS	Storage-with-Surveillance
WHMIS	Workplace Hazardous Materials Information System
WIP	Work Instruction Package
WLDP	Whiteshell Laboratories Decommissioning Project
WMA	Waste Management Area

4. Management Systems Documents

The purpose of the CNL management system is to integrate the organization's structures, capabilities, resources, and processes to enable effective and efficient program delivery, while maintaining compliance with requirements to safety, quality, and applicable legislation and regulations.

CNL's management system is based on a comprehensive framework that covers all aspects of the business as described in the *CNL Management System Manual* [1]. The Functional management structure consists of Functional Lead Areas which can be further broken down into individual Functional Support Areas, and the functional organization made up of Functional Responsible Executives, Functional Support Managers, and Subject Matter Experts as listed in the CNL *Functional Authorities List* document [10].

The application of the management system requirements shall be graded so as to deploy appropriate resources, based upon:

- The significance and complexity of the activity.
- The hazards and magnitude of the potential impact (risk) associated with the health, safety, security, environment (HSSE) and quality.
- The possible consequence if an activity is carried out incorrectly.

The selected grading needs to be consistent with the applicable CNL requirements, applicable external codes, and standards, as well as licence and regulatory requirements.

The Management System document hierarchy applicable to the WLDP Quality Assurance Plan (QAP) includes the following documents:

- The *Whiteshell Laboratories Organization* document (ORG) [5] describes the management structure, specific roles and responsibilities and interfaces.
- The *Site Licences, Certificates, Permits, Facilities & Representatives* [11] document provides the names of individuals responsible for facilities and laboratories and the *Functional Authorities List* [10] for supporting processes and programs.
- The *Whiteshell Laboratories Site Governing Document Index* [15] has a listing of key procedures, governing documents, and an index of the external requirements and governing documents to support the facility or organization.

4.1 Management System Governing Documents

The following documents make up the suite of Management System Governing documents:

- *Management System Manual* [1]
- *Management System Governing Documentation Index* [12]
- *Functional Authorities List* [10]
- *Site Licences, Certificates, Permits, Facilities & Representatives* [11]
- *Codes, Regulations, Standards and Other Documents* [13]

4.2 Cleanup Program Governing Documents

The following documents make up the suite of Cleanup Program Governing documents:

- *Cleanup Program Description Document* [7]
- *Cleanup Program Requirement Document* [8]
- *Cleanup Governing Documentation Index* [14]

4.3 Whiteshell Laboratories Governing Documents

The following documents make up the suite of Whiteshell Laboratories Governing documents:

- *Whiteshell Laboratories Decommissioning Project Quality Assurance Plan* (this document)
- *Whiteshell Laboratories Organization* [5]
- *Whiteshell Laboratories Site Governing Documentation Index* [15]

5. Management Statement of Commitment

As members of the management team for WL, we are committed to the development, implementation, and continual improvement of the *CNL Management System Manual* [1] and the quality assurance program described in this QA Plan and will seek the same commitment of our staff. We comply with the organization's policies while continually improving the underlying processes to support our decommissioning and supporting activities.

Management shall issue a statement committing the management and staff of the organization to adhere to the requirements of the *CNL Management System Manual* [1] and the quality assurance program.

See Certification and Management Commitment on page 7.

5.1 Policy

The WL Decommissioning Quality Assurance Program is established under the authority of the CNL *Management System Manual* [1] and the CNL *Quality Program Description Document* [2]. CNL has set up of Policies (including one specifically on *Quality* [2]) and supporting principles, which are described in the *Management System Manual* [1].

CNL applies the Decommissioning Quality Assurance Program described in this QA plan to all activities related to decommissioning and supporting activities at WL. Compliance with the QA Program contributes to achieving the decommissioning objectives, protecting the health and safety of persons and the environment (HSE), and meeting the requirements of relevant codes, standards, regulations, and customers.

6. Management Assessment of Effectiveness

6.1 Management System Assessment

The CNL *Management System Manual* [1] describes the requirements for conducting periodic reviews of the effectiveness of the overall management system.

Management shall review the management system with sufficient frequency to confirm its continuing effectiveness. In addition to assessing adherence to requirements, the review shall evaluate the need for changes to the management system itself, including its scope and principles.

An annual *Integrated Management System Review* [16] is completed which includes support documents including review meeting, minutes, presentations, analyses results, and functional support area assessments. A survey is conducted among internal customers of all Functional Support Areas (FSA) that measures how the Effectiveness of each FSA is perceived by FSA's customers. The Effectiveness is determined through questions related to Efficiency, Enable Mission and Sustainability. The review identifies any important, cross-organizational and/or systemic issues, which require intervention or further investigation.

6.2 WL Committees

Various committees provide oversight of WLDP activities. These committees are made up of senior managers, managers, technical experts, and are augmented by supporting staff as needed. Terms of Reference documents describe the committees' mandate, membership and structure, responsibilities, and reporting requirements.

6.2.1 WL Nuclear Performance Assurance Review Board

The WL Nuclear Performance Assurance Review Board (NPARB) provides a functional oversight for processes and facilities important to continued licensing of the WL site. The board reviews important and emerging risk areas, the performance and effectiveness of WL nuclear facilities, and the implementation of supporting processes and compliance programs needed to achieve operational excellence.

The NPARB meets quarterly and is currently chaired by the WL Site Head & General Manager (GM) and WL Site Licence Holder, and co-chaired by a senior manager appointed by the chair. The Terms of Reference for NPARB are documented in the *Nuclear Performance Assurance Review Board* document [17].

6.2.2 Management Review Meeting

The Management Review Meeting (MRM) considers the ImpActs [18] (see Section 7.11 of this QA Plan) and provides management oversight and advice to the MRM Chair for the ImpAct process to ensure prompt and proper disposition of significant problems affecting safe and effective operation. The MRM meets weekly. The Terms of Reference for MRM are documented in *Improvement Action (ImpAct) Management Review Meeting and Management Screening Team Terms of Reference* [19].

6.2.3 WL Site Safety & Health Committee

The WL Site Safety & Health Committee (SSHC) is dedicated to the promotion and improvement of the safety and health of employees and provides a forum for joint employee/management consultation and resolution of safety and health concerns in the workplace. The SSHC is mandated to meet at least nine times per year, but aims to meet monthly, and the meeting is co-chaired by a worker representative and a management representative. The Terms of Reference are documented in *WL Site Safety and Health Committee* [20].

6.2.4 Effectiveness Reviews and Corrective Action Review Board

The *Corrective Action Effectiveness Review Process* [21] describes the methodology and documentation of an effectiveness review. The *Corrective Action Review Board Terms of Reference* [22] defines its mandate and process. The Corrective Action Review Board (CARB) is a CNL Senior Line Management forum that provides continuous oversight of the health and effectiveness of the corrective action and improvement program.

6.2.5 WL Electrical Safety Committee

The WL Electrical Safety Committee (ESC) provides WL employees with a competent technical resource for guidance concerning implementation of electrical safety and work practices and also provides recommendations for the continued improvement of electrical safety at WL. The WL ESC meets monthly and is chaired by the Director, Environment, Radiation Protection, Licensing, & Quality. The Terms of Reference are documented in WL *Electrical Safety Committee* [23]. The ESC also has a representative on the company-wide Electrical Safety Working Group.

6.3 CNL Committees with WL Participation

Various company-wide committees provide oversight of CNL activities. These committees are formed of senior managers, managers, technical experts and augmented by supporting staff as needed. Terms of Reference documents describe the committees' mandate, membership and structure, responsibilities, and reporting requirements. These CNL committees include:

- *Training Oversight Committee* [24]
- *CNL Sustainability Leadership Committee* [25]
- *Health and Safety Policy Committee* [26]
- *Electrical Safety Working Group* [27]

7. Generic Requirements

7.1 The Business is Defined, Planned, and Controlled

WLDP provides integrated operational, compliance and project services to WL, and carries out the decommissioning of the WL site including shut down facilities, buildings, and clean-up of contaminated lands. WLDP's responsibilities include:

- Managing and reducing the risks such as Health, Safety, Security and Environment (HSSE) business and the liabilities associated with the WL site.
- Creating and operating the necessary systems, processes, and facilities for the safe, cost-effective, and compliant management of operational and decommissioning wastes at the WL site.
- Establishing a sound technical base that supports waste management, decommissioning and environmental remediation activities associated with legacy and operational wastes at the WL site.

The mandate of the WLDP is to manage and eliminate the nuclear liabilities safely and effectively (to protect the environment for future generations).

The vision of the WLDP is to be the "best in class" environmental site decommissioning team in Canada through our people, practices, and innovation.

The mission of the WLDP is to decommission safely and efficiently the Whiteshell site using sound environmental and waste management practices while optimizing value to the Canadian public.

The current decommissioning objectives of the WLDP are to:

- Deliver our decommissioning mission safely, more efficiently and effectively, increasing the percentage of our time spent on decommissioning, eliminating wasteful processes, improving our work throughput, and fostering innovation.
- Develop a world-class waste management organization fully integrated with CNL's waste management organization.
- Open, honest, and transparent communications both internally and externally to build trust within our staff, our regulator, our stakeholders, and regional Indigenous groups.
- Implement and use a site-wide work planning process that integrates with, and adds value to, existing processes to help achieve commitments, deliverables, and milestones.
- Work safely, in compliance with applicable requirements, and find innovative ways to expedite completion of Whiteshell decommissioning.
- Develop our highly skilled workforce to support our vision.

Under the WL Target Cost Agreement, CNL prepared a *Performance Baseline and Earned Value Management Plan* [28]. The Performance Baseline is a comprehensive, resource-loaded plan to execute the scope contained in the WL Target Cost Agreement. The Earned Value Management Plan reflects a systematic approach to the integration and measurement of cost, schedule, and technical accomplishments required to achieve closure of WL. In addition, WL developed a *Waste Management Plan* [29] and a *Risk Management Plan* [30]. The Waste Management Plan includes data related to WL waste volumes, waste type/characteristics, and packaging requirements for all wastes to be transported, disposed, or stored. The Risk Management Plan provides a comprehensive process for implementing Risk and Opportunity management.

7.2 The Organization is Defined and Understood

The overall organizational structure is described in the *CNL Management System Manual* [1] and the *Whiteshell Laboratories Organization* [5].

The WL Site Head & GM is the Site Licence Holder for the WL site. The responsibilities of the Site Licence Holder are described in the CNL *Management System Manual* [1].

The current list of individuals with responsibility for nuclear and non-nuclear facilities and buildings at WL is maintained in *Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories* [31].

7.3 Personnel are Competent at the Work They Do

WLDP personnel shall be trained and qualified to perform tasks assigned to them. The selection and qualification criteria (i.e., competence, skills, knowledge, and experience) needed for each position shall be listed in accountability statements and position descriptions, prepared according to *Accountability Statements and Position Descriptions* [32]. In addition:

- Personnel shall be selected according to *CNL Staff Hiring* [33].
- Training plans shall be prepared for personnel in accordance with *Training Analysis* [34].
- Records shall be kept of training in accordance with *Conducting Training* [35].

Trades personnel working on decommissioning tasks shall have an inter-provincial certificate in their respective trade, or work under the direction of a tradesperson who has such a certificate. WLDP personnel shall be trained on CNL programs such as Occupational Safety & Health (OSH), Radiation Protection (RP), Environmental Protection (EnvP), Emergency Preparedness (EmP), and equipment requirements.

Specific training on CNL's *Performance Assurance PDD* [36] shall be provided to personnel with the aim of minimizing human performance errors, ensuring competent and safe execution of activities, and supporting a strong safety culture based on a formal and disciplined approach to all activities.

Management shall review training programs of their staff annually to determine if additional training is needed. Directors, Managers and Supervisors involved in decommissioning and supporting activities shall also perform periodic observation and coaching sessions, as described in *Observation and Coaching* [37], to promote a strong safety culture by reducing human errors and improving safety practices and work processes.

Training needs of WL nuclear facilities persons performing licensed activities (previously referred to as personnel in direct operating positions) shall be assessed and training programs shall be developed as described in the staffing and training plans for WL nuclear facilities, based on the CNL Systematic Approach to Training (SAT) process, as described in *Training and Development* (PDD and PRD) [38] [39].

7.4 Personnel Know What is Expected of Them

The responsibilities held by individuals shall be specified in accountability statements for managers and position descriptions for staff, prepared according to *Accountability Statements and Position Descriptions* [32].

Detailed Decommissioning Plans (DDPs) are created for individual facilities. Decommissioning objectives for WL are documented in *The Whiteshell Laboratories Detailed Decommissioning Plan* (*Volumes 1* to *Volume 12*). Details of proposed end-states and the steps needed to reach them are found in *Volume 1 – Program Overview* [40].

WLDP personnel are individually accountable to their respective Manager, Facility Manager, or Building Superintendent for the safety and quality of their own work. In turn, the Manager, Facility Manager or Building Superintendents are accountable to the Facility Authority or Landlord for executing decommissioning work safely and to the WL Site Head & GM for achieving decommissioning objectives.

Detailed decommissioning results are measured and compared to the expectations in the facility end-state reports. Performance is judged against the goals for the year (during performance appraisals for staff according to *Performance Management and Review Forms for Unionized Employees* [41] and *Performance Management for Non-Unionized Employees* [42]), and against deliverables in the annual review of progress for projects.

The establishment of decommissioning objectives and schedules take into account the required planning and oversight to ensure that decommissioning activities are performed safely and in compliance with applicable regulatory requirements and CNL compliance programs.

7.5 Work is Planned

WLDP maintains integrated resource-loaded schedules for projects and activities that provide a level of detail necessary to manage the work, identify project critical paths, and plan for necessary resources. A master site-wide schedule is maintained to reflect the latest plans as the decommissioning process evolves.

Day-to-day work is covered in various work planning documents and includes work requests, training plans, quality plans, inspection and test plans, work packages, and project execution plans.

The plan for decommissioning the WL site is presented in the *Whiteshell Laboratories Detailed Decommissioning Plan. Volume 1 – Program Overview* [40]. DDPs for individual facilities shall be prepared following the requirements of the CNL *Decommissioning Process* (STD) [64], CNSC Guide G-219 *Decommissioning Planning for Licensed Activities* [43], and *Independent Technical and Readiness Reviews* [45].

For decommissioning work, personnel prepare and coordinate the preparation of Work Plans. The Work Plans are documents containing higher-level plans and instructions for executing individual decommissioning work packages following the requirements of the *Work Planning for WL Decommissioning* [46].

These considerations are further developed to a work-ready state for execution using the *WL Integrated Work Control Process* [51] and documented within the project-specific *WL Decommissioning Work Instruction Package Process* [48].

The Work Plans shall also plan verification activities associated with the decommissioning work package (see Section 7.10 of this QA Plan). Work Plans shall be accompanied by an overview of verification activities, describing execution and verification activities of the decommissioning work. Details of the planned verification items preparation are described in Section 7.10 of this QA Plan.

In addition, any supporting or decommissioning activity that involves a risk of exposure to radiation or contamination shall be planned in accordance with *ALARA Review and Assessment – Planning and Control of Radiation Work* [47] and documented as part of the *Whiteshell Decommissioning Work Instruction Package (WIP) Process* [48].

Work activities for nuclear facilities shall be controlled, executed, and documented according to *Control of Operations* [49] and *Operations & Process Work Change Control* [50]. Work activities for the Maintenance Planning & Work Management will follow the *WL Integrated Work Control Process* [51]. Work activities for Engineering will follow *Design Authority and Design Engineering* (PDD and PRD) [52] [53].

7.6 Experience is Sought, Shared and Used

WLDP staff shall collect and evaluate information and experience from the previous operating phases of the facilities, and from previous and current decommissioning activities to improve decommissioning safety practices and performance standards.

Decommissioning experience (from CNL sites and non-CNL sites) is shared through discussion at Decommissioning Project meetings, Division meetings, Plan of Day meetings and Senior Management team meetings. Safety issues are discussed at regular WL site, branch, and work group meetings, for which a record is kept.

Safety performance and lessons learned of executed work are reviewed and captured in post-job reviews and post-work As Low As Reasonably Achievable (ALARA) reviews, in accordance with the ALARA program, *Radiation Protection* (PRD) [54], *ALARA Review and Assessment – Planning and Control of Radiation Work* [47], *Integrated Work Control* [55] and *Benchmarking* [56]. Benchmarking exercises are performed in order to both gain and share operating experiences with other CNL sites and external organizations.

Sharing of operating experience with other CNL groups as well as other external organizations is also done through CNL's *Performance Assurance* program [36]. Performance Assurance processes to provide feedback include:

- Documentation and distribution of lessons learned from internal and external sources, using communication methods including posting on myCNL, posting on the OPEX website, inclusion in the OPEX Bulletin, inclusion in the OPEX database and inclusion in ImpAct.
- Screening of industry information (any information that may have application to CNL is sent to Branch/Process/Facility Managers).
- Periodic trend analysis of information in the OPEX database, with reporting of trends and other information to facility authorities and senior management.

In addition, experience gained from *problems* (as defined in Section 7.11) shall be used to enhance safety and prevent the recurrence of such *problems*. *Problems* shall be reported, assessed, categorized, and investigated, if necessary, as described in Section 7.11 of this QA Plan.

7.7 Information is Provided in Time to the People Who Need It

WLDP staff are directed to electronic databases on myCNL or to the CNL's Document/Record Management System to access essential information to ensure that the right people have the current and correct information at the right time to prevent the use of obsolete documents.

The *Whiteshell Laboratories Organization* [5] identifies interfaces associated with WLDP, the nature of interface interactions, and functional positions/personnel responsible for controlling the information flow across the organizational boundaries.

7.8 The Performance of Work is Controlled

The safe execution of decommissioning activities, as well as contracted work, shall be controlled using the *WL Integrated Work Control Process* [51], documented within the *WL Decommissioning Work Instruction Package Process* [48] packages.

The safe execution of decommissioning activities, as well as contracted work also follows the *Decommissioning and Demolition Transfer Certificates process* [57] which collectively describes the considerations for final approval and authorization of decommissioning work, as well as adhering to the *Work Permit* procedure [58]. The *Engineering Change Control* process [66] also provides process assurance relevant to the control of decommissioning authorizations & approvals.

Decommissioning work activities shall also be controlled, executed, and documented according to written and authorized procedures. Supporting procedures and instructions shall be issued, as necessary, before any decommissioning activity is started.

Work activities for licensed nuclear facilities shall be controlled, executed, and documented according to *Control of Operations* [49] and *Operations & Process Work Change Control* [50].

Routine work at operating nuclear facilities is controlled through adherence to approved and authorized procedures. The policy of adherence is conveyed to staff through training in the use of the QA plan and Event Free Tools, as well as through periodic safety meetings.

7.9 The Preparation and Distribution of Documents are Controlled

The identification, review, approval, and issue of documents, and removal of obsolete ones, shall be controlled as described in *Creation, Capture, and Use of Information Assets* [59] and *Document Numbering Principles* [60]. New and revised documents shall be reviewed for adequacy and approved for release by authorized personnel, in accordance with *Processes to Create, Capture, and Use Records* [61].

Whiteshell Laboratories Site Governing Documentation Index [15] shall be used to provide a mandatory list of reviewers and an approval responsibility matrix for WLDP formal documents. Formal documents shall follow the requirements of *Protection of Information* [62] to ensure that the sensitivity of CNL information is assessed and the proper level of protection is applied.

7.10 Work is Verified to Confirm that it is Correct

Required verification activities, the extent of which varies depending on the complexity of the work and the potential impact on safety or the environment, shall be specified in work plans and work procedures, including nuclear facility procedures.

Project Leaders shall document planned verification activities as a part of the decommissioning work planning process (see Section 7.5 of this QA Plan) according to *Event Free Tools* [63]. This is done under guidance of the *WL Integrated Work Control Process* [51], within the *WL Decommissioning Work Instruction Package Process* [48] packages, following the *Decommissioning and Demolition Transfer Certificates process* [57], and *Engineering Change Control process* [66].

These processes and resulting documents, together with *Work Planning for WL Decommissioning* [46] shall be used together to plan the execution and verification activities to be performed during decommissioning work.

Work instruction packages, describing execution and verification activities of a specific decommissioning work plan, shall be prepared according to the *WL Integrated Work Control Process* [51], and the *WL Decommissioning Work Instruction Package (WIP) Process* [48] and will form the basis of work execution verification control.

Decommissioning work shall be authorized and documented in accordance with the above referenced processes. The verification of the condition of a facility after decommissioning is partially or totally completed shall be documented in an End-State Report per the CNL *Decommissioning Process* [64]. Radiological release surveys of materials, equipment and buildings shall be conducted using survey methods, techniques, and acceptance criteria compliant with CNL*'s Radiation Protection* requirements [54] and *Radiological Disposition and Clearance of Buildings, Lands and Materials* [65].

Design Engineering verification activities are outlined in *Design Authority and Design Engineering* (PDD and PRD) [52] [53], *Engineering Change Control* [66] and *Execution of Design Review and Verification* [67].

Decommissioning and non-decommissioning verification activities, including prerequisites, inspections, tests, and sequences, hold and witness points, acceptance criteria and required documentation, can also be specified in inspection and test plans. Examples of test plans are Manufacturing Inspection and Test Plan (MITP) and Piping Inspection and Test Plan (PITP).

CNL document *Surveillance* [68] describes the requirements, responsibilities, and process for planning, executing, and recording surveillance activities during design, fabrication, construction/ installation, commissioning, and decommissioning services including surveillance of work performed by external contractors.

7.11 Problems are Identified and Resolved

Problems defined as any event, issue, non-conformance, or opportunity for improvement, shall be identified, reported, tracked, and corrected in accordance with the *Improvement Action (ImpAct) Corrective Action Program* [18]. ImpAct is a standardized process to document and correct problems, prevent occurrence/recurrence of significant problems and address opportunities for improvement at CNL, including WL. ImpAct is part of CNL's *Performance Assurance* program [36] (see Section 7.6 of this QA Plan).

During decommissioning activities, ImpAct shall be used to:

- Document and address *problems* and opportunities for improvement.
- Assign responsible individuals to address *problems* and opportunities for improvement.
- Determine causes of *problems* and implement required corrective, remedial, or compensatory actions.
- Identify trends of *problems* and start corrective actions.
- Identify lessons learned and undertake actions to prevent recurrence.

The trend analysis of problems, conducted in accordance with *Trend Analysis* [69], shall be used to address adverse trends and start corrective action.

The annual review of the management system shall incorporate relevant information resulting from such analysis as outlined in the *Integrated Management System Review* [16].

Improvement Action (ImpAct) Corrective Action Program [18] shall be followed to analyze recurring or serious problems, assign their significance level, determine their causes, and devise corrective, remedial, or compensatory actions to prevent recurrence. ImpAct shall also be used to correct the causes of potential problems to prevent their occurrence.

7.12 Changes are Controlled

Change control applies to any changes during the execution of decommissioning work including but not necessarily limited to scope, schedule, resourcing, documents, processes and practices, technique, configuration, methodology, equipment, and implementation. Changes include the deviation, alteration, or augmentation of the original planned work.

In addition, the requirements of *Independent Technical and Readiness Reviews* [45] shall be followed when a change is made to a DDP or Work Plan that affects the original HSE evaluation.

Changes to formal and support documents (including documents that describe processes and practices) shall be proposed, reviewed, approved, implemented, and documented as described in:

- *Creation, Capture, and Use of Information Assets* [59]
- *Document Numbering Principles* [60]
- *Processes to Create, Capture, and Use Records* [61]

Changes in engineering design, including decommissioning work performed in operating nuclear facilities, shall be proposed, reviewed, approved, implemented, and documented as outlined in *Engineering Change Control* [66].

Changes to nuclear facilities operations and processes shall be proposed, reviewed, approved, and executed as per *Operations & Process Work Change Control* [50].

Changes to organizations are outlined in the *Organizational Change Control Process* [70]. This procedure assigns accountabilities and related requirements for preparing, reviewing, approving, implementing, documenting, and monitoring changes to roles and responsibilities, and to governing documentation.

Changes to the contract between AECL and CNL are managed per the variation process outlined in the WL Target Cost Agreement.

7.13 Records are Maintained

Records provide documented evidence that items and services meet specified requirements. *Retention, Preservation, and Disposition of Information Assets* [71] and *Processes to Retain, Preserve, and Dispose of Information Assets* [72] details how project essential records shall be identified, stored, maintained, protected, and retrieved. In some cases, the procedure is supplemented by local procedures, for example, *WL Engineering Records Management* [73] or *Construction Document & Records Control* [74].

All essential records are stored in CNL'S Document/Record Management system. CNL'S Document/Record Management system is backed up regularly, and records are inspected. Information Management ensures records are complete, valid, legible, retrievable, and traceable as per *Creation, Capture, and Use of Information Assets* [59].

Essential records, formal records, and documents shall be identified and submitted for archiving to Information Management with the corresponding Subject Index (SI). For the current and complete list of AECL Subject Index (ASI) or Basic Subject Index (BSI) number, refer to the official lists on myCNL.

7.14 Assessments are Performed

The effectiveness of the CNL management system and the quality assurance program shall be reviewed on an ongoing basis. This monitoring process includes self-assessments, program surveillance, management system assessments, and independent assessments (see Sections 7.14.1 and 7.14.2 of this QA Plan). Management shall confirm that work activities meet the requirements of the management system and the quality assurance program and identify opportunities for improvement in accordance with *Integrated Management System Review* [16] and *Nuclear Performance Assurance Review Board* [17] processes, which provide functional oversight of the decommissioning and supporting activities.

7.14.1 Self-Assessment

Management shall periodically assess compliance of the implementation of the management system and quality assurance program. The WL Section Head QA/QC, in consultation with the WL Site Head and GM, Directors and the Quality Assurance Specialists, shall prepare an annual line assessment plan which is merged with the company-wide integrated assessment plan to confirm compliance of the implementation of the management system and the quality assurance program. Such self-assessments shall be conducted as specified by the *Self-Assessment* procedure [75]. WLDP personnel shall help with these assessments when requested by management.

7.14.2 Independent Assessments

Independent assessments of the CNL Management System and Quality Assurance program shall be conducted periodically to:

- Evaluate the effectiveness of processes in meeting goals, strategies, plans, and objectives.
- Determine the adequacy of work performance and leadership.
- Evaluate the organization's safety culture.
- Monitor product quality.
- Identify opportunities for improvement.

CNL's Quality Assurance division is responsible for scheduling, planning, preparing, conducting, and reporting quality audits for WLDP, in accordance with *Quality Audits* [76]. An Annual Audit Schedule is prepared based on the Audit Program Plan and is revised, as necessary.

The results of independent assessments shall be documented and reported to the level of management having sufficient responsibility to ensure that any identified problems are resolved.

8. Specific Requirements

8.1 Design

The *Engineering Change Control* process [66] covers the proposal, review, approval, authorization, implementation, and documentation of permanent and temporary changes to facility equipment, systems, structures and components, processes, and controlled computer software as well as the use of non-identical items.

Design work is processed systematically from the receipt of a Change Request, through all work phases to job closure.

Design Authority and Design Engineering (PDD and PRD) [52] [53] defines the technical requirements of the design process for WL Decommissioning. *Execution of Design Review and Verification* [67] defines the process for verification activities to ensure that the design will meet the design requirements. When verifiers are not available within the design organization, verification is performed by competent personnel from outside the WL organization by a qualified third party, the client, or the client's delegate.

Line Management monitors work progress through all phases and verification is conducted at defined stages to provide relevant checks and inputs. The *Contracts and Contractor Management* [77] and *Oversight of Design Agencies* [78] documents provide direction on the management of external design engineering services for use within WL Decommissioning.

The requirements, responsibilities, and process for controlling the preparation, review, approval, and issue of all formal design documentation produced by WL are provided by *Production and Acceptance of Design Documents* [79]. Where traceability is needed in subsequent phases, the affected systems, components, and structures are identified in the design output documents.

Design activities involving pressure boundary items are carried out in conjunction with the *WL Pressure Boundary Quality Assurance Plan* [80].

NOTE: Any software used for safety analysis or design calculations must meet the requirements of CSA N286.7 [81] as per the *Analytical, Scientific, and Design Computer Programs* [82] QAP. As well, any Instrument and Control (I&C) Systems that have real-time programmable electronic systems (PES) must meet the requirements of IEC 61513 as per *Real-Time Programmable Electronic Systems* (PES) [83] QAP.

Engineering at WL must adhere to the *WL Engineering Governing Documentation Index* [89].

8.2 Safety Analysis

Non-routine work to take place in a nuclear facility shall first be reviewed and approved in accordance with *Operations & Process Work Change Control* [50]. Proposed modifications and non-routine work shall be subject to Safety Review Committee (SRC) review as described in *Independent Technical and Readiness Reviews* [45] if they meet the conditions described therein.

Safety Analysis (PDD) [84] defines the requirements, responsibilities and process for the planning, performance, checking, review, and approval of safety analysis.

A requirement for independent review of new facilities, including requirements for safety analysis reports, is described in *Independent Technical and Readiness Reviews* [45].

NOTE: Any software used for safety analysis or design calculations must meet the requirements of CSA N286.7 [81] as per the *Analytical, Scientific, and Design Computer Programs* [82] QAP.

8.3 Safe Operating Envelope

A Facility Authorization (FA) sets out the key requirements, conditions, and limits for safe operation of nuclear facilities, in accordance with the *WL Decommissioning Licence* [6]. The WL Decommissioning Licence lists the Facility Authorization documents.

Operating nuclear facilities at WL must adhere to the *Whiteshell Laboratories Waste Characterization and Processing Governing Documentation Index* [85] or the *Waste Storage and Disposition Facilities Governing Documentation Index* [86].

8.4 Purchasing and Material Management

Procurement activities for services and items required by WLDP shall be performed in accordance with the *Supply Chain* (PDD and PRD) [87] [88] and associated procurement and material management procedures referenced therein.

Specifically, as regards to procurement, items that must meet certain specifications or requirements of technical standards shall be procured from authorized vendors/suppliers and inspected on arrival. Procurement, receipt, handling, storage, and issue of material shall be controlled in accordance with the *Supply Chain* (PDD and PRD) [87] [88].

Other aspects of material control, including selection of quality program requirements, identification, traceability, and inspection and testing, shall be performed in accordance with the *WL Engineering Governing Documentation Index* [89], the *Whiteshell Laboratories Governing Document Index* (GDI) [15], and procedures referenced therein. In particular, for pressure-retaining components and systems the quality control program described in *WL Pressure Boundary Quality Assurance Plan* [80] shall apply.

8.5 Identification and Labelling of Systems and Components

In developing Work Plans, personnel shall ensure that systems, structures, and components in a facility or site area, shall be assigned an equipment code to ensure they can be accurately described in applicable documents and records. Where ambiguity may exist, identification shall be applied before work begins. Equipment codes are recorded and maintained by WL Engineering personnel in accordance with the *WL Engineering Drawing Office Manual* [90].

Items of field equipment required in a facility are assigned an identification code to ensure that equipment can be related to work activities, applicable documents, and records. Equipment requiring maintenance is tracked in the computer maintenance management system database (CMMS).

Systems, structures, and components presenting radiological and non-radiological hazards shall be also labelled.

Equipment that may be required to be operated in an emergency is known to those trained to respond to emergencies (e.g., firefighters, Radiation Protection personnel), including locations and how to use the equipment, and are labelled as needed.

Radiological hazards shall be identified with caution signs in accordance with *Radiation Protection* [54] and associated Radiation Protection Manuals (RPM), such as *Areas and Zones* (RPM-7.2) and *Radiological Hazard Warning Signs* (RPM-7.4).

Non-radiological hazards shall be identified with caution signs in accordance with *Occupational Safety and Health* (PDD) [91] and *Safety Signage* [92].

8.6 Security

Nuclear facilities at WL are located within secured areas surrounded by a security fence. Where required, the individual facilities are locked and have the proper restricted entry signage displayed. Access to facilities shall be controlled following the requirements of *Security* (PDD and PRD) [93] [94] and *Access Control* [95].

The Manager, Emergency Services Operations, is responsible for providing access control, visual monitoring and patrolling, an extensive surveillance system to detect and deter unauthorized access to the laboratories and facilities, and site fire protection. CNL adheres to the security policies of the Government of Canada. The measures for WL Security are specified in *Whiteshell Laboratories Site Security Report* [96].

8.7 Construction and Installation

Construction and installation of nuclear and safety-related systems shall be done in accordance with the requirements of *Construction* [97].

8.8 Commissioning

Commissioning activities shall be done in accordance with the requirements of *Commissioning* [98].

8.9 Turnovers

The turnover process is how a facility, system, building, area or parts thereof is turned over from one lifecycle phase to another (e.g., design to construction, construction to commissioning, commissioning to operations, and operations to decommissioning).

The turnover process requires that, prior to acceptance:

- Turnover documentation shall be completed and collected.
- Boundaries and other information relating to status of a facility, structure, or system shall be clearly defined, for example in the specific decommissioning Work Plan of that facility, structure, or system.
- A walk down shall be completed to verify conditions of the facility, structure, or system.
- Regulatory requirements have been met.

The turnover process of facilities, structures and systems at WL shall be performed and documented in accordance with the requirements described in *Decommissioning and Demolition Transfer Certificates* [57] and *Engineering Change Control* [66].

8.10 Complete Assurance

Design, purchasing, construction, commissioning, and decommissioning activities shall be considered sufficiently complete and safe for the intended use. Completion assurance shall be performed and documented in accordance with the requirements described in *Engineering Change Control* [66], *Commissioning Completion Assurance* [99], *Commissioning* [98] and *Independent Technical and Readiness Reviews* [45].

8.11 Operating the Plant

The current list of individuals with responsibility for nuclear and non-nuclear facilities and buildings at WL is maintained in *Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories* [31]. The Facility Authorities and Landlords are responsible for protection of the environment, and the overall safe operation and use of nuclear and non-nuclear facilities and buildings at WL. The Facility Managers and Building Superintendents are responsible for ensuring that activities taking place in those facilities are in compliance with the:

- Respective Facility Authorization documents.
- Requirements of the WL Decommissioning Licence.
- Regulations from the CNSC.
- Applicable federal and provincial legislation.
- Requirements of the Safety Review Committee (SRC) described in *Independent Technical and Readiness Reviews* [45].
- Management System and Quality Assurance program described in this QA Plan.

The facility/building personnel are responsible for day-to-day safe operation, use, and maintenance of the facilities, in accordance with established practices as well as approved and authorized procedures.

The Facility Authorities and Landlords and the Facility Managers and Building Superintendents, each have the authority to cease or halt the operation of any facility under their control, or any activity within a facility under their control, for reasons of safety or non-compliance with regulatory requirements.

In the absence of Line or Facility Management, Group 1 Radiation Protection staff also has the authority to cease or halt an activity for radiation safety reasons in accordance with *Radiation Protection* [54]. Also, Quality Assurance has the authority to cease or halt an activity for conditions adverse to quality in accordance with the *Stop/Start Work Authority* [100].

8.12 Communications

Clear, concise, and correct communication, within WLDP organization and between WLDP and other organizations, shall be performed through the requirements outlined in the procedure *Event Free Tools* [63]. The aim of this communication is to minimize human performance errors, ensuring competent and safe execution of activities and reaching quality goals.

Directors, Managers, Supervisors, and Project Leaders shall conduct observation and coaching sessions to provide feedback on the work performance, as described in *Observation and Coaching* [37].

Facility Managers and Supervisors shall also hold informal meetings with WLDP staff, and contractor personnel to go over the planned activities and ensure that assignments are clearly communicated and understood.

Technical details of work activities, such as potential hazards, safety measures, and contingencies, shall be communicated to the decommissioning and contractor personnel before the job is undertaken, through pre-job briefings (which may include walk downs). The communication of the technical details of the work activities will follow the requirements outlined in:

- *ALARA Review and Assessment – Planning and Control of Radiation Work* [47]
- *Event Free Tools* [63]
- *Work Planning for WL Decommissioning* [46]
- *Whiteshell Decommissioning Work Instruction Package Process* [48]

8.13 Plant and Status Control

Systems and equipment are entered in the WL maintenance database, which is maintained by WL Maintenance Planning & Work Management personnel. The WL maintenance database identifies both scheduled (preventive) maintenance and demand maintenance (service requests).

Turnover certificates, produced as per *Decommissioning and Demolition Transfer Certificates* [57] (see Section 8.9 of this QA Plan), shall be generated to transfer information on the status of systems, structures and components being decommissioned.

Work areas shall be identified as per *Safety Signage* [92] and *Temporary Safety Barriers* [101]. The status of equipment, systems, structures, components being decommissioned shall be described in the corresponding Work Plan of the facility, as outlined in *Work Planning for WL Decommissioning* [46].

The status of equipment, systems, structures, and components shall be also communicated to WLDP staff during pre-job briefings, following the requirements outlined in:

- *Radiation Protection* [54]
- *Event Free Tools* [63]
- *Work Planning for WL Decommissioning* [46]
- *Work Permit* [58]
- *Hazardous Energy Control* [102]

Changes to systems, structures and components shall be approved, documented, and communicated to WLDP staff. WLDP staff shall record the status of systems, structures, and components in decommissioning or facility logbooks. Deficient equipment shall be identified and isolated, following the requirements of *Occupational Safety and Health* (PDD) [91].

Permitted activities shall be controlled using the *Work Permit* procedure [58]. *Hazardous Energy Control* [102] shall be used, where applicable, to safeguard personnel and property from unexpected release of uncontrolled hazardous substances or energy from equipment, processes or systems, or loss of protective systems inadvertent during the performance of the work.

8.14 Operator Surveillance

Surveillance of WL facilities includes performing routine alarm and equipment tests, radiological surveys, and physical inspections to assess the working condition of structures, systems, and equipment, and to detect and minimize the impact of any potential problems.

Facility staff or maintenance personnel as specified in facility operating procedures shall perform alarm and equipment tests as per *Surveillance and Testing* [103]. Facility staff shall inspect any permanently shut down nuclear facility (as listed in the *WL Decommissioning Licence* [6]) or part of a permanently shut down nuclear facility, to assure that the safe shutdown state is maintained.

Facility staff shall also routinely perform housekeeping inspections on each nuclear facility being decommissioned as described in *Housekeeping Activities in WL Nuclear Facilities* [104]. In turn, Emergency Services Operations staff shall daily inspect any permanently shut down non-nuclear facility to assure that the safe shutdown state is maintained.

For facilities in Storage-with-Surveillance (SwS) phases of decommissioning, SwS plans shall be prepared in accordance with *Decommissioning Process* standard (STD) [64] including details of facility-specific inspection programs specifying the frequency and responsibilities for physical inspections, equipment testing, and monitoring of operating systems.

8.15 Surveillance Testing

Surveillance testing shall be carried out in accordance with *Surveillance and Testing* [103].

8.16 Operating Procedures

The process and responsibilities for the preparation, revision, approval, authorization, review, control, and maintenance of procedures in use at the operating WL nuclear facilities are described in the following documents:

- *Creation Capture and Use of Information Assets* [59]
- *Document Numbering Principles* [60]
- *Document Number Reference System* [105]
- *Standard Format and Presentation of CNL Documents* [106]

Operating procedures and working-level documents providing detailed step-by-step descriptions of tasks and activities, are written to ensure consistent and safe working practices. The level of detail included in an operating procedure is proportionate with the complexity of the activity and the potential hazard.

Procedures shall be reviewed for technical content and presented in a manner that can be easily interpreted and followed by trained facility staff. *Creation Capture and Use of Information Assets* [59] and the *Standard Format and Presentation of CNL Documents* [106] also gives the requirements for the contents and format of operating procedures for WL nuclear facilities.

Temporary procedures are required for planned activities for which routine procedures cannot be used, e.g., during equipment performance testing. These procedures shall be authorized for use for a specified period and shall be reviewed regularly to ensure the conditions governing their application still exist.

When temporary procedures no longer apply, they shall be removed from use (e.g., by being marked “Obsolete”) as soon as practical. The use and duration of temporary procedures shall be minimized. *Creation Capture and Use of Information Assets* [59] gives the requirements for the contents of operating procedures, including temporary procedures, for the WL nuclear facilities.

Operating procedures shall be used and adhered to, including a Usage Classification designation, in accordance with *Event Free Tools* [63]. Operating procedures shall also be made available to staff in a controlled manner as described in *Processes to Create, Capture, and Use Records* [61]. The policy of adherence is conveyed to staff through training in the use of this QA Plan and Event Free Tools, as well as through periodic safety meetings.

8.17 Emergency Procedures

Emergency procedures for buildings shall be developed and maintained to address non-routine conditions calling for immediate response (e.g., bomb or terrorist threat, fires, unexpectedly high radiation fields or airborne contamination as documented in Section 8.25 and 8.26 of this QA Plan, *Emergency Preparedness Requirements* [107] and *Whiteshell Laboratories Emergency Plan* [108]). Current copies of emergency procedures shall be kept in prominent and easily accessible locations in buildings.

If a serious upset or emergency condition occurs and the existing procedure is inadequate or there is no procedure for the situation, WLDP staff shall perform a safe-back-out and put the facility in a safe state. WLDP staff shall also notify the proper Facility Manager and RP personnel, and shall, in any event, document their actions as described in Section 7.11 of this QA Plan (e.g., raising a *Problem*).

The actions taken may include such measures as restricting access to the affected area, limiting the release of contamination, and curtailing the source of the problem, as described in *Whiteshell Emergency Operations Centre Operating Procedure* [109].

Depending on the degree and significance of the event, the Site Emergency Officer can be contacted and the *Whiteshell Laboratories Emergency Plan* [108] can be activated to help deal with the emergency.

8.18 Infrequently Performed Operations

Infrequently performed operations shall be conducted in accordance with the *WL Integrated Work Control Process* [51], *Operations & Process Work Change Control* [50] and *Work Permit* [58]. Technical details of decommissioning or supporting activities, such as potential hazards, safety measures, and contingencies, shall be communicated to personnel before the job is undertaken.

This communication is done through pre-job briefings, following the requirements of *Event Free Tools* [63] and for detailed work planning by following the *Whiteshell Decommissioning Work Instruction Package (WIP) Process* [48] and *Work Permit* [58].

8.19 Maintenance

Systems, structures, and components in nuclear and non-nuclear facilities are maintained through a combination of maintenance activities, as described in the *WL Integrated Work Control Process* [51]. Maintenance activities are conducted by following procedures and practices which have been approved through processes defined in procedure *WL Integrated Work Control Process* [51] as well.

The Maintenance Program at WL covers all maintenance activities including the program basis, work assessment, work planning/scheduling, monitoring, inspecting, testing, calibrating, servicing, overhauling, repairing, modification, and replacement of parts to ensure that systems, structures, and components function as per design.

Maintenance at WL must adhere to *Maintenance* [110].

8.20 Calibration of Measuring and Monitoring Devices

Calibration of system instrumentation by MP&WM is carried out as per *Calibration* [112]. A maintenance database is used to schedule preventive maintenance and instrument calibrations (see Section 8.19 of this QA Plan).

Radiation-protection equipment shall be maintained and calibrated in accordance with the requirements of *Radiation Protection* [54], *Radiation Protection Instrumentation* [113], and *Care and Control of Calibrated Monitoring and Measurement Equipment* [114].

NOTE: The *Calibration Program QAP* [111] and associated *Calibration* procedure [112] outlines the calibration policies and procedures involved in the selection, use, calibration, and control of equipment and instruments used during calibration.

8.21 Periodic Inspection

Periodic inspections shall be carried out for a nuclear and non-nuclear facility in conformance with applicable codes and standards, as part of the *WL Integrated Work Control Process* [51]. Facility operation and use shall be scheduled to accommodate the required periodic inspections.

8.22 Systems Health Monitoring

The condition of structures, systems, and components are evaluated through the *WL Integrated Work Control Process* [51], which takes into consideration common and recurring problems and recommends changes and/or improvements.

8.23 Chemistry Control

Chemistry control encompasses activities associated with maintaining the radiological and chemistry specifications for the active liquid waste and the lagoons, including:

- Monitoring of chemical parameters to detect abnormal conditions and correct them in a prompt fashion.
- Periodic sampling, analysis, and screening of chemical data for chemistry control problems.

The active liquid waste treatment systems and the lagoons have Standard Operating Procedures specifying how to perform technical activities in that facility.

Additionally, bulk chemicals, laboratory chemicals, corrosive agents, and cleaning agents shall be effectively controlled to ensure safe and proper handling, storage, and use in accordance with *Safe Storage and handling of Hazardous Products* [115], *Operation of WL Hazardous Waste Storage Facility Building 570* [116]. The requirements of *Workplace Hazardous Material Information System (WHMIS)* [117] shall be followed for labelling all such materials.

8.24 Radiation Protection

WLDP management shall ensure that the principles of *Radiation Protection* [54] are effectively applied and implemented in aspects of WLDP activities. Particularly, they shall:

- Provide and maintain a radiologically safe working environment.
- Satisfy themselves that WLDP personnel have proper Radiation Protection training proportional with the nature of their duties.
- Put into place measures to minimize radiation exposure hazards.
- Monitor dosimetry data to assess the effectiveness of Radiation Protection measures.

Personnel dosimetry, radiological surveys and zoning, radiological work planning, engineering controls, access control, and a comprehensive radiation protection training program shall be in place to ensure that the radiological dose received by personnel is maintained ALARA.

Such measures shall be carried out according to *Radiation Protection* [54] and *Occupational Safety and Health* (PDD) [91], which ensure the safety and protect the health of WLDP personnel and contractors from radiological and non-radiological hazards while working at WL. In particular, safety and training requirements for contractors shall be assessed and documented in accordance with *Contractor HSE Assessments* [118].

Non-radiological hazardous material and industrial hazards shall be controlled through compliance with *Occupational Safety and Health* (PDD) [91] and *Environmental Protection* (PDD) [119]. Non-radiological hazards shall be identified with safety signage according to *Safety Signage* [92].

Particularly, non-radioactive hazards created by the decommissioning activities at WL, such as open holes, unsafe flooring, and excavation, shall be identified through commercially available industry standard safety signs in accordance with the *American National Standard Institute*, ANSI Z535.2 [120].

Contamination shall be controlled in accordance with *Radiation Protection* [54] and the associated Radiation Protection Manuals (RPM) governing contamination control, such as *Design and Modifications* (RPM-7.1), *Radiological Areas and Zones* (RPM-7.2), *Access Control* [95], *Radiological Hazard Warning Signs* (RPM-7.4), etc. In addition, workers shall be protected against non-radiological contamination according to the requirements of *Occupational Safety and Health* (PDD) [91].

Specific radiological contamination and decontamination control measures for decommissioning activities shall be assessed, documented, and controlled in accordance with *ALARA Review and Assessment – Planning and Control of Radiation Work* [47] and *Work Planning for WL Decommissioning* [46].

8.25 Fire Protection

A fire safety program, as outlined in *Fire Protection* (PDD) [121], shall be applied to ensure that fire safety measures are in place at WL.

Fire Protection at WL must adhere to the *Fire Protection Governing Documentation Index* [122].

8.26 Emergency Preparedness

Emergency procedures, compliant with the *Emergency Preparedness* (PDD) [107], have been developed and implemented to ensure the protection of personnel, the public, the environment, and the facilities from radiological and non-radiological hazards resulting from unplanned events and abnormal conditions.

These procedures are described in the *Whiteshell Laboratories Emergency Plan* [108]. The *Whiteshell Emergency Operations Centre Operating Procedure* [109] provides procedures for setting up and operating the WL Emergency Operations Centre (EOC), which is the planned location for site decision-making and communication during control and recovery from emergency events.

This procedure describes the:

- Emergency conditions that may occur
- Emergency signals and alarms
- Organization, authority, and responsibilities of personnel in emergency situations
- Communications
- Resources
- Emergency response training
- Correct response for each identified emergency condition

Procedures shall be reviewed and accepted by the WL Emergency Preparedness Program Manager prior to issue. Emergency procedures shall be prepared, reviewed, revised, approved, authorized, and distributed in a controlled manner as outlined in *Creation, Capture, and Use of Information Assets* [59]*, Processes to Create, Capture, and Use Records* [61]*, and Retention, Preservation and Disposition of Information Assets* [71].

Building emergency procedures are also applicable to decommissioning activities performed within a building or facility. These procedures shall be updated or supplemented if the decommissioning activities introduce a risk for hazards or emergencies outside the scope of the hazards and response procedures described in the building emergency procedure.

The effectiveness of the Emergency Preparedness program is evaluated on a regular basis using drills, exercises, inspections of emergency equipment/supplies, and audits.

Dissemination of public information will follow the requirements set out in *Public Information Program for Canadian Nuclear Laboratories* [123].

8.27 Workplace Safety

Specific training on CNL's *Performance Assurance* program [36] and *Occupational Safety and Health* program [91] shall be provided to WLDP personnel. This training has the goal of minimizing human performance errors, ensuring competent and safe execution of activities, and supporting a strong safety culture based on a formal and disciplined approach to all activities.

The Rules to Live By are CNL's commitment to the health and well-being for all employees. WLDP personnel are responsible for our own safety and the safety of those we work with. The Rules to Live By (listed below) are critical to ensuring safety:

- Hazardous Energy Control: De-energize and secure equipment/systems before work.
- Working at Heights: Use required fall protection systems when working at heights.
- PPE & C: Wear appropriate personal protective equipment and clothing.
- Hoisting / Rigging: Use proper lifting, hoisting, and rigging techniques.

- Confined Space Entry: Obtain necessary approval prior to entering any confined space.
- Temporary Safety Barriers: Respect and comply with barriers.
- Hot Work: Obtain proper clearances required for any hot work.

For WL, the following three Rules to Live By (for a total of ten Rules to Live By) are also included due to the decommissioning work taking place:

- Traffic Safety: Follow local law and regulations regarding traffic controls and safety (speed limits, signs, etc.).
- Heavy Equipment: Stay alert and be aware at all times while in areas where heavy equipment is operating.
- Excavations: Confirm utility locates, verify slopes are stable, and be aware of potential atmospheric hazards.

WLDP management and staff shall ensure that a strong safety culture, based on a formal and disciplined approach, prevails on activities related to WLDP work, as outlined in *Performance Assurance* (PDD) [36].

WLDP personnel shall also carry out their duties in compliance with the applicable compliance programs. They shall use and adhere to approved working documents, as described in *Event Free Tools* [63].

WLDP personnel shall also apply safe work practices using a systematic, formal, and disciplined approach while performing their duties, as described in *Event Free Tools* [63].

Self-Checking practices, as per *Event Free Tools* [63] shall be performed in WLDP work to enhance attention to detail, prevent errors, and detect abnormal equipment or errors in verbal and written instructions.

In addition, WLDP personnel, when faced with an uncertain situation, shall apply Conservative Decision-Making in such a way that the final decision made always reflects Caution, as described in *Event Free Tools* [63].

WLDP management and staff shall promote a strong safety culture within the WL Decommissioning Project organization [5] and other organizations, as described in *Observation and Coaching* [37]. In addition, they shall ensure that the principles of *Radiation Protection* [54] are effectively applied and implemented in all aspects of WLDP activities.

More specific worker safety measures shall be described in detail in the work plan or in enhanced planning support documentation (e.g., a radiation work plan (RWP)), prepared, according to *Work Planning for WL Decommissioning* [46], to decommission a specific facility).

Particularly, the corresponding hazard assessments prepared as *Whiteshell Decommissioning Work Instruction Package (WIP) Process* [48] or *ALARA Review and Assessment – Planning and Control of Radiation Work* [47], shall describe worker safety requirements such as protective clothing and equipment, internal and external dosimetry, and radiological control hold points.

In addition, worker safety measures shall also be addressed in a comprehensive manner though pre-job briefing sessions, in accordance with *Event Free Tools* [63].

Prior to execution, WLDP work shall be documented, controlled, and authorized as described in:

- *WL Integrated Work Control Process* [51]
- *WL Decommissioning Work Instruction Package Process* [48]
- *Decommissioning and Demolition Transfer Certificates process* [57]
- *Engineering Change Control* process [66]

The requirements described in *Workplace Hazardous Material Information System (WHMIS)* [117] shall be followed for hazardous materials.

8.28 Hazardous Waste Management

Wastes generated as part of routine activities and projects in facilities being decommissioned shall be characterized and segregated into radioactive and non-radioactive categories as outlined in *Waste Management* (PDD) [124]. Wastes shall be minimized through good housekeeping, proper practices, and decontamination.

Radiological Disposition and Clearance of Buildings, Lands and Materials [65] provides the requirements, processes, and procedures for planning, conducting, evaluating, and documenting radiological disposition and clearance surveys in support of the decommissioning of buildings and lands at WL. This includes building materials and equipment, interior and exterior building surfaces, ground surfaces, and excavated soils.

During WLDP (decommissioning and supporting) work activities, wastes shall be identified, tagged, and traced to their final storage or disposition in appropriate waste management facilities.

Hazardous radioactive and non-radioactive solid and liquid waste shall be managed in compliance with *Management of Waste* [125] and *Non-Radioactive Hazardous Chemical Waste Handling and Storage* [126], which deals with the various categories of non-radioactive hazardous waste at WL. Handling and storage of radioactive liquid and solid waste currently takes place in Buildings 100 and 300, the Waste Handling Area and Waste Management Area (WMA).

Non-radioactive wastes and materials shall receive radiological clearance surveys in accordance with *Radiological Disposition and Clearance of Buildings, Lands and Materials* [65] and *Whiteshell Laboratories Closure Project Waste Management Process Plan* [127].

8.29 Effluent Control

Environmental Protection Program requirements are documented in *Environmental Protection* (PDD) [119] and supplemented by *Environmental Protection Governing Documentation Index*

[128]. The Environmental Protection Program provides the framework to implement CNL's *Environment Policy* [129].

Effluent monitoring shall comply with *Management and Monitoring of Emissions* [130], and shall be provided as part of the Environmental Protection Program, in accordance with the following WL procedures:

- *Waste Management and Effluent Control* [131]
- *WL Effluent Verification Monitoring Plan* [132]
- *Verification Monitoring and Environmental Monitoring Station Maintenance and Calibration Technical Procedure* [133]
- *WL Environmental Monitoring Plan* [134]

Additional monitoring is conducted to meet the WL Decommissioning Licence requirement and reported annually (e.g., WL Compliance Monitoring Report [135]).

8.30 Decommissioning

Cleanup (PDD and PRD) [7] [8] and *Decommissioning Process* (STD) [64] describe the decommissioning process as applied to decommissioning activities throughout the facility lifecycle. This lifecycle spans from preliminary decommissioning planning prior to construction, through shutdown, detailed decommissioning planning, and execution until the final end-state is achieved. The decommissioning process is applied in a graded manner for licensed and non-licensed facilities, buildings, engineered structures, and sites.

The CNL *Cleanup Governing Documentation Index* [14] provides an index to governing and procedural documents approved and authorized for use in the Decommissioning Program. The process is based on fundamental principles and sound practices for excellence in decommissioning practices.

The decommissioning process supports the Management System Framework described in the *Management System Manual* [1] and *Quality* [2].

The *WLDP Quality Assurance Plan* (this document) describes the quality assurance program applied to WLDP (decommissioning and supporting) activities at WL.

9. Normative Annex

9.1 Supplementary Requirements for Decommissioning

9.1.1 Decommissioning Organization

The overall organizational structure is described in the *CNL Management System Manua*l [1] and the *Whiteshell Laboratories Organization* [5].

The WL Site Head & General Manager is the Site Licence Holder for the WL site. The responsibilities of the Site Licence Holder are described in the *CNL Management System Manual* [1].

The current list of individuals with responsibility for nuclear and non-nuclear facilities and buildings at WL is maintained in *Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories* [31].

The organizational roles and responsibilities for the decommissioning process are described in *Cleanup* (PDD) [7].

9.1.2 Decommissioning Stages

Cleanup (PDD and PRD) [7] [8] and *Decommissioning Process* (STD) [64] describes the decommissioning process steps and activities that occur throughout the lifecycle, including design, construction, commissioning, operations, and decommissioning. The decommissioning process applies until the final end-state is achieved; including any required environmental remediation of soils and affected lands as described in the *Environmental Remediation Process* [136] document.

9.1.3 Preliminary Decommissioning Plan

The *Whiteshell Laboratories Detailed Decommissioning Plan. Volume 1 – Program Overview* [40] provides information equivalent to that contained in Preliminary Decommissioning Plans (PDPs). For any new nuclear facility construction, the Facility Authority shall prepare a PDP before construction begins using guidance as provided within the *Land Use Process* [137] and in consideration of the *Cleanup* program description and program requirements documents (PDD and PRD) [7] [8].

PDPs shall include the information listed in the *Decommissioning Planning for Licensed Activities* [43] and *Decommissioning Process* (STD) [64] documents and shall be revisited and updated, as necessary.

9.1.4 Detailed Decommissioning Plan

WLDP staff has prepared several volumes of a collection of Detailed Decommissioning Plans (DDPs) to describe the scope, organization, and schedule of the WL decommissioning efforts. *The Whiteshell Laboratories Detailed Decommissioning Plan. Volume 1 – Program Overview* [40] provides the details of the overall WL decommissioning program.

The subsequent volumes of DDPs for specific facilities shall be prepared in accordance with the *Decommissioning Planning for Licensed Activities* [43] and *Independent & Technical Readiness* [45] that describes the requirements for independent review of CNL's facilities, buildings, and sites in Canada.

These DDPs shall be prepared in accordance with the *Decommissioning Planning for Licensed Activities* [43] and *Independent & Technical Readiness* [45], using guidance as provided within the *Land Use Process* [137] and in consideration of the *Cleanup* program description and program requirements documents (PDD and PRD) [7] [8].

The DDPs shall be reviewed and approved by facility management and confirmed by the CNL Safety Review Committee (SRC) and, if necessary, by CNSC staff, before decommissioning work is undertaken.

9.1.5 Waste Assessment

Waste streams and volumes expected to be generated during each decommissioning stage shall be documented in facility DDPs. More specifically, Work Plans of facilities, structures or components being decommissioned shall include a summary of the expected waste volumes to be generated while performing the decommissioning work.

The Work Plans shall also include reuse and recycling initiatives, as well as storage and disposal options, as outlined in *Work Planning for WL Decommissioning* [46] and the creation of associated waste management plans. Requirements governing the safe management of radioactive material and waste during the decommissioning activities, and described in the Work Plan, shall be identified in the following corresponding safe work documents:

- *Whiteshell Decommissioning Work Instruction Package Process* [48] or in Radiological Work Assessments (RWA)
- Radiological Work Plans (RWP) as described in *ALARA Review and Assessment – Planning and Control of Radiation Work* [47].

Assessments for radioactive and non-radioactive wastes shall be based on the waste categories described in *Management of Waste* [124], and in *Whiteshell Laboratories Closure Project Waste Management Process Plan* [127]. Acceptance criteria for waste categories and transfer from the decommissioning place to the Waste Management Area shall be based on the requirements outlined in *Safety Analysis Report for the Whiteshell Laboratories Waste Management Area* [138].

9.1.6 Hazards Assessment

Hazards shall be assessed for facilities at WL to be decommissioned as part of the preparation of the DDP. The hazard sources are characterized based on facility history (process knowledge) and operating records, surveys of hazardous materials inventories (e.g., asbestos, PCBs), and radiological surveys.

The specific analytical tools used to assess hazards are developed on a case-by-case basis, depending on the size and complexity of the facility and the magnitude of the hazard sources. General information on hazards shall appear in the DDP.

Specific and rigorous hazards assessments shall be performed during the preparation of the Work Plan for decommissioning of a facility, as described in *Work Planning for WL*

Decommissioning [46] and further developed as part of the *WL Work Instruction Package (WIP) Process* [48], as per the *WL Integrated Work Control Process* [51].

In particular, the ALARA Program described in *Radiation Protection* [54] shall be used to assess radiological and industrial hazards as described in *ALARA Review and Assessment – Planning and Control of Radiation Work* [46] and *Whiteshell Decommissioning Work Instruction Package (WIP) Process* [48].

Work involving exposure to hazards and potential process system damage shall be controlled and assessed with the *Work Permit* procedure [58] to ensure that proper protective measures are applied.

The hazards assessment for a facility shall be updated for the needs of the next phase of decommissioning, as the successive decommissioning end-states are reached.

When required, Fire Safety Plans shall be prepared for specific decommissioning work in accordance with the requirements of the National Building Code of Canada [139] and National Fire Code of Canada [140].

9.1.7 Decommissioning Procedures

The process and responsibilities for the revision, review, approval, authorization, control, and maintenance of all decommissioning procedures are described in:

- *Creation, Capture, and Use of Information Assets* [59]
- *Document Numbering Principles* [60]
- *Processes to Create, Capture, and Use Records* [61]
- *Retention, Preservation and Disposition of Information Assets* [71]

Formal documents produced by WLDP staff shall follow the requirements of *Protection of Information* [62] to ensure that the sensitivity of CNL information is assessed and the proper level of protection is applied.

Personnel shall prepare Work Plans to describe the activities involved in decommissioning work, in accordance with *Work Planning for WL Decommissioning* [46]. Work Plans are intended to ensure the work is performed safely (see Section 7.5 of this QA Plan).

Working-level documents providing detailed systematic descriptions of routine tasks and activities are written to ensure consistent working practices. The level of detail included in a procedure shall be proportional with the complexity of the activity and the potential hazards. These documents shall be reviewed for technical content and correctness by reviewers selected according to *Creation, Capture, and Use of Information Assets* [59].

Procedures shall be presented in a manner that trained WLDP staff can easily understand, following the requirements of *Standard Format and Presentation of CNL Information* [106].

9.1.8 Decommissioning End-States

The licensee shall submit an end-state report to the CNSC for acceptance. The end-state report should be submitted no more than two years after completing the decommissioning activities [44].

An end-state report shall be prepared once the predetermined interim or final end-state condition specified in a specific Work Plan has been achieved. Alternatively, the reason why the pre-determined interim or end-state condition was not achieved shall be documented.

The end-state report shall include a summary of decommissioning activities performed, lessons learned, post-work ALARA reviews, results, observations, and findings collected during the execution of the Work Plan, as well as the requirements outlined in *Decommissioning Process* [64].

Final end-state documentation shall also be prepared once the predetermined final end-state condition specified in the facility DDP has been achieved. This final end-state documentation shall review the decommissioning process described in the DDP. This decommissioning review process will include references to "end-state reports of work package", lessons learned, post-work ALARA reviews, and formal post-job reviews generated during the execution of the DDP.

Where the decommissioning strategy includes a deferment period, an interim end-state report is required at the beginning of the deferment period, as outlined in *REGDOC-2.11.2, Decommissioning* [44]. In that situation, the end-state report supports the Storage-with-Surveillance (SwS) plan for the facility.

The content of final end-state reports shall conform to the requirements of *Independent Technical and Readiness Reviews* [45] and *REGDOC-2.11.2, Decommissioning* [44]. Final end-state reports shall be prepared, revised, reviewed, approved, and distributed following *Creation, Capture, and Use of Information Assets* [59].

Following the final stage of decommissioning of the WL site, end-state documentation shall be placed on public record in the National Archives of Canada.

10. References

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[2] *Quality,* 900-514200-PDD-001, 47487865

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[4] *Decommissioning Quality Assurance for Nuclear Power Plants*, CSA N286.6-98 (R2003), CSA

[5] *Whiteshell Laboratories Organization,* WL-514100-ORG-002, 48734936

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[7] *Cleanup (PDD),* 900-508300-PDD-001, 52080159

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[23] *WL Electrical Safety Committee,* WL-508245-TOR-001, 17226228

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[25] *CNL Sustainability Leadership Committee,* ENVP-509200-TOR-001, 52711429.

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[29] *Whiteshell Laboratories Waste Management Plan,* WL-508600-PLA-001, 17196209.

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[33] *CNL Staff Hiring,* 900-510000-MCP-012, 40864472.

[34] *Training Analysis,* 900-510200-STD-001, 41557836.

[35] *Conducting Training,* 900-510200-STD-003, 35265284.

[36] *Performance Assurance Program Description Document,* 900-514000-PDD-001, 12494609.

[37] *Observation and Coaching,* 900-514000-MCP-006, 12497548.

[38] *Training and Development (PDD),* 900-510200-PDD-001, 51748477.

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[49] *Control of Operations,* WL-508238-PRO-724, 17207094.

[50] *Operations & Process Work Change Control,* WL-508200-PRO-697, 16753031.

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[62] *Protection of Information,* 900-508710-STD-002, 12497604.

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[97] *Construction,* 900-505240-MCP-001, 12605653.

[98] *Commissioning*, 900-505250-MCP-001, 12607850.

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[107] *Emergency Preparedness,* 900-508730-PDD-001, 50982494.

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[117] *Workplace Hazardous Material Information System,* 900-510400-MCP-007, 12611926.

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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Functional Authorities REV 7.1

900-514100-LST-001

Approved by	Title	Date
Angela Coulas	Director, Oper Excellence	2023/06/06

Effective Date: 2023/06/15
Expiry Date: 2026/06/05

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
7.1	2023/06/05	Issued as “Approved for Use”.	A. Dash	S. Toelly	A. Coulas
7.1D1	2023/05/26	Issued for “Review and Comment”. Minor revision Updated as per Memos from Responsible Executives and formal announcements. Adopted new template and updated references.	A. Dash	S. Toelly	
7	2022/06/23	Issued as “Approved for Use”.	A. Dash	A. Coulas	A. Coulas
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2D1	2018/12/07	Issued for "Review and Comment". Updated personnel listed in roles. Updated framework structure. Removed tables for Program Authority (absorbed into Functional Support Manager and Designated Representative of the License roles) and Senior Quality Representative (absorbed into Quality and Information Management Roles).	E. Edwards	C. Williams M. Steedman R. Sadhankar S. Karivelil D. McIntyre K. Leroux L. Fleury P. Boyle Y. Dube A. Coulas	
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0	2016/12/20	Issued as "Approved for Use". Supersedes: 145-514100-016-000-0001	G. Garrett	G. Garrett	K. Daniels

Table of Contents

1. Scope and Applicability

Information contained in this list is applicable to all activities, and those who perform them, managed by the Canadian Nuclear Laboratories Ltd. (CNL).

2. Purpose

This document captures the current status of appointments of personnel to Corporate Governance and Corporate Functional Authority roles such as CNL Board of Directors, Executive Team, Functional Authorities and Responsible Executives that are integral to the management system. The management system is defined in the *CNL Management System Manual* [1].

This document also provides an index to governing documents for Functional Support Areas that make up the management system framework.

This document is not used to assign an individual to a role. Such appointments are covered by other processes, as described in *Authority Management* [2] or *Organizational Change Control* [3].

3. Roles and Responsibilities

Responsibilities associated with the roles defined in this document are captured in the *CNL Management System Manual* [1].

3.1 Management System Functional Support Manager

The Management System Functional Support Manager is responsible for:

- Maintaining the controlled list of Functional Authorities; and
- Providing a copy of approved versions of this document to the Canadian Nuclear Safety Commission (CNSC) for information.

4. List

This section identifies individuals appointed to Corporate Governance roles and specific Corporate Functional Authority roles.

4.1 Canadian Nuclear Laboratories Board of Directors

Role	Name	Effective Date
Chair of the Board	Jane Preston	2019 August 17
Member of the Board	Jack Craig	2019 February 02
Member of the Board	Keith Wettlaufer	2015 September 13
Member of the Board	Howard Shearer	2016 August 25

Role	Name	Effective Date
Member of the Board	Terry Michalske	2018 May 31
Member of the Board	Yaprak Baltacioglu	2019 April 01
Member of the Board	Colin Jones	2023 February 14
President and Chief Executive Officer	Joe McBrearty	2020 April 01

4.2 Canadian Nuclear Laboratories Executive Team

Role	Name	Effective Date
President and Chief Executive Officer	Joseph McBrearty	2020 April 01
Chief Operating Officer	Peter Stalker	2022 February 01
Vice-President, Science & Technology	Jeffrey Griffin	2020 March 23
Vice-President, Business Management	Randy Hendrickson	2023 April 10
Vice President, Environmental Remediation Management and Stewardship and Renewal Group	Monica Steedman	2023 January 01
Vice-President, Central Technical Authority and Chief Nuclear Officer	Andy Tisler	2022 July 27
Vice-President, Capital	Brian Savage	2019 June 19
Vice President, Corporate Affairs / Vice-President Business Development	Lou Riccoboni	2020 July 01
Vice-President, Health, Safety, Security, and Environment	Jeff Willman	2020 July 01
Vice-President, Legal & Insurance	Doug McIntyre	2020 July 01
Vice-President, Human Resources	Todd Cook	2021 April 19
Vice-President, Isotope Business	Ram Mullur	2021 April 5

4.3 Canadian Nuclear Laboratories Corporate Functional Authorities

Role	Name	Effective Date
Chief Engineer	John Slade	2016 May 09
Chief Security Officer	Will Graydon	2022 June 20
Chief Regulatory Officer	Sarah Brewer	2022 June 20

Role	Name	Effective Date
Chief Information Officer (Acting)	Tom Vaughan	2022 October 03
Chief of Staff	Kirstie York	2020 June 22
Ombuds Officer	Tricia Gazarek	2021 March 01
Chief Safety & Licensing Officer	David Garrick	2018 August 13
Management Representative for Quality	Doug Cram	2019 April 23

4.4 Canadian Nuclear Laboratories Management System Functional Authorities

Responsible Executive	Functional Support Area	Functional Support Manager	Functional Support Manager Designate(s)	Governing Document Index
President & CEO, Joseph McBrearty and Chief Operating, Officer Peter Stalker	**Management System**	Angela Coulas	Alexandra Dash	900-514100-GDI-001
	Property (Asset) Management	Scott Campbell	Janice Pyke	900-508400-GDI-001
VP Business Management, Randy Hendrickson	**Supply Chain**	Khalil Ibrahim	Chad Charbonneau	900-505210-GDI-001
	Prime Contract	Sheila Brooks		900-513000-GDI-001
	Information Management	Tom Vaughan	Yanick Dubé	900-511300-GDI-001
	Project Management Office	Lisa Phillips	Lisa Rose	900-502000-GDI-001
	Information Technology	Tom Vaughan	Yanick Dubé	900-511200-GDI-001
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	Finance	Imran Sajid		900-512000-GDI-001

Responsible Executive	Functional Support Area	Functional Support Manager	Functional Support Manager Designate(s)	Governing Document Index
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VP Legal, Doug McIntyre	**Legal Services**	Gabrielle Kaufmann	Maureen Wagner	900-513700-GDI-001 900-513700-GDI-003
VP Corporate Affairs, Lou Riccoboni	**Corporate Affairs**	Pat Quinn	Philip Kompass	900-513400-GDI-001
VP Business Development, Lou Riccoboni	**Business Development & Commercial Ventures**	Keith Summers		900-504000-GDI-001
VP Science & Technology, Jeff Griffin	**Conduct of Research**	Richard Dufour	Chelsea Trudeau	900-507400-GDI-001 (In Development)
VP Health, Safety, Security, and Environment, Jeff Willman	**Environmental Protection**	George Dolinar	Carla De Waele	900-509200-GDI-001
	Radiation Protection	Robert Corby	Marc Jones	900-508740-GDI-001
	Occupational Safety & Health	Erin Broughton	Len Schryer	900-510400-GDI-001
	Health Centre	Rosetta McGirl		900-510900-GDI-001
	Emergency Preparedness	Adrian Bilton	Ben Wilson	900-508730-GDI-001
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VP Central Technical Authority & CNO, Andy Tisler	**Conduct of Operations**	Kathy Leroux	Ross Mirault	900-508200-GDI-001
	Fitness for Service	David Meldrum	Sean Cameron	900-508230-GDI-001
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	Configuration Management	John Slade	Madhulika Gogulapati	900-508130-GDI-001
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	Safety Analysis	Dave Garrick	Mahmoud Karam Allan Bakewell	900-508770-GDI-001
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	Nuclear Criticality Safety	Dave Garrick	Kendall Erlandson	900-508550-GDI-001
	Nuclear Materials & Safeguards Management	Angela Coulas	David Koopman	900-508510-GDI-001

5. References

[1] *CNL Management System Manual*, 900-514100-MAN-001, 12489834.

[2] *Authority Management,* 900-514100-MCP-001, 12602208.

[3] *Organizational Change Control,* 900-510000-MCP-009, 50931129.

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

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Annual Program Report	Rapport annuel sur les programmes
Canadian Nuclear Laboratories	**Laboratoires Nucléaires Canadiens**
Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2018	**Rapport de surveillance réglementaire pour les sites des Laboratoires Nucléaires Canadiens: 2018**
Public Meeting	Réunion publique
Scheduled for: November 7, 2019	Prévue pour : Le 7 novembre 2019
Submitted by: CNSC Staff	Soumise par : Le personnel de la CCSN

e-Doc 5753144 (WORD)
e-Doc 5926886 (PDF)

Canada

Summary

This Commission member document (CMD) concerns the Regulatory Oversight Report for sites operated by Canadian Nuclear Laboratories (CNL) for the 2018 calendar year. CNL is the licensee for each of these sites.

No actions are required of the Commission. This CMD is for information only.

Résumé

Ce document à l’intention des commissaires (CMD) porte sur le Rapport de surveillance réglementaire pour les sites exploités par les Laboratoires Nucléaires Canadiens (LNC). LNC est le titulaire de permis pour chacun de ces sites.

Aucune mesure n’est requise de la Commission. Ce CMD est fourni à titre d’information seulement.

Signed/signé le

August 16, 2019

Karine Glenn FOR

Haidy Tadros

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice générale

Direction de la réglementation du cycle et des installations nucléaires

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EXECUTIVE SUMMARY

The *Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2018* is a Commission member document (CMD) which presents the Canadian Nuclear Safety Commission (CNSC) staff's assessment of licensee performance at sites that are licensed to Canadian Nuclear Laboratories (CNL) for the 2018 calendar year. This report also provides an update on CNSC staff's activities related to public information, community engagement and relevant aspects of the CNSC's Independent Environmental Monitoring Program.

CNSC staff use the safety and control area framework to evaluate the performance of each licensee. This report provides performance ratings for all 14 safety and control areas (SCAs); it focuses on radiation protection, environmental protection and conventional health and safety, in particular. Taken together, these SCAs provide a meaningful overview of the safety performance of the facilities addressed in this report. Highlights of the other 11 SCAs are also provided where relevant. The report also includes information on the licensee's public information programs, its engagement with Indigenous groups and communities, reportable events, significant facility modifications and areas of increased regulatory focus, where applicable to the sites. Where possible, trends are shown and information is compared to previous years.

In order to assess the safety performance of licensees, the CNSC conducts regulatory oversight activities consisting of onsite inspections, technical assessments, reviews of reports submitted by licensees, reviews of events and incidents, general communication with licensees and exchanges of information with them. While licensee performance across all SCAs is not explicitly documented in this report, CNSC staff's regulatory oversight activities extend to all SCAs. CNSC staff confirm that in 2018, CNL sites continued to perform licensed activities safely. For this reporting year, CNSC staff rated all SCAs as "satisfactory" with the exception of the security SCA at Whiteshell Laboratories which was rated as "below expectations". This will be elaborated upon during the October 2/3, 2019 Whiteshell relicensing hearings.

Overall, CNSC staff's compliance activities determined that:

- radiation protection programs at all sites adequately controlled radiation exposures, keeping doses as low as reasonably achievable (ALARA)
- environmental protection programs at all sites were effective at protecting people and the environment
- conventional health and safety programs at all sites continued to protect workers

Therefore, CNSC staff conclude that in 2018, the CNL sites covered by this regulatory oversight report made adequate provisions for the health and safety of workers, the protection of the public and the environment, and Canada's international obligations. Documents referenced in this CMD are available to the public upon request.

1 INTRODUCTION

For the purposes of the *Nuclear Safety and Control Act* (NSCA) [1], and its associated Regulations, the Canadian Nuclear Safety Commission (CNSC) regulates Canada's nuclear industry to protect the health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely, and are required to implement programs that make adequate provision for meeting legislative and regulatory requirements.

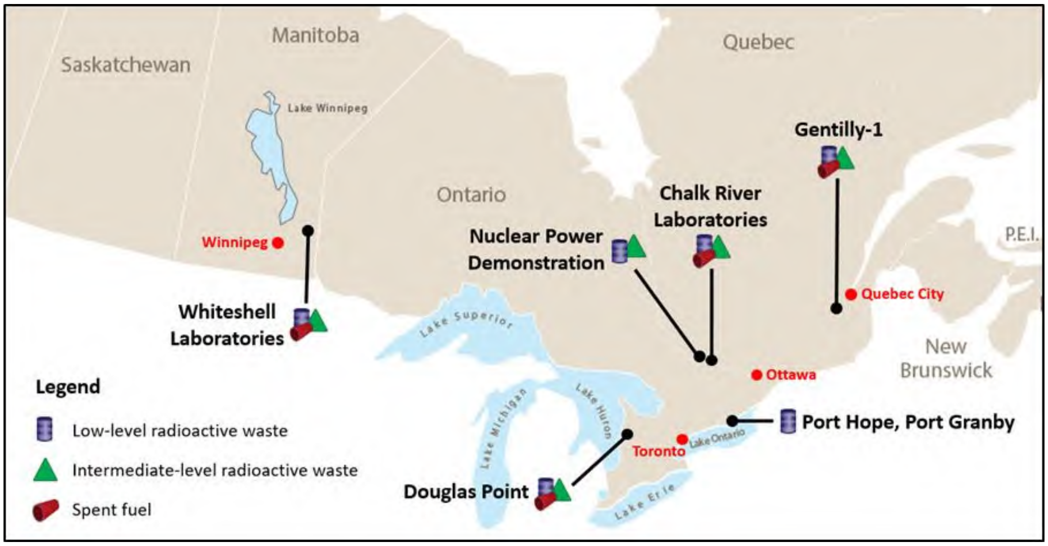
CNSC staff produce regulatory oversight reports (ROR) on various sectors of the Canadian nuclear industry as a means to report to the Commission on CNSC staff oversight activities at those sites and on licensee performance. The Commission has directed CNSC staff to report to the Commission annually on the safety performance of sites operated by Canadian Nuclear Laboratories (CNL) in the form of an ROR. This is the first report to cover all major CNL sites. This ROR includes data for the 2018 calendar year and describes:

- Information on licensee operations, licence changes, major developments at licensed facilities and sites, as well as any significant events;
- The CNSC's regulatory efforts, public information and Indigenous and community engagement activities, and Independent Environmental Monitoring Program (IEMP) results;
- The performance rating for all safety and control areas (SCAs) relevant to each CNL site;
- Performance data on the SCAs of radiation protection, environmental protection, and conventional health and safety for each CNL site; and
- Highlights from other SCAs as applicable.

The sites covered by this report are shown in Figure 1, and the licences are listed in Table 1. These sites were most recently before the Commission in relation to the following Commission member documents (CMD):

- CMD 18-H2 [2], the relicensing of the Chalk River Laboratories site;
- CMD 18-M30 [3], a progress update covering all CNL sites with the exception of CRL;
- CMD 18-H103 [4], the one-year extension of the Whiteshell Laboratories licence;
- CMD 18-H107 [5], the separation of the single licence which previously covered the Douglas Point, Gentilly-1 and Nuclear Power Demonstration sites into three licences, each covering one site; and
- CMD 19-H101 [6], an amendment to the Port Granby Project licence.

Figure 1: Sites covered by this CMD



Within the CNSC, compliance and licensing activities at the sites covered by this report are regulated under the fuel cycle program. The risk classification of these sites within the fuel cycle program is included in Table 1. Each licensed facility or activity under the fuel cycle program is categorized into low, medium and high categories. The appropriate category is determined based on considerations such as the safety of workers and the public (i.e. radiation protection and conventional health and safety), the safety of the environment, and security. For example, a facility's or activity's risk is assessed based on the types of hazards, the consequences of a program failure and the complexity of the operations. This classification is reassessed if licensed activities were to substantially change, or when there are changes to the information and assumptions used for the initial categorization. Each regulatory program within the CNSC establishes the risk considerations most appropriate for the types of facilities and activities being regulated.

Table 1: Licences covered by this CMD

SITE/FACILITY/PROJECT	LICENCE NUMBER	FUEL CYCLE PROGRAM RISK CLASSIFICATION
Chalk River Laboratories (CRL)	NRTEOL-01.00/2028	High
Whiteshell Laboratories (WL)	NRTEDL-W5-8.05/2019	Medium
Port Hope Project (PHP)	WNSL-W1-2310.02/2022	Medium
Port Granby Project (PGP)	WNSL-W1-2311.02/2021	Medium
Douglas Point (DP) Waste Facility	WFDL-W4-332.02/2034	Low
Gentilly-1 (G-1) Waste Facility	WFDL-W4-331.00/2034	Low
Nuclear Power Demonstration (NPD) Waste Facility	WFDL-W4-342.00/2034	Low
Port Hope Pine Street Extension Temporary Storage Site	WNSL-W1-182.0/2021[1]	Low
Port Hope Radioactive Waste Management Facility	WNSL-W1-344-1.8/ind[1]	Low
NRTEOL = Nuclear Research and Test Establishment Operating Licence NRTEDL = Nuclear Research and Test Establishment Decommissioning Licence WNSL = Waste Nuclear Substance Licence WFDL = Waste Facility Decommissioning Licence		

Note that the last four digits of these licence numbers is the year in which they will expire. “ind” stands for “indefinite”. Not covered by this ROR are CNL’s nuclear substance licences, which are included in the annual *Regulatory Oversight Report on the Use of Nuclear Substances*. In 2018, DP, G-1 and NPD were collectively licensed under WFDL-W4-332.01/2034.

A licence issued under the NSCA contains the period for which the licence is valid, licensed activities and a standard set of licence conditions. A licence conditions handbook (LCH) accompanies each licence in Table 1, with the exception of WNSL-W1-182.0/2021 and WNSL-W1-3441.8/ind, which are small temporary storage sites for low level waste. A LCH contains compliance verification criteria used by CNSC staff to ensure compliance with the conditions of the licence. The risk classifications listed in Table 1 are among the factors used by CNSC staff in determining the frequency and scope of regulatory activities at each of these sites. This approach is part of the CNSC’s risk informed considerations for regulating a broad range of facilities and activities.

[1] These licences cover small areas containing low-level waste which will be cleaned up under the PHP. For the remainder of this document, they are included under the PHP unless mentioned separately.

Section 2 of this report includes a brief description of each site and major licensed activities in the period covered by this report.

CNSC staff conduct regular oversight activities to ensure CNL continues to meet the regulatory requirements of these licences, as described in more detail in Sections 3, 4 and 5 of this document. Changes made to licences or LCHs during this review period are described in Section 3.

2 CANADIAN NUCLEAR LABORATORIES

CNL is responsible for the management of nuclear sites owned by Atomic Energy of Canada Limited (AECL). The content in this ROR encompasses the sites listed in Table 1 above, and are described in more detail in the sections below.

CNL took responsibility for operating these sites from AECL in 2014, as part of AECL's transition to a Government-Owned, Contractor-Operated model. In 2015, AECL transferred all shares in CNL to the Canadian National Energy Alliance, a consortium of engineering and technology companies, that manages and operates CNL under a Government-Owned, Contractor-Operated model.

2.1 Chalk River Laboratories

Chalk River Laboratories (CRL) is located in the province of Ontario, 160 kilometers (km) northwest of Ottawa and occupies a total area of 37 km^2 and a built-up area of approximately 0.4 km^2 (Figure 2). The site is immediately adjacent to the Ottawa River. CRL operates under a single licence, which includes 12 Class I nuclear facilities in an operational state, such as the Zero Energy Deuterium (ZED-2) research reactor, processing facilities, fuel manufacturing facilities, and hot cells. The site also includes 13 different waste management areas (five in operation and eight in long-term monitoring), four Class II nuclear facilities that contain prescribed equipment such as accelerators and irradiators, and more than 50 radioisotope laboratories, support facilities and offices[2].

Figure 2: A view of the CRL built-up area

[2] A detailed description of this site is included in CMD 18-H2, which was presented to the Commission on January 23-25, 2018

CNSC staff have classified CRL as ‘high’ risk due to the diversity of activities currently carried out on the site, the storage of large quantities of radioactive waste including spent nuclear fuel and legacy liabilities from past activities. The cessation of molybdenum-99 production in 2016 and the permanent shut down of the National Research Universal (NRU) reactor in 2018 have significantly lowered the risk profile of the site. The level of risk at the site will decrease further as CNL’s decommissioning work and repatriation of highly enriched uranium (HEU) continues. The public and Indigenous groups in the CRL area continue to show a high level of interest in CNL’s current activities at CRL, and in CNL’s future plans for the site.

2.1.1 Major Activities at CRL in 2018

The CRL site is undergoing a period of rapid change. Where permitted by the current licensing basis, CNL is shutting down and decommissioning legacy facilities, and constructing and commissioning replacement facilities throughout the site. CNL has also advanced their program to host a Small Modular Reactor at the CRL site, and has further proposed to construct and operate a Near-Surface Disposal Facility at the CRL site; these topics are discussed in more detail in sections 5.4 and 5.5, respectively.

Permanent Shutdown of the NRU Reactor and the Molybdenum-99 Production Facility

The NRU reactor operated until March 31, 2018, when it was permanently shut down. By the end of May 2018, CNSC staff confirmed the reactor had been defueled and CNL had moved all fuel into wet storage in the NRU rod bays. By the end of September 2018, CNSC staff assessed that all heavy water had been drained from the NRU reactor vessel and temporarily stored safely, pending processing and storing in metal drums. CNL is progressively and permanently draining and/or de-energizing systems which are no longer needed so that the NRU facility can be placed in a state of storage with surveillance.

Figure 3: The NRU Reactor Hall

CNL's Molybdenum-99 Production Facility (MPF) had ceased to operate in October 2016, at which time CNL placed it in a standby state in case the decision was made to produce more molybdenum-99. The MPF depended on the NRU reactor for irradiated targets, and with the shutdown of NRU CNSC staff have confirmed it has since transitioned to a safe shutdown state.

Repatriation of Highly Enriched Uranium (HEU)

Under the joint regulatory oversight of the CNSC and the United States Nuclear Regulatory Commission (USNRC), CNL has been safely returning materials which contain HEU to the United States. Both countries have rigorous regulatory requirements in place based on international standards, and shipments take place when both the CNSC and USNRC give approval. The HEU originates from materials imported to Canada for research and medical isotope production at CRL. It consists of spent HEU fuel rods from the National Research Experimental (NRX) and NRU reactors and HEU dissolved in acid, a by-product of CNL's past production of molybdenum-99. As of the end of 2018, CNSC staff conclude that CNL's repatriation work continues safely. To date, CNL has repatriated upwards of 95% of HEU in spent fuel from the CRL site, and upwards of 75% of liquid HEU. The movement of HEU has led to increased monitoring from the International Atomic Energy Agency (IAEA), which will continue for the duration of the repatriation project.

2.2 Whiteshell Laboratories

Whiteshell Laboratories (WL) is a former nuclear research and test facility located near Pinawa, Manitoba that was established by AECL in the early 1960s. The main campus (Figure 4) hosts the 60 megawatt thermal (MWth) Whiteshell Reactor No. 1 (WR-1), a SLOWPOKE demonstration reactor (SDR), and other research and support facilities. Located approximately 2.7 km north-east of the main campus is a waste management area which contains low-level waste (LLW), intermediate-level waste and high-level radioactive waste.[3]

Figure 4: WL Main Campus *(Source: CNL)*

The WR-1 reactor and SDR were permanently shut down in 1985 and 1990 respectively, and in 1997 AECL discontinued most research programs and operations at WL. Decommissioning commenced in 2003. Currently, CNL is carrying out active decommissioning work at the site with the exception of WR-1, which remains in storage with surveillance.

According to CNL's Detailed Decommissioning Plans (DDPs) for WL, decommissioning will be completed by 2050 with plans for a subsequent 200-year period of institutional control.[4] In 2016, the CNSC received an application by CNL to change the decommissioning approach for WR-1 from full dismantlement to in-situ decommissioning. This new approach is currently under review by CNSC staff, and is described further in Section 5.9.

[3] A detailed description of this site is included in CMD 19-H4 [7], which will be presented to the Commission on October 2/3, 2019.
[4] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

CNSC staff have classified WL as ‘medium’ risk given the presence of used nuclear fuel and other radioactive wastes at the site, CNL’s ongoing decommissioning work, and the legacy of past research operations at the site. The public and Indigenous groups in the WL area continue to show a high level of interest in CNL’s current decommissioning activities at WL, and in CNL’s future plans for the site.

2.2.1 Major Activities at WL in 2018

As authorized by its current licence, in 2018 CNL carried out hazard reduction and characterization activities at the site in preparation for planned demolition of the active liquid waste treatment centre. These activities included the removal of asbestos, application of fixatives on the interior of tanks, and the removal of various equipment. CNL also carried out hazard reduction and characterization activities in preparation for the decommissioning of WR-1, such as the removal of asbestos and the characterization of reactor components.

2.3 Remediation Sites

CNL is the licensee responsible for the implementation of the Port Hope Area Initiative (PHAI), which consists of the Port Hope and Port Granby projects. These projects involve the clean-up of historic low-level radioactive waste contamination found in Port Hope and Port Granby, and its emplacement in new long-term waste management facilities (LTWMFs), one located in each community. The scope of the PHAI is defined by a legal agreement between the municipalities of Port Hope and Clarington and the Government of Canada, originally signed in 2001. The legacy wastes in Port Hope and Port Granby are a federal liability because they ultimately derive from the operations of a former Crown Corporation, Eldorado Nuclear Limited (ENL). ENL became the privately-held Cameco Corporation (Cameco) in 1988 and wastes produced after that time are the responsibility of Cameco.

The Port Hope and Port Granby projects are each divided into three phases, namely:

- Phase 1 – ongoing operation, care and maintenance of existing legacy facilities, and development of design and licensing documentation;
- Phase 2 – implementation, including the construction and operation of new LTWMFs, and the remediation of legacy waste; and
- Phase 3 – long-term monitoring and maintenance of the LTWMFs.

CNSC staff have assessed CNL’s work under the PHAI as ‘medium’ risk. While the radiological and environmental hazards posed by the work are low, the conventional health and safety risks are elevated due to the extensive use of heavy equipment on these sites. CNL’s remediation work carried out under the PHAI is also extremely visible to the public, as it takes place in and around the communities of Port Hope and Port Granby. This has led to an elevated level of interest from Indigenous groups and the public.

2.3.1 The Port Hope Project

The Port Hope Project (PHP) involves the construction of an engineered above-ground containment mound, which will safely isolate legacy LLW in the Municipality of Port Hope. The project involves the excavation of roughly 1,500,000 m^3 of uranium and radium refining waste from a legacy waste management facility (WMF) and waste from various sites in the urban area of the municipality, and its emplacement in a LTWMF (Figure 5). The PHP is currently in the implementation phase (Phase 2) of its three phase project. Phase 2 includes the construction and operation of a waste water treatment plant (WWTP); the construction and operation of the LTWMF, including the excavation and emplacement of LLW in cells prepared to accept this waste; site remediation and restoration; and, the capping of the LTWMF once complete. Excavation and emplacement of wastes is expected to continue to 2023. As part of Phase 2 of the PHP, CNL is performing extensive radiological surveys of residential and commercial properties in Port Hope. To date, CNL has identified over 1,000 properties which will need remediation. Remediation work on these small-scale sites began in December 2018 with three properties and is conducted according to CNL procedures reviewed by CNSC staff.

The final phase of the project (Phase 3) will involve long-term monitoring and maintenance of the LTWMF under continued CNSC regulatory oversight.[5]

Figure 5: An overview of the site prior to Port Hope LTWMF construction, overlaid with LTWMF features *(Source: CNL)*

[5] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

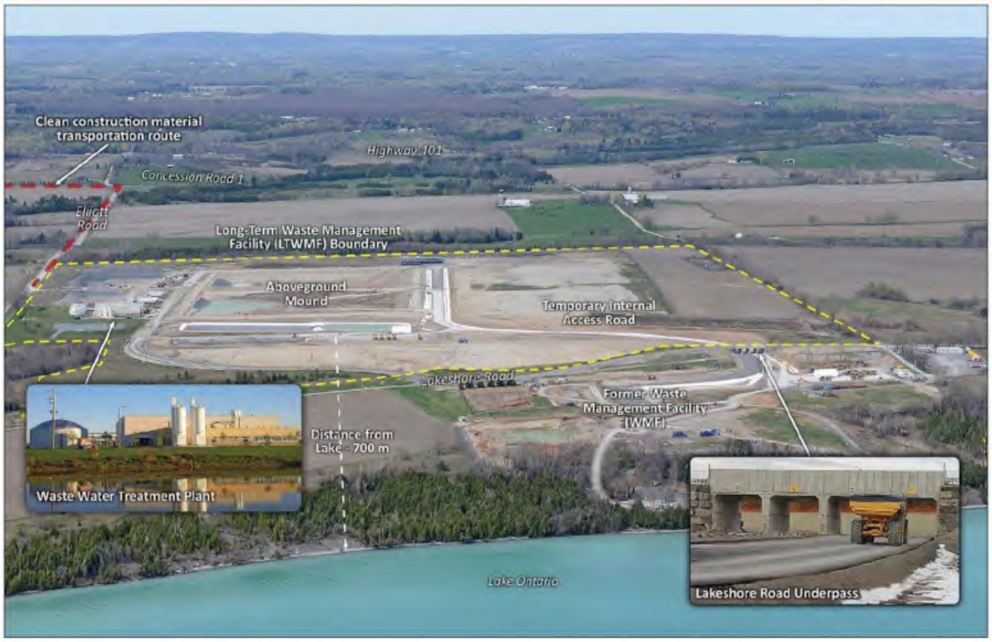
In addition to the main licence for the PHP, CNL holds two other licences for the interim management of legacy LLW in Port Hope, which are associated with and included under the PHP. The Port Hope Pine Street Extension Temporary Storage Site and the Port Hope Radioactive Waste Management Facility will both be remediated under the PHP, with the LLW being transferred to the Port Hope LTWMF.

2.3.2 Port Granby Project

The Port Granby Project (PGP) involves the construction of an engineered above-ground containment mound, which will safely isolate legacy LLW in the Municipality of Clarington. The project involves the excavation of roughly 450,000 m^3 of uranium and radium refining waste from a legacy WMF, and its emplacement in a LTWMF (Figure 6). The PGP is currently in the implementation phase (Phase 2) of a three phase project, which includes the construction and operation of a WWTP; the construction and operation of the LTWMF, including the excavation and emplacement of LLW in cells prepared to accept this waste; the capping of the LTWMF once complete; and site remediation and restoration. The excavation and transfer of LLW has been under way in Port Granby since 2016. The final phase of the project (Phase 3), will involve long-term monitoring and maintenance of the LTWMF under continued CNSC regulatory oversight.[6]

[6] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

Figure 6: Location of the Port Granby WMF and new LTWMF (LTWMF boundary indicated by dashed yellow line) *(Source: CNL)*



2.3.3 Major Activities at Remediation Sites in 2018

CNSC staff confirmed that CNL has continued with construction, operation and remediation work during 2018 at both the PHP and the PGP. This has included:

- At the PHP, the completion of construction of Cell 3 of the LTWMF, and continued construction work on Cell 2; the ongoing emplacement of LLW into Cell 1; the expansion of the collection pond associated with the WWTP, to allow CNL to better manage impacted water generated at the site; ongoing surveys and the commencement of remediation at small-scale sites (e.g. residential properties) and industrial sites (e.g. the Centre Pier) in Port Hope; the commissioning of an IAEA portal monitor to independently measure safeguarded uranium being transferred from Cameco's Port Hope Conversion Facility; and, significant preparations for the remediation of the Port Hope harbour.
- At the Port Hope Pine Street Extension Temporary Storage Site and the Port Hope Radioactive Waste Management Facility, the removal of all LLW from several of the sites covered by these licences.
- At the PGP, the continued excavation and emplacement of LLW; the verification of large areas of the legacy Port Granby WMF as meeting the clean-up criteria in the licence, and the backfilling of some of those areas; the addition of temporary storage for impacted water via the construction of eight 6,000 m^3 tanks; and, continued preparation for the closure and capping of the PGP LTWMF (the end of Phase II), currently scheduled to begin in 2019.

Figure 7: A remediated section of the old Port Granby Waste Management Facility

2.4 Prototype Power Reactors

The Douglas Point (DP), Gentilly-1 (G-1), and Nuclear Power Demonstration (NPD) waste facilities are three shutdown power reactors which are undergoing decommissioning. For these sites CNL is employing a deferred decommissioning strategy. The three phases of deferred decommissioning are:

- Phase 1 – bring the facility to a safe sustainable shut down state suitable for storage with surveillance;
- Phase 2 – the storage with surveillance period; and
- Phase 3 – final decommissioning where the facility achieves its final end state.

The duration of each phase may vary depending on the decommissioning plan for each of the facilities; these plans are reviewed by CNSC staff prior to implementation. Note that these phases are distinct from the three phases of the remediation projects described in Section 2.3 above.

Currently the DP, G-1 and NPD sites are each in a state of storage with surveillance (Phase 2), as authorized by their licences. All are required to implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection.

CNSC staff have classified the Prototype Power Reactor sites as ‘low’ risk, given that these three sites are all in storage with surveillance. Should CNL begin active decommissioning or otherwise make major changes to operations at these sites, the risk classification would be reevaluated by CNSC staff. The public and Indigenous groups in the area of the DP, G-1 and NPD sites continue to show a high level of interest in CNL’s future plans for these sites, especially in regards to CNL’s proposed accelerated decommissioning activities, discussed further in Section 5.9.

2.4.1 Douglas Point Waste Facility

DP, located in Tiverton, Ontario on the Bruce nuclear site (Figure 8) is a partially decommissioned prototype power reactor. The 200-megawatt electric (MWe) prototype Canada deuterium uranium (CANDU) power reactor was put into service in 1968 and permanently shut down in 1984. At DP, CNL is managing low- and intermediate-level radioactive wastes and used nuclear fuel in concrete dry storage canisters. Additionally, CNL is undertaking decommissioning planning activities for Phase 3 to render the site appropriate for industrial use. CNSC staff have assessed CNL's preliminary decommissioning plans (PDPs), and noted that Phase 3 activities are planned to begin in 2060.[7] In July of 2019, CNL submitted to the CNSC an application for a licence amendment which would allow CNL to begin dismantlement work at DP. Such an amendment will require a separate decision by the Commission with the hearing currently expected to be in 2020.

Figure 8: DP Waste Facility *(Source: CNL)*

[7] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

2.4.2 Gentilly-1 Waste Facility

G-1, located in Bécancour, Québec within Hydro-Québec's Gentilly-2 site (Figure 9, outlined in yellow and adjacent to Hydro-Québec's Gentilly-2 reactor), is a partially decommissioned prototype power reactor. The 250 MWe boiling water reactor was put into service in 1972 and shut down in 1984. At G-1, CNL is safely managing low- and intermediate-level radioactive wastes and used nuclear fuel in concrete dry storage canisters. Additionally, CNL is undertaking decommissioning planning activities in support of Phase 3 to render the site appropriate for industrial use. According to current decommissioning plans accepted by CNSC staff, Phase 3 activities are planned to begin in 2064, well outside the term of the current licence.[8] The commencement of dismantlement work at G-1 would first require a separate decision by the Commission.

Figure 9: G-1 Waste Facility, outlined in yellow *(Source: CNL)*

[8] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

2.4.3 Nuclear Power Demonstration Waste Facility

NPD located in Rolphton, Ontario (Figure 10) is a partially decommissioned prototype power reactor. The 20 MWe prototype CANDU power reactor was placed into service in 1962, and operated until 1987. At NPD, CNL is managing low- and intermediate-level radioactive wastes, according to their CNSC assessed and accepted storage with surveillance plan. Additionally, CNL is undertaking decommissioning planning activities in support of Phase 3 to render the licensed site appropriate for industrial use. According to CNL's decommissioning plans, Phase 3 activities are planned to begin in 2030.[9] In 2016 CNL submitted an application to the CNSC to modify the decommissioning approach for NPD from full dismantling to in-situ decommissioning, which could accelerate the decommissioning process. This new approach requires the Commission's approval as outlined in Section 5.9.

Figure 10: NPD Waste Facility *(Source: CNL)*

2.4.4 Major Activities at Prototype Power Reactors in 2018

CNL is currently carrying out a number of hazard reduction and waste characterization activities at DP, G-1 and NPD, in line with decommissioning plans reviewed and accepted by CNSC staff.

[9] A detailed description of this site is included in CMD 18-M30, which was presented to the Commission on August 22, 2018.

Examples of activities carried out by CNL in 2018 include:

- At DP, CNL demolished various ancillary buildings and structures, including the Emergency Cooling Injection System (ECIS) tank and characterized the ECIS bunker; installed a new membrane on the reactor building roof to repair damage caused by seagulls; removed all Moderator Purification System resins and shipped them for processing in the United States; and transferred all low-activity liquid waste (135,000 litres) to CRL’s Waste Treatment Centre.
- At G-1, CNL removed and processed various low-level wastes from the reactor building; removed all Heat Transport Purification System and Moderator Purification System resins, which were shipped to CRL for storage; and, shipped Moderator Purification System cover water (20,000 litres) to CRL’s Waste Treatment Centre.
- At NPD, CNL conducted geological, structural, and radiological characterization activities in support of their proposed in-situ decommissioning plan; and, ceased routine batch releases of effluent to the Ottawa River. CNL now ships all contaminated water from the NPD sumps to CRL for treatment.

3 THE CNSC'S REGULATORY OVERSIGHT OF CNL

This section of the 2018 CNL ROR contains information on the licensees' compliance with the requirements of the NSCA and associated Regulations made under the NSCA, each site's licence and LCH, and any other applicable standards and regulatory documents.

The information provided in this ROR covers the 2018 calendar year and, where applicable, includes trends and comparisons to previous years. CNSC staff use the SCA framework to assess, evaluate, review, verify and report on licensee performance. The SCA framework includes 14 SCAs, which are subdivided into specific areas that define its key components. Appendix B provides definitions of these SCAs and their specific areas, Appendix C provides information on the CNSC's ratings methodology, and Appendix D contains detailed SCA ratings for each site.

This ROR report largely focuses on three SCAs, namely radiation protection, environmental protection, and conventional health and safety, as they provide a good overview of safety performance at CNL sites. The varied nature of CNL's activities across their different licenses means that not all SCAs apply equally to all sites or activities. Although not explicitly documented in this report, all relevant SCAs are assessed during compliance inspections and reviews of CNL's documents, and a rating is generated for each SCA each year. CNSC staff use RORs to inform the Commission of major findings or topics of interest in all SCAs, as shown in Section 5. The report also includes information on CNL's public information programs, engagement with Indigenous groups and communities, 2018 reportable events, any significant facility modifications, and areas of increased regulatory focus.

In addition, the report includes a list of references, the definitions of acronyms, a glossary and other appendices. Appendix A is a list of CNSC inspections carried out at CNL sites in 2018, Appendices E and F contain information on dose to workers and the public respectively, Appendix G contains health and safety information, Appendix H provides the total annual releases of radionuclides for each CNL site during 2018, and Appendix I lists select relevant websites.

3.1 Regulatory Activities

The CNSC ensures licensee compliance through verification, enforcement and reporting activities. CNSC staff develop compliance plans for each site commensurate with the risk associated with the site. CNSC staff implement the compliance plans by conducting regulatory activities including on-site inspections, desktop reviews and technical assessments of licensee programs, processes and reports. These activities can result in licensees being found in non-compliance with CNSC requirements, at which point CNSC staff will place corrective enforcement actions on the licensee and track those actions to completion.

During the reporting period, CNSC staff spent over 42,000 hours working on compliance and licensing at CNL sites. This included effort from CNSC staff in 36 different divisions spread over nine directorates.

Compliance Activities

In 2018, CNSC staff spent 2,700 hours in the field conducting 28 inspections, and nearly 22,000 hours in the office conducting desktop reviews, technical assessments of licensee documents, and preparing for inspections.

A summary of CNSC staff's inspection activities is shown in Table 2, and a more detailed table of inspections is available in Appendix A. All inspections include verification activities related to the conventional health and safety and radiation protection SCAs. The enforcement actions which resulted from these inspections were provided to CNL via detailed inspection reports and recorded in the CNSC regulatory information bank to ensure they are tracked to completion. CNSC staff verify on an ongoing basis that the licensee has complied with the conditions of enforcement actions and that all actions are closed in the specified timeframes. CNSC staff's assessment of the risk significance of the enforcement actions issued in each inspection are included in Appendix A.

Table 2: Compliance Inspections at CNL Sites during 2018

Site, Facility or Project	Inspections in 2018	Enforcement Actions Issued
Chalk River Laboratories	12	12
Whiteshell Laboratories	2	1
Port Hope Project	5	14
Port Granby Project	6	22
Douglas Point Waste Facility	1	2
Gentilly-1 Waste Facility	1	None
Nuclear Power Demonstration Waste Facility	1	None

The number of inspections carried out at a given site in a year varies with CNSC staff's assessment of the risk of that site and the activities the licensee is carrying out at the site. It is also informed by incidents or situations that may warrant a reactive (unplanned) inspection. For context, compare the number of inspections in 2018 to Table 3 below, which shows the baseline number of inspections CNSC staff expect to carry out over a 10-year period at CNL sites, based on a site's risk categorization. This baseline is augmented as needed to take into account facility- or site-specific information. Annually, the plan is reviewed and the number of inspections increased or the focus areas changed, as justified by changes in licensee activities, or in order to ensure licensee compliance.

Table 3: 10-year Baseline Inspection Plan for CNL sites

Site risk categorization	High	Medium	Low
Minimum number of inspections over a 10-year period	32	15	3

Licensing Activities

In 2018, CNSC staff spent about 17,500 hours on licensing activities, which includes the drafting of new licences, the preparation of Commission Member Documents, the drafting and/or revision of LCHs, and discussions with CNL on all of the above. A summary of changes to CNL's licences and LCHs over the period covered by this ROR is shown in Table 4 below.

Table 4: Changes to CNL Licences and LCHs in 2018

Site, Facility or Project	Licence Changes in 2018	LCH Changes in 2018
Chalk River Laboratories	Issuance of new 10-year licence in March 2018, following public hearings in January 2018.	A new LCH was issued in May 2018, associated with the new licence.
Whiteshell Laboratories	Issuance of 1-year extension to the previous licence in August 2018, valid for the 2019 calendar year and with no change to any authorizations.	No change to the LCH in 2018.
Port Hope Project	No change to the licence in 2018.	No change to the LCH in 2018.
Port Granby Project	No change to the licence in 2018. In 2018, CNL requested a licence amendment to incorporate Release Limits for the new Waste Water Treatment Plant, as described in CMD 19-H101. The Commission granted approval for the revised licence in April 2019.	No change to the LCH in 2018. A new LCH was issued in April 2019, associated with the new licence.
Douglas Point, Gentilly-1 and Nuclear Power Demonstration waste facilities	No change to the licence in 2018. In 2018, CNL requested a separation of the single licence covering these three sites into individual licences for each site, as described in CMD 18-H107. The Commission granted approval for separation of the licence in February, 2019.	No change to the LCH in 2018. Three new LCHs have been issued in 2019, associated with the licence separation.

IAEA Safeguards Activities

Under the terms of the Canada-IAEA safeguards agreements, the IAEA has the right to perform independent verification activities at various types of sites in Canada. The Port Granby Project is the only site covered by this ROR which is not under IAEA safeguards. CNL must submit various types of information to the CNSC and IAEA in order to support the IAEA's verification activities, in addition to providing access to the site to the IAEA. In 2018, CNL provided information and access as required.

In 2018, the IAEA carried out activities at CNL sites as shown in Table 5 below to verify nuclear material inventories and assure the absence of undeclared nuclear material and activities. IAEA activities are not CNSC compliance inspections, but CNSC staff accompany the IAEA in roughly 75% of their activities. They may therefore result in CNSC staff issuing recommendations or enforcement actions to the licensee. In 2018, no enforcement actions resulted from CNSC staff's participation in IAEA activities. Sites which did not host an IAEA activity in 2018 are omitted from the table.

Table 5: Activities carried out by the IAEA at CNL sites during 2018

Site, Facility or Project	Activity					
	PIV	DIV	SNRI	IIV	UI	CA
Chalk River Laboratories	16	23	9	0	2	1
Whiteshell Laboratories	0	1	0	0	0	0
Port Hope Project	0	1	0	2	0	0
Gentilly-1 Waste Facility	1	1	0	0	0	0
PIV = Physical Inventory Verification DIV = Design Information Verification SNRI = Short Notice Random Inspection	IIV = Interim Inventory Verification UI = Unannounced Inspection CA = Complementary Access					

3.2 Chalk River Laboratories

For 2018, CNSC staff rated all 14 SCAs for CRL as "satisfactory". CNSC staff performed 12 inspections at the CRL site in 2018, and issued 12 enforcement actions, 10 of which remain open at the time of this report. The majority of the open actions are related to an inspection which was conducted in December 2018 and which focused on training at the CRL site. The open actions do not pose any immediate threat to safety, security or the environment, but require CNL to make programmatic changes to address the findings. In order to ensure that these findings are adequately addressed, CNSC staff will be performing further follow-up work on training at CNL in 2019.

During a desk-top review of CRL's safeguards reports in 2018, CNSC staff determined that previously identified issues with timely reporting persisted. In response, CNL submitted and began implementing an action plan in December 2018. During 2019 CNSC staff have continued to monitor the accuracy of the CRL's safeguards reports.

Due to the complexity of the CRL site and the risk level it poses, CNSC staff have a permanent site office at the CRL site which is staffed by CNSC inspectors. These inspectors are allowed unrestricted access to the CRL site, and carry out both scheduled inspections and frequent walk-downs of CRL facilities and activities. This allows them to maintain a more organic level of knowledge of the activities at the site, and to perform compliance verification activities in response to any situations of concern.

3.3 Whiteshell Laboratories

For 2018, CNSC staff rated 13 of 14 SCAs for WL as "satisfactory", the exception being the SCA of Security, discussed further below. CNSC staff performed two inspections at the WL site in 2018, and issued one enforcement action, which has since been closed.

During the period covered by this report, CNSC staff raised concerns regarding ongoing issues with CNL's security program at Whiteshell Laboratories. These concerns led to the CNSC issuing an inspector's Order to CNL, to implement changes to CNL's security posture at the site. CNSC staff have evaluated CNL's 2018 performance at the WL site in the SCA of Security as 'below expectations'. CNL has provided an action plan to CNSC staff, and has made significant progress in addressing the conditions of the Order. In June 2019, CNSC staff and CNL provided an update to the Commission on the progress against the Order in a closed session.

CNSC staff expect CNL's performance in this SCA to improve in 2019. CNSC staff have nonetheless increased regulatory oversight of this SCA at Whiteshell in 2019 as a part of its graduated enforcement strategy.

3.4 The Port Hope Area Initiative

For 2018, CNSC staff rated all 14 SCAs for each of the PHP and PGP sites as "satisfactory". CNSC staff performed 11 inspections at PHAI sites in 2018, and issued 37 enforcement actions, four of which remained open at the time of this report. These open actions relate to CNSC staff's requests for further documentation regarding the installation of the baseliner system in Cell 3 of the Port Hope LTWMF, and so do not pose a threat to safety, security or the environment. These actions are being tracked to completion by CNSC staff.

Due to CNSC staff's verification of specific milestones in CNL's construction and remediation work, such as the installation of baseliner systems at the LTWMF, a relatively high number of inspections were carried out by CNSC staff at PHAI sites in 2018. Similarly, CNSC staff also carried out inspections of CNL's remediation verification at the PGP, that is, CNL's work to ensure that a given area is now clean. Such verifications must be carried out prior to CNL backfilling the remediated area.

Figure 11 - CNSC inspector observes CNL's radiation survey of a residential property in Port Hope

CNSC staff's targeting of these milestones has led to a higher number of inspections than otherwise would be the case, given the risk profile of PHAI sites. The relatively high number of enforcement actions at the PHAI in 2018 is due to the higher number of inspections and the non-routine nature of PHAI operations relative to other CNL sites, which have been in steady operation for decades. Enforcement actions at PHAI sites in 2018 were of low safety significance.

3.5 DP, G-1 and NPD Waste Facilities

For 2018, CNSC staff rated all 14 SCAs for each of the DP, G-1 and NPD sites as "satisfactory". CNSC staff performed one inspection at each of the DP, G-1 and NPD sites in 2018, and issued two enforcement actions (both at DP), which have since been closed. These enforcement actions were of low safety significance such as ensuring that the site-specific emergency phone number is listed on radiation zoning signs. Given that these facilities remained in a state of storage with surveillance in 2018, they continued to be categorized as low risk by CNSC staff and received limited inspection effort.

3.6 Focused Inspections at CNL sites in 2018

The CNSC uses an external complaint process as a method to learn of and address unreported non-compliances associated with its regulatory mandate. In some cases, CNSC staff carry out reactive focused inspections in order to address specific concerns raised through this process. In 2018, CNSC staff carried out two such inspections, one at CRL and one at the PHAI sites. These were carried out in response to information received by CNSC staff which alleged deficiencies in safety culture at those sites, specifically related to the raising issues by CNL staff. As part of these inspections, CNSC staff reviewed CNL documents and records, and interviewed current and former CNL staff.

Neither inspection found evidence that CNL discourages staff from raising safety-related issues, although the team identified some reluctance amongst those workers interviewed on CNL sites with regards to raising other issues in general. CNSC staff have requested that CNL carry out a safety culture self-assessment by the end of December 2019, and communicate the results of that self-assessment to CNSC staff by the end of March, 2020.

4 THE CNSC'S ASSESSMENT OF SAFETY AT CNL SITES

The CNSC regulates all aspects of safety at nuclear sites in Canada, including risks to workers, the public and the environment, among others. Information related to the SCAs of radiation protection, environmental protection and conventional health and safety are presented in this section, as these three SCAs are representative of CNL's overall safety performance. In particular, the SCAs of radiation protection and conventional health and safety are a good measure of the safety of workers at CNL sites, while the SCA of environmental protection is a good measure of the safety of the public and the environment.

For both the radiation protection and environmental protection SCAs, the concept of Action Levels (ALs) are used. ALs are a specific dose of radiation or other parameter that, if reached, may indicate a loss of control of part of a licensee's radiation protection program or environmental protection program. If an AL is exceeded, CNL must establish the cause and, if applicable, take steps to restore the effectiveness of relevant programs. Action level exceedances are reportable to the CNSC under the Radiation Protection Regulations and the timing to report any exceedances is provided in the REGDOC-3.1.2 Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills [8].

4.1 The Environment and the Public

Protection of the environment and the public are linked in the SCA of environmental protection, which covers programs that identify, control and monitor all releases of radioactive and hazardous substances and the effects on the environment from facilities or as a result of licensed activities.

CNSC staff concluded that the environmental protection SCA at CNL sites covered by this ROR met applicable regulatory requirements and was thus "satisfactory" in 2018, unchanged from the previous year.

Table 6: Environmental Protection Ratings for CNL Sites in 2018

Safety and control area	CRL	WL	PHP[10]	PGP	DP	G-1	NPD
Environmental protection	SA	SA	SA	SA	SA	SA	SA

CNSC staff have arrived at this conclusion on the basis of independent assessment of CNL's effluent and emissions monitoring data and environmental monitoring data, ongoing evaluation of CNL's Environmental Management System (EMS, a part of CNL's overall Management System), and also on the basis of activities carried out during inspections at CNL sites in 2018.

[10] Note that WNSL-W1-182.0/2021 and WNSL-W1-344-1.8/ind are included under the PHP in this table

Effluent and Emissions Control at CNL sites

At all CNL sites, airborne and waterborne releases of radioactive and hazardous substances remained below regulatory limits in 2018. As required by the Class I Nuclear Facilities Regulations [9], at CRL, WL, DP, G-1 and NPD, CNL implements effluent and environmental monitoring programs. Although they are not Class I facilities, similar programs are also in place for PHAI sites.

Of note in 2018:

- Releases to the environment from the CRL site have decreased due to the permanent shutdown of the NRU reactor, in addition to the decrease in 2016 from the shutdown of the Molybdenum-99 Production Facility. Releases to the environment from the CRL site are tabulated in Tables H-1 and H-2 of Appendix H.
- Notwithstanding the overall decrease in emissions, CRL exceeded Action Levels for environmental protection three times for releases of radioactive substances to the air. These three exceedances were all associated with work being carried out in the NRU facility. Two of these exceedances were in adjacent weeks and were related to a planned defect-fuel experiment being carried out by CNL, while the third was related to work on the heavy water purification system, after NRU had been permanently shut down. CNSC staff have assessed that there was no impact on workers, the public or the environment as a result of these exceedances.
- Following a recommendation from CNSC staff, CNL ceased direct releases of liquid effluent (both radiological and hazardous) to the environment from the Wells Area Sump in NPD, and began collecting that effluent and shipping it to CRL for treatment prior to release. These former releases of liquid effluent did not exceed any action levels or regulatory limits, but were not a best practice for waste management.

CNL's Environmental Management System

The CNSC requires that licensees develop and maintain EMSs in order to provide a documented framework for integrated activities related to environmental protection. CNL has established a corporate EMS, a part of the overall CNL Management System, which applies to all CNL sites in Canada. CNL's EMSs for CRL and WL conform to, and are registered to, the International Standards Organization 14001:2015 Standard, Environmental Management Systems – Requirements with Guidance for Use [10]. EMSs include activities such as establishing annual environmental objectives, goals and targets. CNSC staff confirmed that CNL meets objectives, goals and targets through regular compliance verification activities.

Assessment and monitoring

CNSC staff confirmed that CNL, in accordance with its environmental protection and monitoring programs, successfully carried out required effluent and environmental monitoring, site inspections, environmental awareness training and program implementation for the sites covered by this ROR. Through compliance activities conducted during 2018, CNSC staff concluded that environmental monitoring conducted at CNL sites and the discharge of treated effluent from CNL sites both met regulatory requirements.

Of note in 2018:

- CNL continued to sample and analyze groundwater for radiological and hazardous contaminants at the PHAI, CRL, and WL. Results in 2018 were consistent with historical data, and in some cases concentrations of contaminants have decreased.
- In 2017 the Commission amended the licence for the PHP with regards to in-situ management of arsenic in groundwater under Cell 1. CNL established a trigger level of 50µg/l in groundwater down-slope from Cell 1, and no results in 2018 were above this level.

Protection of the Public

CNL is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from their licensed operations. The effluent and environmental monitoring programs currently conducted by the licensee are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

CNSC receives reports of discharges to the environment through the reporting requirements outlined in CNL's licences and LCHs. The review of hazardous (non-radiological) discharges to the environment from CNL's sites indicates that the public and environment are protected.

Based on CNSC staff reviews of the programs at CNL sites, CNSC staff concluded that the public continues to be protected from CNL operational emissions.

Environmental Risk Assessment

CNSC staff develop monitoring requirements and compliance plans for each site, commensurate with the risk associated with the licensed activities. The Environmental Risk Assessment (ERA) is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment to human and non-human (biological) receptors. Currently, all CNL sites covered by this ROR have acceptable environmental protection programs in place to ensure the protection of the public and the environment.

Of note in 2018:

- CNSC staff evaluated the results of CNL's 2018 groundwater monitoring at the PHP and CRL, and concluded that results remain consistent with historic data and in some cases are showing improving results over time.
- CNSC staff continue to monitor CNL's sampling of groundwater seeping through the bluffs overlooking Lake Ontario at the PGP, which contain elevated levels of fluoride, arsenic, uranium and nitrates. The water quality in these seeps is expected to improve over time as CNL continues to excavate and remove the legacy wastes which is the source of these contaminants.
- CNSC staff received an updated ERA covering the entire CRL site, as an update to the previous 2012 ERA. Among other topics, the 2018 ERA covers buildings/facilities/infrastructure constructed or in the process of construction since 2012, as well as buildings demolished, decommissioned or in the process of decommissioning since 2013. CNSC staff are reviewing this document and will provide comments to CNL in 2019.
- CNSC staff reviewed CNL's Environmental and Biophysical Monitoring Plan for both the Port Hope and Port Granby projects. Monitoring data for all environmental media are within or below the predictions made in the previous Environmental Assessments for those projects, demonstrating that the risks from emissions from PHAI sites are very low.

4.1.1 Independent Environmental Monitoring Program (IEMP) Results

In addition to licensees carrying out required monitoring of their operations, the CNSC carries out its Independent Environmental Monitoring Program (IEMP) to verify and confirm that the public and the environment around licensed nuclear facilities remain safe. The IEMP is a regulatory tool that complements the CNSC's ongoing compliance verification program. The IEMP involves CNSC staff taking samples from publicly accessible areas around nuclear sites, and measuring and analyzing the level of relevant contaminants in those samples.

Samples may be taken for air, water, soil, sediment, vegetation, and some food, such as locally-grown produce. Samples are analyzed at the CNSC's laboratory for both radiological and non-radiological contaminants related to the activities of the nuclear site. CNSC staff compare contaminant levels in samples to applicable guidelines and/or natural background levels. All IEMP sample results and associated standards are posted on the CNSC's IEMP website, which is linked in Appendix I.

Figure 12: CNSC staff collect water samples on the St. Lawrence River near G-1 and G-2 in September 2018

In 2018, CNSC staff conducted independent environmental monitoring around the sites covered by this CMD as shown in Table 7. IEMP results for the areas surrounding these sites indicate that the public and the environment in the vicinity of these sites are protected.

Table 7: IEMP Activities Around Sites Covered by this Report in 2018

Site	Date(s)
Nuclear Power Demonstration	August and October 2018
Gentilly-2 Nuclear Facility (including the Gentilly-1 Waste Facility)	September 2018

It is a priority for the CNSC that IEMP sampling reflects Indigenous traditional land use, values and knowledge where possible. As part of the CNSC's ongoing relationship building with Indigenous communities, CNSC staff collaborated with the Algonquins of Ontario (AOO) in the development of the sampling plan for the NPD Waste Facility. CNSC staff included many of AOO requested locations in the sampling plan conducted in August. Additionally, in October, CNSC staff collected a variety of samples with the aid of AOO Knowledge Holders. This included traditional and medicinal plants. The results were provided to the AOO in May 2019.

CNSC staff plan to carry out IEMP sampling campaigns in the vicinity of the CRL, DP, and PHAI sites in 2019.

4.2 Protection of Workers at CNL Sites

The mandate of the CNSC includes consideration of the safety of all workers at licensed sites, including licensee staff, contractors, and sub-contractors, etc. The SCAs of radiation protection and conventional health and safety are considered to be the most direct measure of the licensee's performance in these areas.

Table 8: Radiation Protection and Conventional Health and Safety Ratings for CNL Sites in 2018

Safety and control area	CRL	WL	PHP[11]	PGP	DP	G-1	NPD
Radiation protection	SA	SA	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA	SA	SA

4.2.1 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations* [11]. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA). CNL sites are required to implement and maintain a radiation protection program; this program meets the requirements of the *Radiation Protection Regulations*.

For 2018, CNSC staff rated the radiation protection SCA at all CNL licensed sites as "satisfactory" based on regulatory oversight activities. CNSC staff have come to these conclusions on the basis of inspections performed at CNL sites, along with desktop reviews.

Application of ALARA

In 2018, CNL continued to implement the ALARA program, and the subsidiary site-specific radiation protection plans for the sites covered by this ROR. These site-specific plans contain commitments to apply ALARA measures for all CNL activities.

CNL's application of ALARA within their radiation protection program includes management commitment and oversight, personnel qualification and training, design analyses of facilities and systems, provision of protective equipment and ALARA assessments/reviews of radiological activities.

[11] Note that WNSL-W1-182.0/2021 and WNSL-W1-344-1.8/ind are included under the PHP in this table

The CRL site is the most complex of CNL's sites, with diverse work activities that represent radiological risks to workers. At CRL in 2018, CNL developed 39 radiological work assessments and four radiological work plans/procedures to ensure that work activities at the CRL site were consistent with the ALARA principle. These documents incorporate radiological control hold points and radiological control measures.

Worker dose control

At CNL, workers, including employees and contractors, conducting work activities which present a reasonable probability of receiving an occupational dose greater than 1 millisievert (mSv)/year are considered as Nuclear Energy Workers (NEWs). Workers, whose job function do not present a reasonable probability of receiving an occupational dose greater than 1 mSv/year, are considered non-NEWs. Radiation exposures to NEWs and to non-NEWs are monitored by CNL to ensure compliance with the CNSC's regulatory dose limits and to maintain radiation doses ALARA.

CNL uses CNSC licensed dosimetry for measuring and controlling external doses. Internal exposure is assessed through a routine bioassay program dependent on worker tasks or duties.

In 2018, no worker at a CNL site (whether a NEW or a non-NEW) received a radiation exposure in excess of the CNSC regulatory effective dose limits. More detailed data on doses to NEWs and non-NEWs at CNL sites is available in Appendix E.

Radiation protection program performance

Radiation protection program performance at CNL sites was assessed in 2018 through CNSC staff compliance activities, including inspections and desktop reviews. CNL's compliance with the *Radiation Protection Regulations* and CNSC licence requirements was satisfactory.

Action levels for radiological exposures are established for each of the CNL sites as part of CNL's radiation protection program. In March of 2018, a radiation protection action level exceedance occurred at the PGP. A NEW received a committed effective dose from exposure to radon of 0.70 mSv and a whole body effective dose of 0.46 mSv, for a total of 1.16 mSv effective dose over a 4 week period, exceeding CNL's action level of 1 mSv over a 4 week period. The worker was present in waste excavation areas, where levels of radon gas above natural background are likely. Through an investigation, CNL concluded that this action level exceedance did not represent a loss of control of their radiation protection plan, due to the nature of the work activities being performed by the worker. CNSC staff are satisfied with CNL's reporting and investigation of the action level exceedance. CNL's radiation protection action levels at the PHAI had been in force since before the excavation of waste began at PHAI sites. In February 2019, CNL revised the PHAI radiation protection plan action levels to 3 mSv over a 4 week period, which better aligns with current work activities at the PHAI sites and the likelihood of exposure to radon at levels above natural background.

There were no other radiation protection action level exceedances in 2018 at the other sites covered by this ROR.

Radiological hazard control

Radiation and contamination monitoring programs continued to be implemented at CNL's sites in 2018, to control and minimize radiological hazards and the spread of radioactive contamination. These programs include the use of radiological safety zones to maintain effective management of radiological hazards, along with control measures and monitoring for surface contamination, personnel contamination, radiation dose rates, and airborne radioactivity.

CNL performed routine contamination monitoring of the workplace to identify surface contamination in order to prevent inadvertent transfer of contamination. Dose rate measurements and, where appropriate, in-plant air monitoring were routinely performed in the workplace to confirm that radiation exposures are kept ALARA. The radiological hazard surveys conducted in 2018 by CNL's staff did not identify any adverse trends, and were consistent with expected radiological conditions.

Estimated dose to the public

As part of their annual reporting to the CNSC, CNL provides data on dose to a hypothetical member of the public, who is representative of someone who spends considerable time in proximity to the licensed site. In all cases, CNL's data indicates that doses to the public resulting from CNL's operations are orders of magnitude less than the 1 mSv limit prescribed in the *Radiation Protection Regulations*. This dose data is available in Appendix F.

4.2.2 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and protect workers. CNL licenced sites must develop, implement and maintain effective safety programs to promote safe and healthy workplaces and minimize incidences of occupational injuries and illnesses.

For 2018, CNSC staff rated the conventional health and safety SCA at all CNL licenced sites as "satisfactory" based on regulatory oversight activities. These included inspections, desktop reviews of CNL documentation, and an ongoing review of items raised via CNL's 'improvement action' or ImpAct tool. CNL uses the ImpAct tool to record all incidents at all CNL sites, from relatively minor occurrences such as wildlife on site roads, to events which are reportable to the CNSC. All of CNL's ImpAct data is available to CNSC staff, whether that data relates to events which must be reported to the CNSC or to events of lower significance. Overall, the compliance verification activities conducted by CNSC staff at CNL sites confirmed that CNL continues to view conventional health and safety as an important consideration.

Practices

In addition to the NSCA and its associated regulations, CNL's activities must comply with Part II: Occupational Health and Safety of the Canada Labour Code [12], its Canada Occupational Health and Safety Regulations [13], and other applicable federal and provincial health and safety acts and regulations.

CNL's Occupational Safety and Health program applies to all work performed by CNL employees, and CNL is accountable for ensuring the health and safety of contractors at work places controlled by CNL. When evaluating safety practices at a site, CNSC staff do not distinguish between the licensee's own staff and staff employed by contractors or sub-contractors, considering all to be 'workers' and equally subject to CNSC requirements and to the licensee's policies and procedures for the site. This is relevant for CNL as at many CNL sites there are numerous contractors performing a wide variety of different tasks.

During 2018, CNSC staff verified CNL safety practices during compliance inspections and site walk-downs, all of which incorporated the verification of aspects related to conventional health and safety, as well as during desktop reviews and technical assessments.

Performance

The key performance indicators for conventional health and safety are the number of recordable lost-time injuries (RLTI) that occur per year, RLTI severity and RLTI frequency. An RLTI is defined as a workplace injury that results in the worker being unable to return to work for a period of time. RLTI severity and frequency provide context to the number of RLTIs. RLTI severity quantifies the number of lost work days experienced per 100 employees, while RLTI frequency quantifies the number of lost-time injuries relative to the number of hours worked.

Data on RLTI, RLTI frequency and RLTI severity since 2014 are included in Appendix G for all sites covered by this ROR.

There were no RLTIs at PHAI sites, DP, NPD, and G-1 in 2018. Both CRL and WL had RLTIs in 2018, but these sites also had relatively more hours worked than the sites that had no RLTIs.

For comparison, CNL's reported RLTI frequency is lower than lost time injury rates at most comparable industries in Ontario (for instance, construction and manufacturing) in 2018, as per the Ontario Workplace Safety and Insurance Board (WSIB) data [14] included in Appendix G. CNSC staff consider this to be a conservative comparison because Ontario LTI data includes only injuries for which compensation claims were allowed, rather than all reportable injuries as is included in CNL's data. Ontario numbers are also lower than those for Manitoba, the location of the only CNL site which is both outside of Ontario and reported an LTI in 2018. On the basis of compliance activities carried out in 2018 and a review of CNL's data, CNSC staff are satisfied with CNL's conventional health and safety performance at the sites covered by this ROR.

5 EVENTS AND OTHER MATTERS OF REGULATORY INTEREST

5.1 Reportable Events

Detailed requirements for reporting unplanned situations or events at CNL licensed sites to the CNSC are included in the applicable LCH. CNSC Regulatory Document 3.1.2 *Reporting Requirements for Non-Power Reactor Class I Facilities and Uranium Mines and Mills* came into force for applicable CNL licensees in January 2019. Over the period covered by this report, CNL has complied with the requirements for submission of these reports.

A summary of events reported to the CNSC by CNL in 2018 are presented in Table 9.

Table 9: Number Reportable Events by Site from January 1, 2018 to December 31, 2018

Site	Number of Events
Chalk River Laboratories	35
Douglas Point Waste Facility	0
Gentilly-1 Waste Facility	0
Nuclear Power Demonstration Waste Facility	2
Whiteshell Laboratories	0
Port Hope	5
Port Granby	5

For each event, CNL completed an investigation and established corrective actions, where appropriate. For simpler events, CNL reported on both the event and the corrective actions in one report, while for more complicated events, multiple reports (e.g. initial verbal report, preliminary written and full written reports) may be submitted. In all cases, CNSC staff reviewed this information, came to a consensus determination of qualitative safety significance, and further steps (follow-up questions, incorporation of follow-up activities into subsequent compliance activities, etc.) were taken as appropriate. For reportable events which occurred in 2018, CNSC staff are satisfied with CNL's corrective actions.

Many of these events were of low safety significance, such as the failure to calibrate radiation detectors in unoccupied buildings at the prescribed frequency, and had no impact on the health and safety of workers or the public, the environment, or security.

Eight events at CRL were directly related to the operation of the now shut-down NRU reactor. There were three instances of releases of radioisotopes to the environment which exceeded action levels, therefore necessitating reporting to the CNSC and an internal investigation by CNL. These releases did not exceed regulatory limits. Events related to NRU operation will no longer occur now that it is permanently shut down, although work continues in the NRU building in order to transition that facility into a state of storage with surveillance.

Events which CNSC staff assess as meeting specific risk criteria are the subject of "Event Initial Reports" from CNSC staff to the Commission. In 2018, there were no Event Initial Reports related to events at CNL sites. There have been two Event Initial Reports thus far in 2019, which for completeness are shown in Table 10 below and are available on the CNSC's website. CNSC staff continue to follow up on both events; they will be covered in more detail in the 2019 ROR for CNL sites.

Table 10: Event Initial Reports at CNL Licensed Sites from January 1, 2018 to Present

CMD Number	Event
19-M9	Worker injured on January 9, 2019 at CNL Port Granby Project
19-M10	Power Outage at Chalk River Laboratories

5.2 Public Engagement

The area of public engagement has two aspects, those of activities carried out directly by CNSC staff, and of activities carried out by CNL.

5.2.1 CNSC staff

The NSCA mandates the CNSC to disseminate objective scientific, technical and regulatory information to the public concerning its activities and the activities it regulates. CNSC staff fulfill this mandate in a variety of ways, including the publishing of RORs and through 'Meet the Regulator' sessions. CNSC staff also seek out other opportunities to engage with the public and Indigenous groups, often participating in meetings or events in communities with interest in nuclear sites. These allow CNSC staff to answer questions about the CNSC's mandate and role in regulating the nuclear industry, including CNL's sites.

A list of outreach activities carried out by CNSC staff in 2018 and targeted at, or otherwise relevant to, CNL's activities is presented in Table 11 below. These are separate from CNSC staff's Indigenous engagement activities described in Section 5.3 below

Table 11: CNSC Staff Outreach Related to CNL Sites and Projects in 2018

Date	Event	Location
June, 2018	Meet the Regulator Session – CNL focus	Ottawa, ON
June, 2018	Meet the Regulator Session	Gatineau, QC
September, 2018	Port Hope & District Agricultural Society Fair, Port Hope, ON	Port Hope, ON

Of the events listed, the Port Hope & District Agricultural Society Fair in Port Hope, ON, was considered to be particularly successful by CNSC staff. CNSC staff participated in a pre-existing and well-attended event in the community and were able to discuss the CNSC's role and mandate with a large number of members of the public from the region.

Figure 13 - CNSC staff speaking to members of the public at the 2018 Port Hope & District Agricultural Society Fair

Given the success of that event, and given CNL's many new plans for its various sites, in 2019 CNSC staff have continued to carry out targeted outreach activities at pre-existing events in communities near CNL's sites.

5.2.2 Canadian Nuclear Laboratories

To ensure open and transparent information about nuclear facilities is available to the public, the CNSC requires licensees to implement and maintain a public information program and disclosure protocol (PIDP). All of the CNL sites covered by this ROR are required to have such a program, and CNSC staff consider that CNL's PIDPs for the sites covered by this ROR meet all requirements.

Public Information Program for CRL

CNL's PIDP for the CRL site meets all regulatory requirements for public information and disclosure. CNL provides open and transparent means for the public to obtain desired operational, environmental, and safety information about the facility. CNL has a public website, listed in Appendix I, where members of the public and Indigenous groups can access extensive environmental reporting and information about reportable events at CNL sites. CNL also has regular engagement sessions with the community to update stakeholders on licensed activities and uses multiple communications tools to allow the public access to facility information. CNSC staff consistently oversee CNL's implementation of the PIDP to ensure that CNL continues to meet its obligations regarding dissemination of information.

Public Information Program for PHAI

CNL's public information program for the PHAI has been developed based on CNSC requirements for public information and disclosure, and allows members of the public to obtain plain-language information on all aspects of the PHAI projects. CNL also ensures timely public disclosure following the occurrence of any unplanned events at PHAI sites via its website. CNSC staff confirm through compliance activities that CNL proactively shares project-related information with interested parties and continues to build relationships with its stakeholders. CNL's public information strategies and approaches ensure the Port Hope and Port Granby communities have access to up-to-date information on the PHAI.

Public Information Program for WL, DP, G-1 and NPD

CNL's public information program for WL, DP, G-1 and NPD has been developed in accordance with CNSC regulatory requirements, and allows members of the public to obtain plain language information on all aspects of these projects. CNL maintains up-to-date information on all decommissioning projects on their website, and ensures appropriate public disclosure following the occurrence of unplanned events. CNL also regularly engages with their communities to confirm they are receiving desired information on project activities.

5.3 Indigenous Consultation and Engagement

As an agent of the Government of Canada and as Canada's nuclear regulator, the CNSC recognizes and understands the importance of consulting and building relationships with Indigenous peoples in Canada.

CNSC staff are committed to building long-term relationships with Indigenous groups who have interests in nuclear facilities' regulation within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build partnerships and trust. The CNSC's Indigenous engagement practices, which include information sharing and funding support (through the CNSC's Participant Funding Program (PFP)) for Indigenous peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation.

CNSC staff efforts in 2018 supported the CNSC's ongoing commitment to meeting its consultation obligations and building relationships with Indigenous peoples with interests in the CNL sites covered by this ROR. In particular, CNSC staff continued to work to meet its Duty to Consult obligations with regards to CNL's proposed projects (the NSDF, the NPD Closure Project, and in-situ decommissioning of the WR-1 reactor), topics discussed further in Sections 5.5 and 5.9 below. CNSC staff also continued to identify opportunities for formalized and regular engagement throughout the lifecycle of the other CNL sites, including meetings and workshops. Through this engagement, CNSC staff welcomed the opportunity to discuss and address all topics of interest and concern to the Indigenous communities.

In addition, to ensure that interested Indigenous communities were made aware of this ROR, CNSC staff provided interested communities with notice of the PFP opportunity to review and comment on the report and the opportunity to submit a written intervention and/or appear before the Commission as part of the Commission meeting. As well, copies of the report will be sent to all Indigenous communities and organizations who have requested to be kept informed of activities at the CNL sites.

To ensure licensees engage Indigenous communities, in February 2016 the CNSC published REGDOC-3.2.2, *Aboriginal Engagement*, which sets out requirements and guidance for licensees proposing projects that may raise the Crown's duty to consult. CNSC staff continued to monitor the engagement work conducted by CNL to ensure that they continue to actively engage and communicate with Indigenous groups who have interest in their facilities, and that they are following the guidance of REGDOC 3.2.2 when appropriate. Below is a summary of the engagement activities specific to each facility in this report conducted by CNSC and CNL during the reporting period.

5.3.1 Chalk River Laboratories and Nuclear Power Demonstration

The CRL and NPD sites fall within the traditional territories of the Algonquins of Ontario (AOO), Algonquins of Quebec, the Métis Nation of Ontario and the Williams Treaties First Nations. The Indigenous groups and organizations who have expressed a direct interest in the CRL and NPD sites include: the Algonquins of Ontario, Algonquins of Pikwàkanagàn, Métis Nation of Ontario (MNO), the Algonquin Anishinabeg Nation Tribal Council, Kebaowek First Nation, Kitigan Zibi Anishinabeg First Nation, Anishinabek Nation, the Algonquin Nation Secretariat, and Williams Treaties First Nations: Alderville First Nation, Beausoleil First Nation, the Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation.

CNSC consultation and engagement activities

In 2018 the focus of CNSC staff's consultation and engagement activities with regards to the CRL and NPD sites has been on the proposed NSDF for low level waste at CRL and the proposed NPD closure project. CNSC staff have continued to send letters with key project information updates, conduct phone calls, and engage in meetings with the above mentioned groups to discuss their areas of interest related to the proposed NSDF and NPD closure projects and how the CNSC will be incorporating their comments and addressing their concerns as part of the regulatory process, including the ongoing environmental assessments being conducted under the *Canadian Environmental Assessment Act*, 2012 (CEAA 2012, [15]) for each project. In addition, through its PFP, the CNSC has funded two Indigenous Knowledge (IK) studies for AOO and MNO in relation to the two projects. The CNSC also continued to offer funding under the PFP to interested Indigenous groups to help them participate in the remainder of the regulatory process, including for additional meetings with CNSC staff. The CNSC will continue to consult with Indigenous groups who have interests or concerns in relation to the NSDF and NPD closure projects, as well as on other areas of interest related to CRL.

CNL engagement activities

CNSC staff observed that CNL has a dedicated Indigenous engagement program that covers their operations and activities at the CRL and NPD sites.

Consistent with the requirements and guidance of CNSC REGDOC 3.2.2: *Aboriginal Engagement* [16], throughout 2018, CNL met and shared information with interested Indigenous communities and organizations. These efforts have included emails, letters, meetings, site visits and tours, community visits, and workshops among others with a major focus being on the NSDF and NPD Closure projects. CNL is also in the process of negotiating Memorandums of Understanding with AOO and MNO, and has contributed funding to above-mentioned IK studies conducted in relation to NSDF and NPD closure by AOO and MNO.

CNSC staff continue to be satisfied with the level and quality of Indigenous engagement conducted by CNL with regards to their operations and proposed projects at the CRL and NPD sites and continue to adhere to the guidance of REGDOC 3.2.2.

5.3.2 Whiteshell Laboratories

The WL site falls within the traditional territories of Sagkeeng First Nation, Manitoba Métis Federation (MMF), Brokenhead Ojibway Nation, Black River First Nation, Hollow Water First Nation, and the First Nations represented by Grand Council of Treaty 3 and Chiefs of Ontario: Northwest Angle #33, Shoal Lake #40 First Nation, Wabaseemoong Independent Nations, and Iskatewizaagegan #39 Independent First Nation. These Indigenous groups and organizations have all expressed interest in the WL site.

CNSC consultation and engagement activities

In 2018 the focus of CNSC staff's consultation and engagement activities with regards to the WL site has been on the proposed in-situ decommissioning of WR-1 and the proposed licence renewal for the WL site. CNSC staff have continued to send letters with key project information updates, conduct phone calls, and engagement meetings with the above mentioned groups to discuss their areas of interest related to WR-1 and WL relicensing. CNSC staff have continued to discuss with interested Indigenous groups how their comments and concerns will be incorporated and addressed as part of the regulatory process, including the ongoing environmental assessment being conducted under CEAA 2012 for WR-1.

In addition, through its PFP the CNSC has funded three IK studies in relation to the WR-1 project, including for Sagkeeng First Nation, MMF, and one for Black River First Nation, Brokenhead Ojibway Nation, and Hollow Water First Nation. The CNSC also continued to offer funding under the PFP to interested Indigenous groups to help them participate in the remainder of the regulatory process including additional meetings with CNSC staff. The CNSC will continue to consult with Indigenous groups who have interests or concerns in relation to WR-1, the WL licence, as well as on other areas of interest related to WL.

CNL engagement activities

CNSC staff observed that CNL has a dedicated Indigenous engagement program that covers their operations and activities at the WL site.

Consistent with the requirements and guidance of CNSC REGDOC 3.2.2: *Aboriginal Engagement*, throughout 2018, CNL met and shared information with interested Indigenous communities and organizations. These efforts have included emails, letters, meetings, site visits and tours, community visits, and workshops among others with a major focus being on WR-1. CNL has also contributed funding to the above-mentioned IK study conducted in relation to WR-1 by Sagkeeng First Nation. CNSC staff continue to be satisfied with the level and quality of Indigenous engagement conducted by CNL with regards to their operations and proposed projects at WL and continue to adhere to the guidance of REGDOC 3.2.2.

5.3.3 The Port Hope Area Initiative

The PHAI falls within the traditional territories of the Williams Treaties First Nations and the MNO. The Indigenous groups and organizations who have expressed a direct interest in the Port Hope and Port Granby Projects include: Mohawks of the Bay of Quinte, MNO, and the Williams Treaties First Nations: Alderville First Nation, Beausoleil First Nation, the Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island First Nation.

CNSC consultation and engagement activities

CNSC staff regularly engage with Indigenous groups with interest in the Port Hope Project and the Port Granby Project. In 2018, CNSC staff met with the Williams Treaties First Nations, and MNO Region 8 in order to provide updates on a number of CNSC regulated facilities and activities in their traditional territories, including the Port Hope and Port Granby projects. As part of these meetings the interested Indigenous groups did not raise any issues or concerns with regards to these CNL projects. However, CNSC staff welcome the opportunity to continue to provide project updates and discuss any areas of interest and concern with Indigenous groups in relation to the Port Hope and Port Granby projects.

CNL engagement activities

CNSC staff observed that CNL has a dedicated Indigenous engagement program that covers their remediation sites. CNSC staff confirm that CNL invited representatives from Curve Lake First Nation, Hiawatha First Nation, Mississaugas of Scugog Island, and Alderville First Nation for an in-person engagement in November 2018 for an update on the Port Hope Area Initiative and a tour of the project sites. CNL also continues to send information about Port Hope and Port Granby and their potential impacts on the environment to interested Indigenous groups, as well as invitations to participate in events and public information sessions.

5.3.4 DP and G-1 Waste Facilities

The Douglas Point reactor falls within the Traditional Territory of the Chippewas of Nawash Unceded First Nation and Saugeen First Nation, who together form the Saugeen Ojibway Nation (SON). The Douglas Point reactor also falls within the asserted traditional harvesting territory of the Métis Nation of Ontario (MNO). In addition, the Douglas Point reactor falls within the asserted traditional harvesting territory of the Historic Saugeen Métis (HSM). The Indigenous groups and organizations who have expressed a direct interest in Douglas Point include SON, MNO, and HSM. The G-1 site lies within the traditional territory of the Abénakis of Wôlinak and Odanak, represented by the Grand Conseil de la Nation Waban-Aki (GCNWA) as well as the Nation huronne-wendat.

CNSC consultation and engagement activities

CNSC staff regularly engage with Indigenous groups with an interest in the Douglas Point reactor. In 2018, CNSC staff met with SON, HSM and MNO Region 7 on multiple occasions in order to provide updates on a number of CNSC regulated facilities and activities of interest. Although the discussions during 2018 focused on the Bruce Nuclear Generating Station licence renewal, CNSC staff welcome the opportunity to discuss any areas of interest with Indigenous groups in relation to Douglas Point as they arise.

More recently in May 2019, CNSC staff signed a Terms of Reference with SON to formalize the engagement on numerous items regarding nuclear activities in SON Traditional Territory. CNSC staff are open to including updates related to the Douglas Point reactor as a part of their formalized engagement with SON, should SON express an interest. CNSC staff are also in the process of signing a Terms of Reference with MNO to formalize engagement. CNSC staff are open to including activities related to the Douglas Point reactor as part of their formalized engagement with MNO Region 7, should they express an interest. CNSC staff have also signed a Terms of Reference with HSM to formalize engagement. CNSC staff are open to discussing the Douglas Point reactor as part of their formalized engagement with HSM, should they express an interest.

In 2018, CNSC staff have not received any questions, comments or feedback from Indigenous groups with an interest in the Gentilly site regarding issues or concerns they may have in relation to the Gentilly-1 reactor. However, CNSC staff welcome the opportunity to discuss any areas of interest with Indigenous groups in relation to Gentilly-1 upon request.

CNL engagement activities

CNSC staff observed that CNL has a corporate wide program dedicated to Indigenous engagement. In 2018, CNL has not received any questions or communications from Indigenous groups expressing interest in DP or G-1. CNL has informed CNSC staff that they welcome the opportunity to engage with Indigenous groups on these facilities should they express an interest.

5.4 Possible Small Modular Reactors at CNL sites

In April of 2018, CNL extended an invitation to proponents of Small Modular Reactor (SMR) demonstration projects to be considered in CNL's evaluation process for the possible construction and operation of an SMR at a site owned by AECL. In March of 2019, Global First Power (GFP), the proponent of a 5MWe high-temperature gas cooled reactor, submitted to the CNSC an application for a licence to prepare a site for an SMR at the CRL site. In June of 2019, CNSC staff received updated documents from GFP in support of the application, and in July of 2019, the Project Description was posted on the Canadian Environmental Assessment Agency's website for comment by the public, Indigenous groups, and other interested stakeholders.

Decisions on the environmental assessment pursuant to CEAA 2012 and the application for the licence to prepare a site will be made by the Commission at a future public hearing.

5.5 CNL's Proposed Near Surface Disposal Facility

CNL is currently proposing to construct and operate a low-level radioactive waste disposal facility known as the Near Surface Disposal Facility (NSDF) on a portion of the CRL site. The construction and operation of such a facility is not included in the current licensing basis for the CRL site.

The NSDF is intended to accept low-level radioactive waste, predominantly that generated by CNL's decommissioning work, contaminated soil, and legacy waste from past operations. The waste CNL proposes to accept into the NSDF will largely be from the CRL site, but will also include a small amount of waste from other CNL sites. CNL submitted a draft Environmental Impact Statement (EIS) in March of 2017 for comment by the public, the CNSC and other provincial and federal departments, and submitted a licence application to the CNSC at the same time. CNL received extensive comments on the draft EIS, and CNSC staff further provided extensive comments on technical documentation related to the licence application. CNL expects to submit a revised EIS and licence application in October of 2019.

The NSDF proposal requires an EA decision under CEAA 2012 by the Commission affirming that the project will not cause significant adverse environmental effects. Should the Commission decide favourably, the proposal requires approval by the Commission to proceed with the construction of the facility. The possible construction and operation of the NSDF is out of the scope of this ROR.

5.6 Certified Staff at CRL

Condition 2.3 of the CRL licence requires that persons appointed to the positions of Senior Reactor Shift Engineer and NRU Health Physicist be certified by the CNSC. This licence condition was put in place when NRU was still an operating reactor. The position of Senior Reactor Shift Engineer became obsolete once NRU was permanently defueled and dewatered.

At present, CNSC staff confirm that CNL retains an adequate complement of certified NRU Health Physicists to support radiological work in NRU. CNSC staff continue to evaluate the conditions under which the requirement for certified NRU Health Physicists will no longer apply.

5.7 Fitness for Duty at High Security Sites

In January of 2018, the CNSC published REGDOC-2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, version 2 [17]. This REGDOC "…sets out requirements and guidance for managing fitness for duty of workers in relation to alcohol and drug use and abuse at all high-security sites, as defined in the *Nuclear Security Regulations*." REGDOC-2.2.4 Volume II, version 2, will apply to the CRL and WL sites, and requires that licensees use a urine drug-testing process to test staff in safety-critical and safety-sensitive positions for the presence of drugs above specified limits.

Licensees have requested that their implementation dates for this REGDOC be delayed to allow consideration of industry-proposed amendments regarding the use of oral fluid testing. CNSC staff have agreed to this delay and are assessing the industry-proposed amendments. Should the REGDOC be amended, the revised draft will be subject to Commission approval at a future date.

5.8 Updates to CNL's Corporate Programs

During 2018 CNL has continued its work to transition its management system away from the older suite of AECL documentation and towards a modern CNL-specific set of documentation. The most visible aspect of this work for CNSC staff is CNL's creation and revision of their Corporate-level program documentation, which can apply to all sites under the control of CNL and as such are the keystone of their management system.

Key Corporate-level documents are listed in the LCHs for multiple CNL sites, and form part of the licensing basis for those sites. CNSC staff consider that including these high-level documents in LCHs renders all relevant subsidiary CNL documents in the licensing basis. This provides CNSC staff with access on request to the documentation necessary to verify CNL's compliance with CNSC requirements.

During 2018, CNSC staff received 52 Corporate-level documents from CNL for technical review. These reviews often resulted in comment being returned to CNL for action or for consideration, which in turn can lead to revised documents being provided by CNL to CNSC staff for comment.

5.9 Waste and Decommissioning

CNL's activities at each of the sites covered by this report involve the generation, storage and managing of radioactive wastes. CNL has pursued accelerated decommissioning strategies at many of its sites, resulting in an actual or planned increase in the rate of generation of radioactive wastes. CNSC staff maintain oversight of CNL's current and future management of radioactive wastes via inspections, desktop reviews, and technical assessments.

Radioactive wastes stored on the sites covered by this report consist of high, intermediate and low-level radioactive waste. The inventory of wastes stored at CNL sites is included in *Canada's Sixth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2017)* [18]. The report can be found on the CNSC's website.

During 2018, CNL continued to employ effective programs for the characterization, minimization, segregation, handling, storage, monitoring, and processing (where applicable) of radioactive and hazardous wastes. CNL sorts and compacts wastes where possible in order to minimize the volume which must be stored.

CNL participated in "Waste Reduction Week in Canada" during October of 2018. The goal of this annual program is to educate, engage, and empower Canadians to reduce, reuse, and recycle waste. During the waste reduction week, CNL conducted various promotional activities to engage employees to learn about waste reduction and environmental sustainability.

The Chalk River Site

Two major activities related to radioactive waste were underway at CRL in 2018. Firstly, CNL continued to retrieve fuel from legacy tile holes for transfer to the Fuel Packaging and Storage facility. CNL also began to store sea containers of radioactive waste generated through decommissioning work; this work began once CNSC staff determined that it was within the licensing basis for the CRL site. CNL intends to eventually transfer much of this material to the proposed NSDF, should that facility receive Commission approval. CNSC staff carried out inspections of CRL's Waste Management and Decommissioning program in 2018 to ensure the ongoing safety of these activities. CNSC staff also reviewed three Detailed Decommissioning Plans for buildings at CRL, and CNL's Comprehensive Preliminary Decommission Plan for the CRL site. CNSC staff have assessed and concluded that these documents met regulatory requirements. During 2018, CRL continued to accept radioactive waste from locations across Canada, and continued to use off-site contractors for volume reduction work on select wastes.

CNL continued decommissioning work in various facilities on the CRL site in 2018, including in ancillary buildings associated with the NRX reactor and the Plutonium Recovery Laboratory, among others.

Accelerated Decommissioning Proposals for WL and NPD

Decommissioning at CNSC licensed sites must be carried out according to decommissioning plans which are reviewed and accepted by the CNSC. CNL has such plans in place, but for the WL and NPD sites, CNL is now seeking to change both the timelines and the methods to be used to decommission.

The CNSC has received formal proposals from CNL to accelerate decommissioning at NPD and the WR-1 reactor at WL. Both of these proposals involve ‘in-situ decommissioning’, where major underground structures would be left in place, filled with grout, and capped. In both cases, in-situ decommissioning is not permitted by the current licensing basis, nor is it the end-state documented in CNL’s current CNSC staff-accepted decommissioning plans.

For each of the NPD and WR-1 projects, CNL has submitted a licence application to the CNSC and prepared a draft EIS for comment by the public, the CNSC and other provincial and federal departments. CNSC staff undertook a review of CNL’s draft EISs and conducted licensing reviews pursuant to the NSCA and its associated regulations. As the responsible authority, and working with other federal departments, CNSC staff have identified a number of areas where additional information will need to be included in the final EISs and other technical supporting documentation. For each project, complete licensing and EIS submissions are required before CNSC staff can complete their assessment and proceed to public hearings.

For each project, following receipt of a complete licensing submission and final EIS, CNSC staff will write a CMD containing staff’s assessment of the licence amendment and the EA report, in support of a hearing on the topic. This CMD will be available to the public and Indigenous groups prior to the Commission’s public hearing, the date of which has not been set. The public will be offered the opportunity to submit written and/or oral interventions. Because there will be separate Commission decisions on these projects, they are out of the scope of this ROR.

Financial Guarantees for CNL sites

AECL is a Schedule III, Part 1 Crown Corporation under the *Financial Administration Act* and an agent of Her Majesty in Right of Canada. As an agent of Her Majesty in Right of Canada, AECL’s liabilities are ultimately liabilities of Her Majesty in Right of Canada. While the restructuring of AECL has seen the ownership of CNL transferred to the Canadian National Energy Alliance, AECL retains ownership of the lands, assets and liabilities associated with CNL’s licences. These liabilities have been officially recognized by the Minister of Natural Resources in a letter dated July 31, 2015 [19]. CNSC staff thus consider that specific financial guarantees for AECL’s sites are not required.

5.10 Emergency Management at the CRL site

During the January 2018 relicensing hearing for the CRL site, the Commission requested an update on emergency planning at the CRL site following the permanent shutdown, defueling and dewatering of the NRU reactor.

CNL has assessed that a severe accident in the NRU facility, that is, an accident involving severe fuel degradation, is no longer possible. CNSC staff concur with this assessment. Due to this reduction in risk, CNL's Severe Accident Management Program (designed specifically for NRU operations) is no longer in use. Ongoing work in NRU is now managed under CNL's Emergency Operating Procedure, as is used for the remainder of the CRL site. CNSC staff are in agreement with this change.

6 OVERALL CONCLUSIONS

This report summarizes the CNSC staff assessment on the performance of CNL at the CRL, WL, PHAI, DP, G-1 and NPD sites in 2018. CNSC staff concluded that these sites operated safely during 2018. This conclusion is based on assessments of licensee activities that included site inspections, reviews of reports submitted by licensees, and event and incident reviews, supported by follow-up and general communication with the licensees.

For 2018, the performance in all 14 SCAs was rated as “satisfactory” with the exception of the Security SCA at WL, which was rated “below expectations”.

CNSC staff’s compliance activities confirmed that:

- Radiation protection programs at all CNL sites adequately controlled radiation exposures, keeping doses ALARA;
- Environmental protection programs at all CNL sites were effective in protecting the environment; and
- Conventional health and safety programs at all CNL sites continue to protect workers.

CNSC staff will continue to provide regulatory oversight at all CNL sites, to ensure that CNL continues to make adequate provision to protect the health, safety and security of workers, Canadians and the environment, and continues to implement Canada’s international obligations on the peaceful use of nuclear energy.

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16. REGDOC-3.2.2, "Aboriginal Engagement", https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/published/html/regdoc3-2-2/index.cfm

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18. *Canada's Sixth National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2017),* http://nuclearsafety.gc.ca/pubs_catalogue/uploads/joint-convention-sixth-national-report-oct-2017-eng.pdf

19. Letter, Hon. G. Rickford to M. Binder, July 31, 2015 (e-Doc 4815508)

20. CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*, March 2014

21. CMD 17-M38, *Event Initial Report: Release of untreated water at Port Hope Project Long Term Waste Management Facility*, August 17, 2017 (e-Doc 5314921)

ACRONYMS

Acronym	Definition
AECL	Atomic Energy of Canada Limited
AL	Action Level
ALARA	As Low As Reasonably Achievable
ALWTC	Active Liquid Treatment Centre
AOO	Algonquins of Ontario
BE	Below Expectations
Cameco	Cameco Corporation
CANDU	Canada Deuteurium-Uranium
CEAA 2012	Canadian Environmental Assessment Act, 2012
CMD	Commission Member Document
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
DDPs	Detailed Decommissioning Plans
DP	Douglas Point
DRL	Derived Release Limit
EA	Environmental Assessment
ECIS	Emergency Cooling Injection System
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ENL	Eldorado Nuclear Limited
ERA	Environmental Risk Assessment
FS	Fully Satisfactory
G-1	Gentilly-1
GCNWA	Grand Conseil de la Nation Waban-Aki
GFP	Global First Power
HEU	Highly Enriched Uranium
HSM	Historic Saugeen Métis
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program

Acronym	Definition
IK	Indigenous Knowledge
Km	Kilometers
LCH	Licence Conditions Handbook
LLA	Long-lived Alpha
LLW	Low-Level Waste
LTWMF	Long-Term Waste Management Facility
MMF	Manitoba Métis Federation
MNO	Métis Nation of Ontario
MPF	Molybdenum Production Facility
mSv	Millisievert
MWe	Megawatt Electric
MWth	Megawatt Thermal
NEW	Nuclear Energy Worker
NPD	Nuclear Power Demonstration
NPRI	National Pollutant Release Inventory
NRTEDL	Nuclear Research and Test Establishment Decommissioning Licence
NRTEOL	Nuclear Research and Test Establishment Operating Licence
NRU	National Research Universal
NRX	National Research Experimental
NSCA	Nuclear Safety and Control Act
NSDF	Near Surface Disposal Facility
PDP	Preliminary Decommissioning Plan
PFP	Participant Funding Program
PGP	Port Granby Project
PHAI	Port Hope Area Initiative
PHP	Port Hope Project
PIDP	Public Information and Disclosure Program
RLTI	Reportable Lost Time Injury
ROR	Regulatory Oversight Report
SA	Satisfactory
SCA	Safety and Control Area
SDR	Slowpoke Demonstration Reactor

Acronym	Definition
SMR	Small Modular Reactor
SON	Saugeen Ojibway Nation
UA	Unacceptable
USNRC	United States Nuclear Regulatory Commission
WFDL	Waste Facility Decommissioning Licence
WNSL	Waste Nuclear Substances Licence
WL	Whiteshell Laboratories
WMF	Waste Management Facility
WR-1	Whiteshell Reactor No.1
WSIB	Workplace Safety and Insurance Board
WWTP	Waste Water Treatment Plant
ZED	Zero Energy Deuteurium

GLOSSARY

For definitions of terms used in this document, see REGDOC-3.6 Glossary of CNSC Terminology, which includes terms and definitions used in the *Nuclear Safety and Control Act* (NSCA) and the regulations made under it, and in CNSC regulatory documents and other publications.

A. LIST OF INSPECTIONS AT CNL SITES IN 2018

Table A-1: List of inspections at Chalk River Laboratories

Inspection Number	Dates	SCAs Covered	Number of Enforcement Actions Issued	Safety Significance of Enforcement Actions
CNL-NRU-2018-01	February 13-14, 2018	Conventional health and safety Operating performance Radiation protection Human performance management Security Safeguards and non-proliferation	0	N/A
CNL-FMC-2018-01	February 22, 2018	Conventional health and safety Environmental protection Operating performance Radiation protection	0	N/A
CNL-SD&D-2018-03	March 6, 2018	Conventional health and safety Environmental protection Radiation protection	0	N/A
CNL-CRL-2018-01	June 9-10, 2018	Management system	0	N/A
CNL-UC-2018-01	July 4, 2018	Conventional health and safety Operating performance Radiation protection Waste management	0	N/A
Security Field Inspection	July 24, 2018	Security	2	Low
CNL-WTC-2018-02	August 7-8, 2018	Conventional health and safety Operating performance Radiation protection Waste management	1	Low
CNL-WMA-2018-01	August 9, 2018	Conventional health and safety Operating performance Radiation protection	0	N/A

CNL-EP-2018-01	August 21-24, 2018	Environmental protection Operating performance Human performance management	0	N/A
Security Field Inspection	October 25, 2018	Security	0	N/A
Security Force-on-Force Exercise	November 22, 2018	Security	0	N/A
Training Inspection	December 4-7, 2018	Human performance management Security	9	Low

Table A-2: List of inspections at Whiteshell Laboratories

Inspection Number	Dates	SCAs Covered	Number of Enforcement Actions Issued	Safety Significance of Enforcement Actions
CNL-WL-2018-01	May 15-16, 2018	Operating performance Radiation protection Conventional health and safety Waste management Emergency management and fire protection	0	N/A
CNL-WL-2018-02	October 29-30, 2018	Management system Operating performance Radiation protection Conventional health and safety Human performance management Waste management and decommissioning	1	Low

Table A-3: List of inspections at the Port Hope Project

Inspection Number	Dates	SCAs Covered	Number of Enforcement Actions Issued	Safety Significance of Enforcement Actions
CNL-PHAI-PHP-2018-01	March 7, 2018	Radiation protection	4	Low

CNL-PHAI-2018-01	May 31-June 1, 2018	Management system	0	N/A
CNL-PHAI-PHP-2018-02	July 19, 2018	Radiation protection Environmental protection Conventional health and safety Management system	4	Low
CNL-PHAI-PHP-2018-03	September 8, 2018	Conventional health and safety Emergency management and fire protection Radiation protection	1	Low
CNL-PHAI-PHP-2018-04	October 11-12, 2018	Management system Physical design Radiation protection Conventional health and safety	5	Low

Table A-4: List of inspections at the Port Granby Project

Inspection Number	Dates	SCAs Covered	Number of Enforcement Actions Issued	Safety Significance of Enforcement Actions
CNL-PHAI-PGP-2018-01	February 20, 2018	Environmental protection Radiation protection Conventional health and safety Fitness for service Operating performance Emergency management and fire protection	7	Low
CNL-PHAI-PGP-2018-02	February 21, 2018			
CNL-PHAI-PGP-2018-03	March 8, 2018	Conventional health and safety Radiation protection	10	Low
CNL-PHAI-PGP-2018-04	April 17-19, 2018	Conventional health and safety Management system	5	Low
CNL-PHAI-PGP-2018-05	July 20, 2018	Radiation protection Environmental protection Conventional health and safety Management system	0	N/A
CNL-PHAI-PGP-2018-06	November 22-23, 2018	Environmental protection Radiation protection Conventional health and safety	0	N/A

Table A-5: List of inspections at Douglas Point, Gentilly-1 and Nuclear Power Demonstration

Inspection Number	Dates	SCAs Covered	Number of Enforcement Actions Issued	Safety Significance of Enforcement Actions
Douglas Point CNL-DPWF-2018-01	September 19, 2018	Radiation protection Human performance management Conventional health and safety Operating performance Security Emergency management and fire protection	2	Low
Gentilly- 1 CNL-G-1-2018-01	March 7, 2018	Conventional health and safety Management system Radiation protection Waste management and decommissioning	0	N/A
NPD CNL-NPD-2018-01	October 16-17, 2018	Radiation protection Human performance management Conventional health and safety Security Emergency management and fire protection Waste management Environmental protection	0	N/A

B. SAFETY AND CONTROL AREA DEFINITIONS

The CNSC evaluates how well licensees meet regulatory requirements and CNSC performance expectations for programs in 14 safety and control areas (SCAs). The SCAs are grouped into three functional areas: management, facility and equipment, and core control processes.

Table B-1: Safety and Control Area Framework

Functional area	Safety and control area	Definition	Specific areas
Management	**Management system**	Covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.	▪ management system ▪ organization ▪ performance assessment, improvement and management review ▪ operating experience (OPEX) ▪ change management ▪ safety culture ▪ configuration management ▪ records management ▪ management of contractors ▪ business continuity
	Human performance management	Covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.	▪ human performance program ▪ personnel training ▪ personnel certification ▪ initial certification examinations and requalification tests ▪ work organization and job design ▪ fitness for duty
	Operating performance	Includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.	▪ conduct of licensed activity ▪ procedures ▪ reporting and trending ▪ outage management performance ▪ safe operating envelope ▪ severe accident management and recovery ▪ accident management and recovery
	Safety analysis	Covers maintenance of the safety analysis that	▪ deterministic safety analysis ▪ hazard analysis

Functional area	Safety and control area	Definition	Specific areas
Facility and equipment		supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards.	▪ probabilistic safety analysis ▪ criticality safety ▪ severe accident analysis ▪ management of safety issues (including research and development programs)
	Physical design	Relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.	▪ design governance ▪ site characterization ▪ facility design ▪ structure design ▪ system design ▪ component design
	Fitness for service	Covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.	▪ equipment fitness for service/equipment performance ▪ maintenance ▪ structural integrity ▪ aging management ▪ chemistry control ▪ periodic inspection and testing

Functional area	Safety and control area	Definition	Specific areas
Core control processes	**Radiation protection**	Covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).	▪ application of ALARA ▪ worker dose control ▪ radiation protection program performance ▪ radiological hazard control ▪ estimated dose to public
	Conventional health and safety	Covers the implementation of a program to manage workplace safety hazards and to protect workers.	▪ performance ▪ practices ▪ awareness
	Environmental protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.	▪ effluent and emissions control (releases) ▪ environmental management system ▪ assessment and monitoring ▪ protection of the public ▪ environmental risk assessment
	Emergency management and fire protection	Covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.	▪ conventional emergency preparedness and response ▪ nuclear emergency preparedness and response ▪ fire emergency preparedness and response
	Waste management	Covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.	▪ waste characterization ▪ waste minimization ▪ waste management practices ▪ decommissioning plans

<table>
<tr><th>Functional area</th><th>Safety and control area</th><th>Definition</th><th>Specific areas</th></tr>
<tr><td>Core control processes</td><td>Security</td><td>Covers programs required to meet security requirements stipulated in the regulations, the licence, orders or expectations for the facility or activity.</td><td>▪ facilities and equipment
▪ response arrangements
▪ security practices
▪ drills and exercises</td></tr>
<tr><td rowspan="2"></td><td>Safeguards and non-proliferation</td><td>Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements, as well as all other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.</td><td>▪ nuclear material accountancy and control
▪ access and assistance to the IAEA
▪ operational and design information
▪ safeguards equipment, containment and surveillance
▪ import and export</td></tr>
<tr><td>Packaging and transport</td><td>Programs that cover the safe packaging and transport of nuclear substances to and from the licensed facility.</td><td>▪ package design and maintenance
▪ packaging and transport
▪ registration for use</td></tr>
<tr><th colspan="4">Other matters of regulatory interest</th></tr>
<tr><td colspan="4">▪ Environmental assessments
▪ CNSC consultation – Indigenous communities
▪ CNSC consultation – other
▪ Cost recovery
▪ Financial guarantees
▪ Improvement plans and significant future activities
▪ Licensee public information program
▪ Nuclear liability insurance</td></tr>
</table>

C. SAFETY AND CONTROL AREA RATING METHODOLOGY

Performance ratings used in this report are defined as follows:

Fully satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the safety and control area or specific area exceeds requirements and Canadian Nuclear Safety Commission (CNSC) expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the safety and control area or specific area meets requirements and CNSC expectations. Any deviation is only minor, and any issues are considered to pose a low risk to the achievement of regulatory objectives and the CNSC's expectations. Appropriate improvements are planned.

Below expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the safety and control area or specific area deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee or applicant is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the overall safety and control area or specific area is significantly below requirements or CNSC expectations or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to an unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken, and no alternative plan of action has been provided. Immediate action is required.

D. SAFETY AND CONTROL AREA RATINGS

Note that the following acronyms are used in this appendix:

FS = fully satisfactory SA = satisfactory BE = below expectations

Table D-1: Safety and control area summary, Chalk River Laboratories, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	BE	BE	BE	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-2: Safety and control area summary, Whiteshell Laboratories, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	BE
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-3: Safety and control area summary, Port Hope Project, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-4: Safety and control area summary, Port Granby Project, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-5: Safety and control area summary, Douglas Point Waste Facility, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-6: Safety and control area summary, Gentilly-1 Waste Facility, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table D-7: Safety and control area summary, Nuclear Power Demonstration Waste Facility, 2014-2018

Safety and control areas	2014	2015	2016	2017	2018
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

E. DOSES TO NUCLEAR ENERGY WORKERS AND NON-NUCLEAR ENERGY WORKERS AT CNL SITES

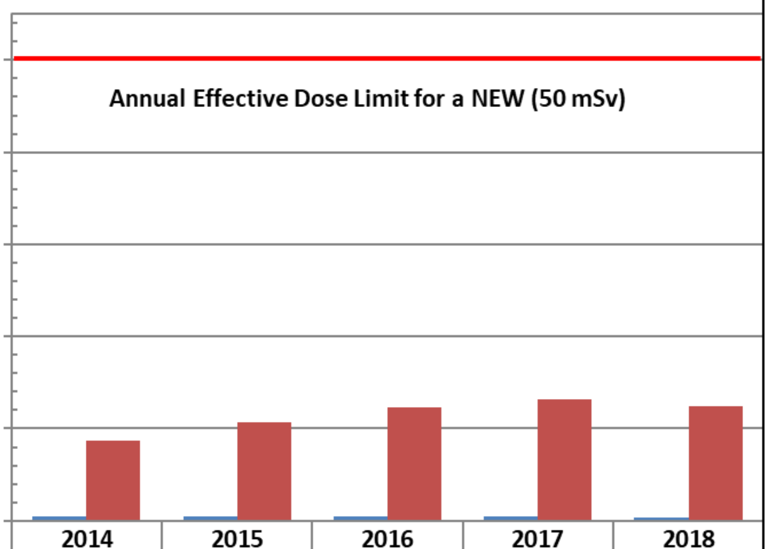
This appendix presents information on doses to Nuclear Energy Workers (NEWs) and non-NEWs at CNL sites.

Chalk River Laboratories

Figure E-1 provides the average effective doses and the maximum effective doses to NEWs from 2014 to 2018. The maximum annual effective dose received by a NEW in 2018 was 12.48 mSv; approximately 25 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period.

The dose fluctuations from year to year are attributed to the scope and duration of the radiological work conducted along with the dose rates associated with the work.

Figure E-1: Average and maximum effective doses to NEWs at CRL from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.43	0.45	0.49	0.44	0.34
Maximum Effective Dose (mSv)	8.66	10.72	12.24	13.13	12.48
Number of Persons Monitored	4615	4410	4387	4515	4227

As shown in tables E-1 and E-2, equivalent doses (skin and extremity) at the CRL site were below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/year. The maximum equivalent (skin) dose received by a NEW in 2018 was 15.84 mSv; approximately 3 percent of the regulatory limit for equivalent dose of 500 mSv in a one-year dosimetry period. The maximum equivalent (extremity) dose received by a NEW in 2018 was 44.83 mSv; approximately 9 percent of the regulatory limit for equivalent dose of 500 mSv in a one-year dosimetry period.

Table E-1: Equivalent (skin) doses to NEWs at CRL from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.53	0.55	0.60	0.53	0.40	n/a
Maximum skin dose (mSv)	21.73	15.75	16.54	19.95	15.84	500 mSv/year

Table E-2: Equivalent (extremity) doses to NEWs at CRL from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average extremity dose (mSv)	3.26	2.84	3.71	6.10	4.85	n/a
Maximum extremity dose (mSv)	22.50	29.32	41.59	85.06	44.83	500 mSv/year

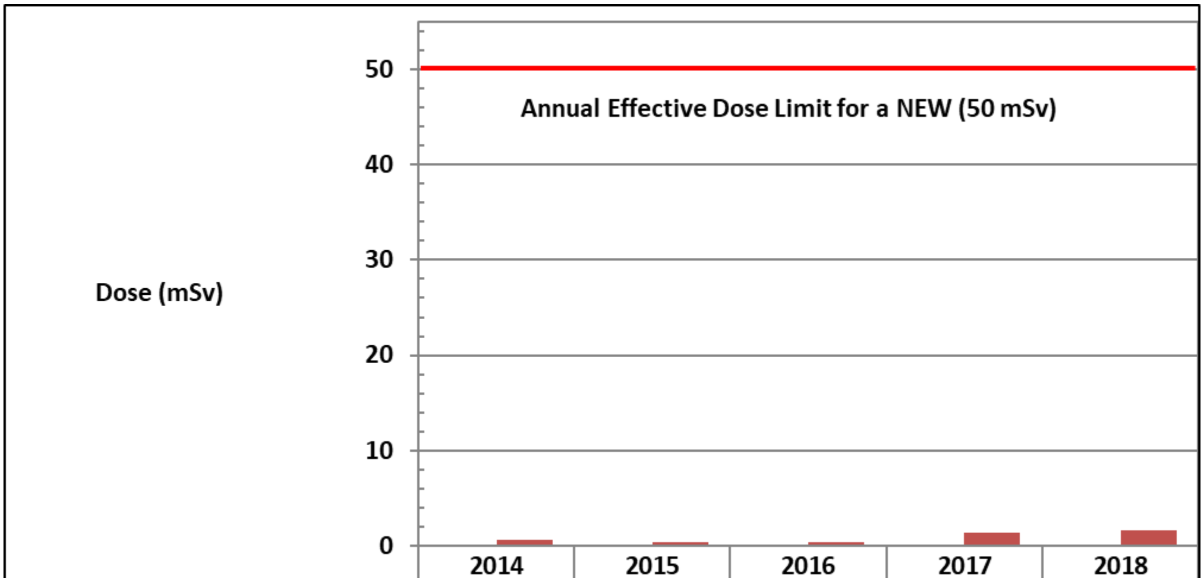
Non-NEWs at CRL

In 2018, the maximum annual effective dose received by a non-NEW was 0.32 mSv; approximately 32 percent of the regulatory limit for effective dose of 1 mSv in a one-year dosimetry period.

Whiteshell Laboratories

Figure E-2 provides the average effective doses and the maximum effective doses to workers from 2014 to 2018. The maximum annual effective dose received by a NEW in 2018 was 1.7 mSv, approximately 3 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period. The highest annual average effective dose in this period was 0.07 mSv. These slight increases in individual exposures, both occurring in 2018, are attributed to decommissioning activities performed in the Building 200 Active Liquid Waste Treatment Centre (ALWTC).

Figure E-2: Average and maximum effective doses to NEWs at WL from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.02	0.04	0.02	0.03	0.07
Maximum Effective Dose (mSv)	0.70	0.40	0.40	1.40	1.65
Number of NEWs Monitored	797	753	659	607	595

As shown in tables E-3 and E-4, equivalent doses (skin and extremity) at the WL site were below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/year. The maximum equivalent (skin) dose received by a NEW in 2018 was 3.72 mSv; approximately 1 percent of the regulatory limit for equivalent dose of 500 mSv in a one-year dosimetry period. The maximum equivalent (extremity) dose received by a NEW in 2018 was 36.71 mSv; approximately 7 percent of the regulatory limit for equivalent dose of 500 mSv in a one-year dosimetry period. The increasing trend in 2017 and 2018 is attributed to decommissioning activities in the ALWTC and maintenance activities (notably manipulator maintenance).

Table E-3: Equivalent (skin) doses to NEWs at WL from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.02	0.04	0.02	0.05	0.12	n/a
Maximum skin dose (mSv)	1.6	0.65	0.36	2.90	3.72	500 mSv/year

Table E-4: Equivalent (extremity) doses to NEWs at WL from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average extremity dose (mSv)	0.36	0.09	0.05	1.51	5.02	n/a
Maximum extremity dose (mSv)	1.25	0.72	0.11	11.35	36.71	500 mSv/year

Non-NEWs at WL

In 2018, external dosimeters issued to non-NEWs at WL did not record any measureable doses.

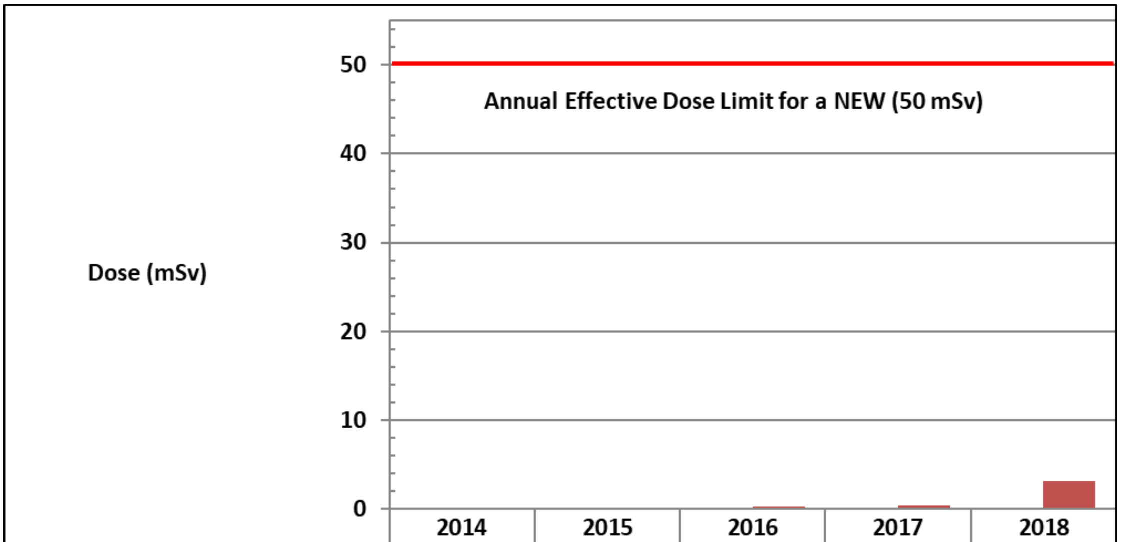
Remediation Sites

Port Granby

Figure E-3 provides the average effective doses and the maximum effective doses for all NEWs from 2014 to 2018. In 2018, the maximum total effective dose for a NEW at the PGP was 3.13 mSv, approximately 6 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period. The average effective dose for all NEWs was 0.06 mSv. In 2018, occupational doses at PGP were higher than previous years. This was attributed to an increase in the scope of work that was performed.

The 2018 total effective dose includes whole body dose, assessed with external dosimetry, and internal dose, assessed from radon and ling-lived alpha (LLA) in air. The total number of NEWs includes all contractors involved in work at the PGP as well as CNL staff.

Figure E-3: Average and maximum effective doses to NEWs at PGP from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.02	0.01	0.01	0.03	0.06
Maximum Effective Dose (mSv)	0.20	0.16	0.30	0.39	3.13
Number of NEWs Monitored	91	118	309	430	489

As shown in Table E-5 below, skin doses at the PGP were also well below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/year. The maximum skin dose for a NEW at the PGP in 2018 was 2.44 mSv, and the average skin dose for all NEWs was 0.05 mSv.

Table E-5: Equivalent (skin) doses to NEWs at PGP from 2014-2018

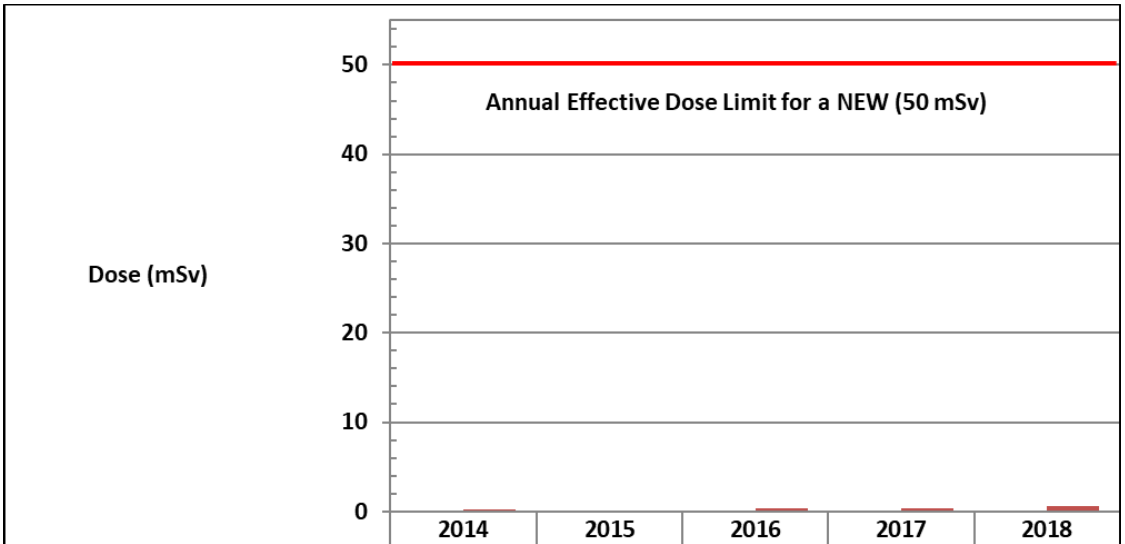
Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.01	0.01	0.01	0.04	0.05	n/a
Maximum skin dose (mSv)	0.16	0.16	0.30	0.34	2.44	500 mSv/year

Port Hope

Figure E-4 provides the average effective doses and the maximum effective doses for all NEWs from 2014 to 2018. In 2018, the maximum total effective dose for a NEW at the PHP was 0.59 mSv, approximately 1 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period. The average effective dose for all NEWs was 0.04 mSv. December 2017 marked the beginning of hauling on-site waste into the newly constructed Cell 1 mound at the PHP.

The 2018 total effective dose includes whole body dose, assessed with external dosimetry, and internal dose, assessed with PAD and/or results from radon progeny and LLA in air. The total number of NEWs includes all contractors involved in work at the PHP as well as CNL staff.

Figure E-4: Average and maximum effective doses to NEWs at PHP from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.02	0.01	0.01	0.03	0.04
Maximum Effective Dose (mSv)	0.20	0.16	0.30	0.34	0.59
Number of NEWs Monitored	91	118	309	343	656

As shown in Table E-6, skin doses at the PHP were also well below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/year. The maximum skin dose for a NEW at the PHP in 2018 was 0.33 mSv, and the average skin dose for all NEWs was 0.04 mSv.

Table E-6: Equivalent (skin) doses to NEWs at PHP from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.01	0.01	0.01	0.04	0.04	n/a
Maximum skin dose (mSv)	0.16	0.16	0.30	0.34	0.33	500 mSv/year

Non-NEWs at Remediation Sites

In 2018, the maximum annual effective dose received by non-NEWs were 0.004 mSv at the PGP, and 0.02 mSv at the PHP. These doses are well below the annual regulatory dose limit of 1 mSv in a one-year dosimetry period.

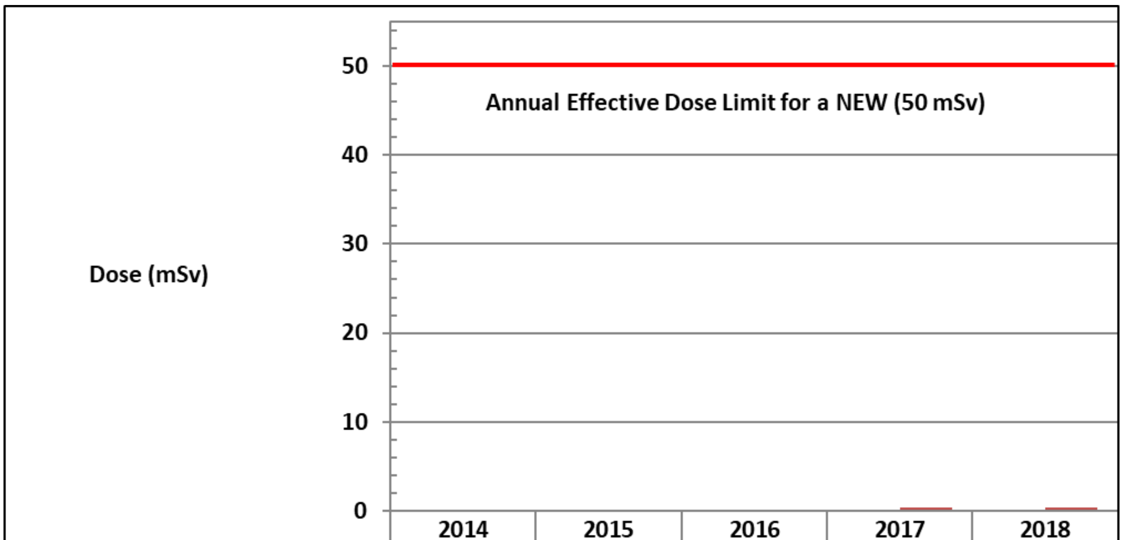
DP, G-1 and NPD Waste Facilities

Douglas Point Waste Facility

Figure E-5 provides the average effective doses and the maximum effective doses to NEWs from 2014 to 2018. In 2018, the maximum effective dose received by a NEW at DP was 0.43 mSv, approximately 1 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period.

There has been an increase in the number of workers at DP over these years, mainly attributed to an increase in project work activities. These work activities have resulted in slight increases in the maximum effective doses to workers when compared to previous years.

Figure E-5: Average and maximum effective doses to NEWs at DP from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.00	0.00	0.01	0.01	0.01
Maximum Effective Dose (mSv)	0.16	0.06	0.11	0.37	0.43
Number of NEWs Monitored	-	64	80	92	123

Annual average and maximum equivalent (skin) dose results for NEWs at DP from 2014 to 2018 are provided in Table E-7. In 2018, the maximum skin dose received by a NEW at DP was 0.43 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Table E-7: Equivalent (skin) doses to NEWs at DP from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Regulatory Limit
Average skin dose (mSv)	0.00	0.00	0.01	0.01	0.01	n/a
Maximum skin dose (mSv)	0.12	0.06	0.11	0.37	0.43	500 mSv/year

Non-NEWs at DP

In 2018, external dosimeters issued to non-NEWs at DP did not record any measureable doses.

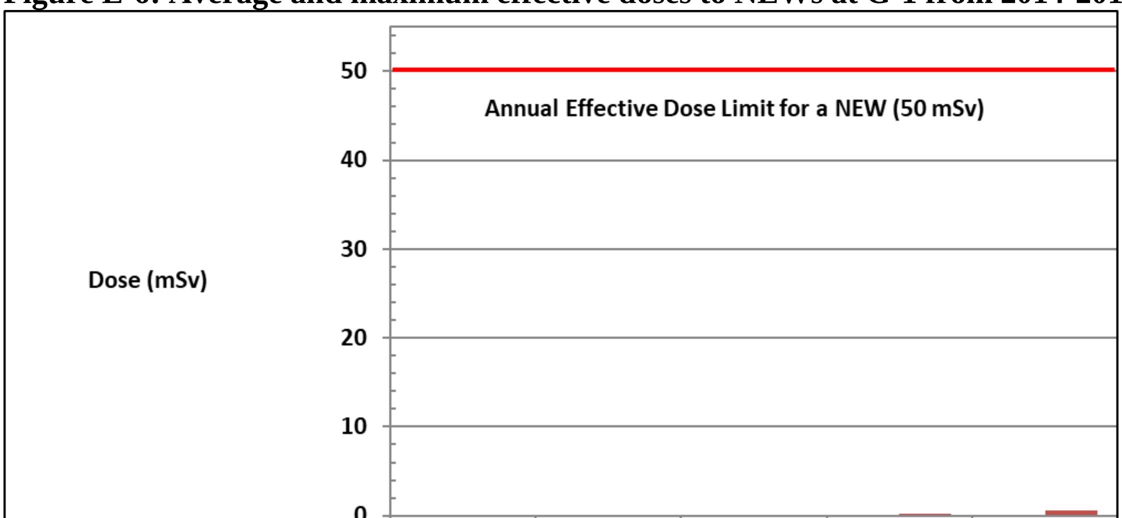
<u>Gentilly-1 Waste Facility</u>

Figure E-6 provides the average effective doses and the maximum effective doses to NEWs at G-1 from 2014 to 2018. In 2018, the maximum effective dose received by a NEW at the G-1 was 0.62 mSv, approximately 1 percent of the regulatory limit for effective dose of 50 mSv.

In 2014, no NEW received any measureable dose above the detection limit of 0.1 mSv for the dosimeter type. The total number of NEWs monitored in 2014 is unavailable.

Since 2015, there has been an increase in the number of workers on site, along with slight increases in radiation doses to NEWs, due to an increase in planned work activities (both maintenance tasks and project activities).

Figure E-6: Average and maximum effective doses to NEWs at G-1 from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	-	0.01	0.01	0.01	0.03
Maximum Effective Dose (mSv)	-	0.04	0.08	0.18	0.62
Number of NEWs Monitored	-	22	49	83	101

Annual average and maximum equivalent (skin) dose results for NEWs at G-1 from 2014 to 2018 are provided in Table E-8. In 2018, the maximum skin dose received by a NEW at G-1 was 0.62 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Table E-8: Equivalent (skin) doses to NEWs at G-1 from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	-	0.01	0.01	0.01	0.03	n/a
Maximum skin dose (mSv)	-	0.04	0.08	0.18	0.62	500 mSv/year

Note: "-" means that no measurable dose was recorded.

Extremity dosimeters were worn by certain contractors in 2018 due to the conduct of hazard reduction projects where the hands were preferentially exposed. The maximum dose recorded on an extremity dosimeter was 17.27 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Non-NEWs at G-1

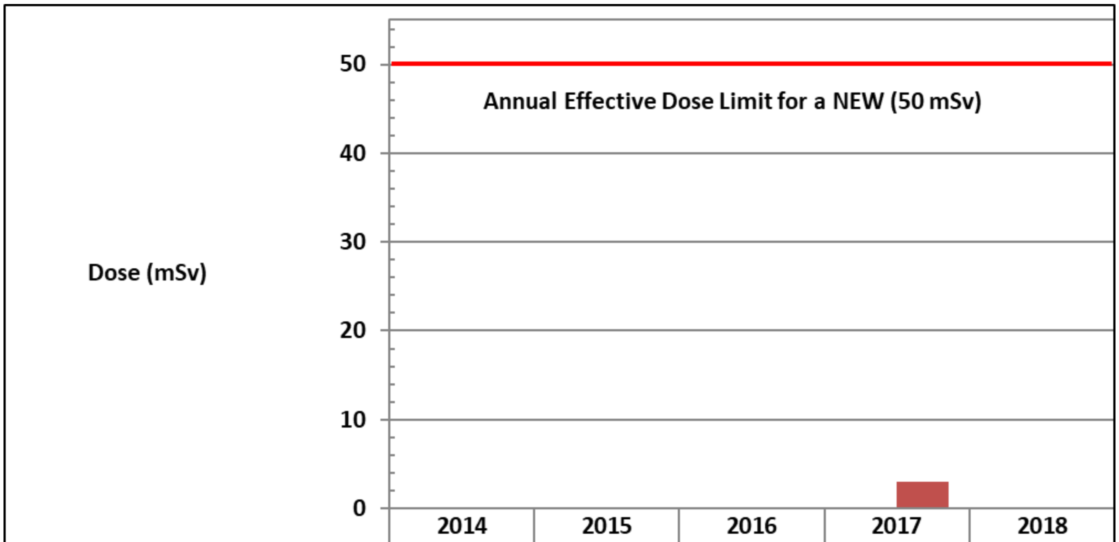
In 2018, external dosimeters issued to non-NEWs at G-1 did not record any measureable doses.

Nuclear Power Demonstration Waste Facility

Figure E-7 provides the average effective doses and the maximum effective doses to NEWs from 2014 to 2018. In 2018, the maximum effective dose received by a NEW at NPD facility was 0.09 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv.

Since 2014, there has been a significant increase of work activities at NPD, including the management of low level radioactive waste and various characterization activities. Particularly in 2017, characterization work and hazard reduction activities (i.e., asbestos abatement) resulted in an increase in radiation doses to NEWs when compared to previous years. The maximum individual effective dose of 3.02 mSv was received by a contractor engaged in asbestos abatement activities in the Boiler Room.

Figure E-7: Average and maximum effective doses to NEWs at NPD from 2014-2018



	2014	2015	2016	2017	2018
Average Effective Dose (mSv)	0.00	0.00	0.00	0.05	0.00
Maximum Effective Dose (mSv)	0.09	0.12	0.05	3.02	0.09
Number of NEWs Monitored	177	211	212	265	186

Annual average and maximum equivalent (skin) dose results for NEWs at NPD, from 2014 to 2018, are provided in Table E-9. In 2018, the maximum skin dose received by a NEW at NPD was 0.09 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Table E-9: Equivalent (skin) doses to NEWs at NPD from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.00	0.00	0.00	0.04	0.00	n/a
Maximum skin dose (mSv)	0.09	0.12	0.00	3.03	0.09	500 mSv/year

Non-NEWs at NPD

In 2018, external dosimeters issued to non-NEWs at NPD did not record any measureable doses.

F. ESTIMATED DOSE TO THE PUBLIC

This appendix contains information on the estimated dose to the public around CNL sites. Regulatory release limits known as derived release limits or DRLs are site-specific calculated releases that could, if exceeded, expose a member of the public of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/year. DRLs are calculated using CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*. [20]

As per the *Radiation Protection Regulations* subsection 1(3), and considering the fact that the radiological releases from all the sites covered by this ROR have remained small fractions of the DRLs applicable to those sites, the contribution to the dose to the public from these releases remains a very small fraction of the prescribed limit for the general public.

Chalk River Laboratories

CNL has implemented an Environmental Monitoring Program (EMP) at CRL, which complies with the CSA N288.4, *Environmental Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills*. Table F-1 provides dose to the public from CNL-CRL site since 2014.

Table F-1: Maximum Effective Doses to a Member of the Public from 2014-2018

Dose Data	2014	2015	2016	2017	2018	Regulatory Dose Limit
Maximum Effective Dose (mSv)	0.060	0.082	0.078	0.087	0.036	1 mSv/year

The maximum dose in each year since 2014 has been well below the dose limit of 1 mSv/year. Furthermore, at no point during that period did the emissions from the CRL site exceed the constraint for dose to the public of 0.30 mSv/yr.

Whiteshell Laboratories

The dose to critical groups from releases from CNL-WL in 2018 was 0.000036 mSv, which is well below the regulatory dose limit of 1 mSv/year.

Table F-2: Maximum effective dose to a member of the public, CNL-WL, 2014-2018

Dose data	2014	2015	2016	2017	2018	Regulatory dose limit
Maximum effective dose (mSv)	<0.002	<0.001	7.5E-05	4.8E-05	3.6E-05	1 mSv/year

Remediation Sites

A modified approach for calculating estimated dose to the public was performed by CNL for PHAI sites in 2018, and included both radon monitoring and fence line dosimeter measurements at both PHP and PGP sites.

The annual estimated doses to the public at PGP and PHP sites in 2018 were 0.020 mSv/year and 0.0275 mSv/year, respectively, which are well below that annual regulatory dose limit of 1 mSv.

Table F-3: Maximum effective dose to a member of the public, PGP, 2014-2018

Dose data	2014	2015	2016	2017	2018	Regulatory dose limit
Maximum effective dose (mSv)	0.00383	0.0084	0.00543	0.00571	0.020	1 mSv/year

Table F-4: Maximum effective dose to a member of the public, PHP, 2014-2018

Dose data	2014	2015	2016	2017	2018	Regulatory dose limit
Maximum effective dose (mSv)	0.02867	0.09352	0.01195	0.0045	0.0275	1 mSv/year

Douglas Point Waste Facility

All releases of radioactive material in DP effluents are a small fraction of their respective DRLs and thus, continue to indicate minimal impact on the public or the environment. DP is located within the Bruce Nuclear Site. The Bruce Power environmental monitoring program captures any environmental impacts from the small contribution from DP. The dose to the public from the Bruce Nuclear Site, including contributions from the DP, remain *de minimus* (below 0.01 mSv/year).

Gentilly-1 Waste Facility

The effluent monitoring plan assessment conducted in 2016 by CNL determined that there is minimal or no source of airborne radioactivity from routine operations at G-1. In addition, all liquid releases were discharged through Gentilly-2 effluent system, operated by Hydro-Québec, and represent a small fraction of the total releases from the larger Gentilly site. The Hydro-Québec's Gentilly-2 environmental monitoring program captures any environmental impacts from the small contribution from G-1. The dose to the public from the Gentilly-2 nuclear site, including contributions from G-1, remain *de minimus* (below 0.01 mSv/year).

Nuclear Power Demonstration Waste Facility

NPD is no longer discharging liquid effluents from the facility sumps to the Ottawa River, and there were no such releases during the 2018 reporting period. All other releases of radioactive material in NPD effluents are a small fraction of their respective DRLs and thus, continue to indicate minimal impact on the public or the environment. CNL's environmental monitoring at CRL will regionally overlap with the NPD waste facility, so information from CRL's off-site environmental monitoring program could also be considered. CNSC staff have determined that the public dose from NPD remains at a very small fraction of the public dose limit.

G. LOST-TIME INJURY INFORMATION

This appendix contains information on the number, frequency and severity of recordable lost-time injuries at the CNL sites covered by this ROR, with data presented back to 2014.

Frequency and severity are calculated per 100 full-time workers (equivalent to 200,000 worker-hours per year) using the following formulas:

Frequency rate = (# of Lost-Time Injuries) x (200 000 hrs of exposure) / (person hours worked)

Severity rate = (# of Working Days Lost) x (200 000 hrs of exposure) / (person hours worked)

Table G-1: Summary of CRL's recordable lost time injuries (RLTI), frequency and severity *(Source: CNL)*

Year	2014	2015	2016	2017	2018
Person Hours Worked (all CNL)	6 248 900	6 294 295	6 405 670	-	-
Person Hours Worked (CRL only)	-	-	-	5 597 015	5 369 450
Lost-Time Injuries	9	2	6	4	5
Working Days Lost	37	7	47	10	69[a]
Frequency	0.29	0.06	0.19	0.14	0.18
Severity	1.18	0.22	1.47	0.36	2.47
[a] Lost time and work days lost in 2018 data is based on US Occupational Safety and Health Administration Guidelines, therefore the rates will be slightly increased .					

Note that prior to 2017, CNL did not provide data for person-hours worked on CRL site alone, therefore total CNL hours worked are used in place of that data. This skews frequency and severity data for the CRL site for the 2014-2016 years, and makes comparison between pre- and post-2017 data for CRL difficult.

For 2018, 69 working days were lost at CRL, the most since 2014. 60 of these were attributable to a single injury, which was incurred when a worker tripped and fell from a flat-bed truck trailer.

Table G-2: Summary of WL's recordable lost time injuries (RLTI), frequency and severity *(Source: CNL)*

Year	2014	2015	2016	2017	2018
Person Hours Worked	883 500	741 000	684 450	706 000	688 000
Lost-Time Injuries	4	0	1	3	1
Working Days Lost	54	0	5	27	5
Frequency	0.9	0	0.29	0.85	0.28
Severity	12.2	0	1.46	7.67	1.45

The frequency numbers for CRL and WL can be compared to lost-time injury rate data from the Ontario Workplace Safety and Insurance Board (WSIB); the WSIB's lost-time injury rate is calculated using the same formula as frequency rate shown above. WSIB data is shown in Table G-3 below.

Table G-3: WSIB Lost-Time Injury Rates data for select industries

Industry Sector	2014	2015	2016	2017	2018
Automotive	1.06	0.94	1.06	1.05	1.14
Construction	1.13	1.09	1.15	1.15	1.13
Municipal	1.51	1.44	1.49	1.65	1.64
Transportation	1.83	1.59	1.76	1.74	1.90
Chemicals/Process	0.69	0.6	0.75	0.73	0.77
Electrical	0.35	0.37	0.4	0.43	0.41
Manufacturing	0.64	0.59	0.67	0.64	0.70

It can be seen that Frequency for lost-time injuries at CNL sites is less than WSIB data for most industries since 2014.

The PHP, PGP, DP, G-1 and NPD sites have not recorded a lost-time injury since 2014; the person-hours worked for these sites are provided below for comparison with the same data for CRL and WL. RLTI frequency and severity cannot be calculated if there are no lost-time injuries over the period in question.

Table G-4: Person-hours worked at PHP, PGP, DP, G-1 and NPD *(Source: CNL)*

Year	2014	2015	2016	2017	2018
Person Hours Worked – PHAI	Not Available				260 776
Person Hours Worked – DP	20 400	28 960	29 600	30 080	31 320
Person Hours Worked – G-1	4 600	6 160	7 240	8 600	9 320
Person Hours Worked – NPD	20 000	32 800	34 900	34 500	30 300
Lost-Time Injuries for PHP, PGP, DP, G-1 and NPD	0	0	0	0	0

H. DERIVED RELEASE LIMITS (DRLS) AND TOTAL ANNUAL RELEASE OF RADIONUCLIDES DIRECTLY[12] TO THE ENVIRONMENT

During the December 2018 Commission meeting, CNSC staff committed to providing an annual update to the Commission on the decision on radionuclide reporting in the National Pollutant Release Inventory (NPRI). The CNSC is making radionuclide release data more readily accessible to the public as part of its commitment to open government and its mandate to disseminate this information to the public. The commitment to provide data on the total annual release of radionuclides in the appendices of the ROR continues within this year's RORs. In addition, the CNSC and the NPRI are working together to establish active links between the CNSC and NPRI web sites. Stakeholder sub-group consisting of environmental non-governmental organizations and industry are completing active beta testing of the links between the NPRI site and existing CNSC data products (RORs, etc). The CNSC has also commenced the creation of downloadable digital databases of radionuclides releases further supplementing the range of CNSC environmental data products linked to the NPRI website. The downloadable databases are expected to become part of the active beta testing activities in the latter part of 2019.

Derived Release Limits

While it is possible to calculate a specific DRL for each radionuclide released by a given site, it may not be practical nor necessary to monitor each of these separately. In such cases, emitted radionuclides may be organized into groups that are selected based on factors such as physicochemical properties and method of monitoring. DRLs can then be established for the radionuclide group applying a number of simplifying and conservative (i.e., protective) assumptions such as assuming that the group is composed entirely of the most restrictive radionuclide representative of the group. The most restrictive radionuclide can differ for different nuclear facilities depending on releases, local conditions and the choice of the representative person. Emission monitoring may then be carried out using a non-radionuclide-specific method for the group rather than for specific radionuclides. The most common DRL groupings for airborne releases are noble gases, radio-iodines, particulate beta/gamma, and particulate alpha, while the most common DRL groupings for liquid releases are beta/gamma emitters and alpha.

Licensees are required to demonstrate that their releases are not only below their respective DRLs but that the sum of their release are below 1 mSv/year, the public regulatory dose limit. To ensure these limits are respected, licensees also are required to develop action levels significantly below their DRLs as a means of detecting elevated releases meriting follow-up investigations and actions to ensure releases are adequately controlled.

[12] Using definitions of the National Pollutant Release Inventory, these are on-site releases directly to atmosphere or surface waters and do not include releases to sewer or off-site treatment, storage or disposal facilities.

Total Annual Release of Relevant Radionuclides to the Environment

The following tables provide the annual load of key radionuclides directly released to atmosphere or to surface waters from licensed facilities operated by CNL for the reporting period of 2014 – 2018. Applicable DRLs are also presented, where they exist. There are no comparisons to limits and guidelines for PHAI sites because the Port Granby Project and the Port Hope Project have limits in their licences which are based on either monthly mean, weekly mean, or each grab sample.

Over this reporting period, there have been no exceedances of licence derived release limits and licence limits.

As CNL is the licence holder for the G-1 waste management facility, releases would be reported in this ROR. However, an effluent monitoring plan assessment conducted in 2016 confirmed that there is minimal or no source of airborne radioactivity at G-1. Therefore, airborne emissions are no longer monitored. Furthermore, all liquids from facility sumps were transferred to the Gentilly-2 facility effluent system to be managed and discharged by Hydro-Quebec. These releases are included in the reported Gentilly-2 releases available in the 2017 and in the 2018 *Regulatory Oversight Report for Nuclear Power Generating Sites*.

Chalk River Laboratories

Table H-1: Chalk River Laboratories annual radionuclide releases to atmosphere for 2014 – 2018.

Year	Tritium: (HTO:Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Argon-41 (Bq)	Xenon-133 (Bq)
DRL	**1.25E+16**	**2.14E+15**	**4.96E+16**	**3.96E+12**	**6.50E+16**	**8.35E+17**
2018	2.29E+14	2.54E+11	6.50E+12	1.02E+08	2.59E+15	N/A [a]
2017	2.50E+14	4.90E+11	6.50E+12	3.82E+08	1.16E+16	N/A [a]
2016	2.30E+14	4.84E+11	8.50E+14	5.17E+10	1.07E+16	3.12E+15
2015	2.77E+14	3.77E+11	1.20E+15	1.03E+11	1.29E+16	4.89E+15
2014	2.60E+14	8.69E+11	2.11E+15	2.06E+11	9.37E+15	8.68E+15

[a] After the safe shutdown of the Molybdenum Production Facility in 2017, there are no longer airborne releases of Xenon-133.

Table H-2: Chalk River Laboratories annual radionuclide releases to surface water for 2014-2018.

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**1.03E+17**	**1.32E+12**	**2.70E+13**
2018	1.93E+13	6.88E+08	2.84E+10
2017	3.81E+13	7.66E+08	4.17E+10
2016	3.50E+13	6.60E+08	3.22E+10
2015	3.94E+13	6.94E+08	3.96E+10
2014	3.07E+13	9.07E+08	2.62E+11

Whiteshell Laboratories

Table H-3: Whiteshell Laboratories annual radionuclide releases to atmosphere for 2014-2018.

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**8.58E+16**	**9.00E+10**	**3.60E+11**
2018	1.31E+10	9.13E+04	1.70E+05
2017	5.03E+10	9.34E+04	2.24E+05
2016	3.24E+10	9.46E+04	2.12E+05
2015	9.88E+10	9.79E+04	2.26E+05
2014	3.48E+10	8.82E+04	3.97E+05

Table H-4: Whiteshell Laboratories annual radionuclide releases to surface water for 2014-2018.

Year	Gross Alpha (Bq)	Uranium-total (Bq)	Plutonium -239/240 (Bq)	Plutonium -238 (Bq)	Americium-241 (Bq)	Gross Beta (Bq)	Strontium-90 (Bq)	Cesium -137 (Bq)
DRL	**1.33E+10**	**1.50E+11**	**1.33E+10**	**1.39E+10**	**1.25E+10**	**a**	**1.56E+11**	**1.39E+11**
2018	3.90E+07	1.16E+07	2.32E+07	1.84E+07	4.21E+06	1.94E+08	3.21E+07	1.51E+07
2017	3.88E+07	1.69E+07	1.20E+07	8.69E+06	5.10E+06	2.97E+08	6.67E+07	1.89E+07
2016	4.59E+07	N/A[b]	N/A	N/A	N/A	2.83E+08	6.08E+07	1.28E+07
2015	4.08E+07	N/A	N/A	N/A	N/A	2.23E+08	3.96E+07	1.65E+07
2014	4.76E+07	N/A	N/A	N/A	N/A	9.31E+07	6.61E+07	2.66E+07

[a] There is no DRL for gross beta because there is a DRL for the regulated components of gross beta (cesium-137 and strontium-90).

[b] Monitoring of uranium-total, plutonium-239/240, plutonium-238, and americium-241 began in 2017.

Port Granby Project

Table H-5: Port Granby Project annual radionuclide releases to surface water for 2014-2018.

Year	Radium-226 (MBq)	Uranium (kg)
2018	1.0	1.3
2017	1.0	1.4
2016	2.4	15.6
2015	4.6	29.0
2014	5.4	36.7

Port Hope Project

Table H-6: Port Hope Project annual radionuclide releases to surface water for 2014-2018.

	Releases from routine operations		Releases from non-routine operations	
Year	Radium-226 (MBq)	Uranium (kg)	Radium-226 (MBq)	Uranium (kg)
2018	0.7	0.5	5676.9	14.6
2017	0.8	0.1	15868.0	110.1
2016	3.3	19.3	N/A	
2015	4.5	20.7	N/A	
2014	7.7	23.0	N/A	

Table H-6 shows both releases from the Port Hope Project due to routine operations, and from emergency releases of treated water. In 2017, CNL began using the new Waste Water Treatment Plant to treat contaminated water, in place of the old Water Treatment Building. Due to heavy rainfall events in both 2017 and 2018, CNL restarted the Water Treatment Building to treat excess contaminated water, in accordance with their water contingency plan, and in order to avoid a release of untreated water to the environment. CNL's water management challenges in 2017 were the subject of an Event Initial Report to the Commission [21]. For both 2017 and 2018, there were no exceedances of regulatory limits and toxicity testing showed that the water was not acutely lethal to fish or to aquatic life.

For both the Port Granby Project and the Port Hope Project, the loadings were calculated by multiplying the monthly total volume released by the monthly average concentrations. The total annual loadings are a sum of the monthly loads.

Douglas Point

Table H-7: Douglas Point annual radionuclide releases to atmosphere for 2014-2018

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)	Carbon-14 (Bq)
DRL	**5.46E+17**	**3.69E+12**	**3.69E+12**	**3.22E+15**
2018	7.96E+11	3.07E+03	4.55E+04	1.51E+09
2017	1.12E+11	1.64E+03	2.29E+04	N/A[b]
2016	1.59E+11	1.68E+03	1.91E+04	N/A
2015	1.33E+10	N/A[a]	N/A	N/A
2014	2.74E+11	N/A	N/A	N/A

[a] Monitoring of gross alpha and gross beta began in 2016.

[b] Monitoring of carbon-14 started in 2018 because new activities that have a potential for a measurable release of C-14 started.

Table H-8: Douglas Point annual radionuclide releases to surface water for 2014-2018.

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**2.04E+17**	**3.43E+13**	**3.43E+13**
2018	2.73E+10	1.18E+07	1.97E+07
2017	3.57E+10	1.12E+07	2.56E+07
2016	2.23E+10	9.00E+06	1.05E+07
2015	4.24E+10	N/A [a]	7.31E+07
2014	5.19E+10	N/A [a]	6.37E+07

[a] Monitoring of gross alpha began in 2016.

Nuclear Power Demonstration

Table H-9: Nuclear Power Demonstration annual radionuclide releases to atmosphere for 2014-2018.

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
DRL	**4.52E+16**	**3.83E+12**
2018	3.08E+11	4.23E+04
2017	1.48E+12	1.84E+05
2016	2.53E+11	4.30E+04
2015	2.15E+11	4.81E+04
2014	2.63E+11	5.27E+04

Table H-10: Nuclear Power Demonstration annual radionuclide releases to surface water for 2014-2018

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
DRL	**4.33E+17**	**2.56E+13**
2018	1.80E+09	5.91E+04
2017	1.08E+11	1.15E+06
2016	7.36E+10	2.56E+06
2015	6.61E+10	4.13E+06
2014	9.60E+10	6.08E+06

I. SELECTED WEBSITES

Atomic Energy of Canada Limited - https://www.aecl.ca/

Canadian National Energy Alliance - http://www.cnea.co/

Canadian Nuclear Laboratories - http://www.cnl.ca/en/home/default.aspx

Canadian Standards Association - https://www.csagroup.org/

The Canadian Nuclear Safety Commission - www.nuclearsafety.gc.ca

The CNSC's Independent Environmental Monitoring Program - https://nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm

CSA Standards via the CNSC website - https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/csa-standards.cfm

Performance Assurance REV 2

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Information Use

Approved by	Title	Date
Angela Coulas	Director, Oper Excellence	2023/11/29

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Table of Contents

1. Scope and Applicability

This company-wide Interpretation document applies to all activities unique to the Performance Assurance Function, performed by Canadian Nuclear Laboratories' (CNL) employees, contractors and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

The Performance Assurance Function supports CNL's responsibility to ensure the safety of its employees and the public, and to protect the environment from potential hazards by implementing the following comprehensive programs which work collaboratively to establish a system that ensures worker safety and promotes continual improvement:

- Problem identification and resolution enables the timely reporting of issues, problems, opportunities for improvement, and events and is inclusive of investigation and corrective action processes. These processes enable CNL to implement measures and mitigations to prevent recurrence.
- Measuring and monitoring processes support the creation of leading indicators through the collection and trending of data and promotes continual improvement through the implementation of programmatic reviews and assessments to confirm compliance to requirements and assesses program health.
- Continual improvement combines measuring and monitoring data with knowledge gained from benchmarking and lessons learned to ensure CNL effectively and efficiently implements improvement changes.
- Human performance provides workers with tools and skills to reduce errors and prevent/eliminate events.

2. Purpose

Performance Assurance supports CNL's ability to improve operational performance, enhance safety, and reduce the occurrence of unplanned events. The Function provides an improvement framework to assist in decision-making while promoting organizational learning, innovation, and continual improvement.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [1] contains specific meanings for those words that require further clarification.

3.1 Definitions

Action Manager	Any individual assigned to perform the task of implementing an action to prevent recurrence, assigned through the ImpAct and regulatory processes.

Active Error	An action (behaviour) that changes equipment, system, or plant state triggering immediate undesired consequences.
Adverse Trend	A negative change in performance data that knowledge, experience, statistical significance, and judgement indicate is unacceptable because of the adverse impact on safety or reliability, quality, budget or schedule or because of the relatively large number of similar performance problems in a bin that indicates a more significant problem is likely to occur if the issue is not addressed.
Apparent Cause	A reasonable conclusion about how and why an adverse condition occurred based on the results of a limited evaluation (from between a day to a week). A limited investigation used to gain a better understanding of what happened or to determine the cause of lower- level performance gaps or adverse trends so that action can be taken to avoid a more serious event.
Apparent Cause Analysis	Analysis performed for a reasonable conclusion about how and why an adverse condition occurred based on the results of a limited evaluation (anywhere from a day to a week).
Barrier Analysis	An analysis technique that identifies any administrative, physical, or engineered controls that are intended to prevent or inhibit an undesirable condition.
Benchmarking	A performance improvement process for measuring and evaluating processes, procedures, and tools utilized by top performing organizations; with the intent of incorporating the best safety, organizational, and business practices within CNL.
Casual Factors	Factors that contribute to the cause of the problem.
Cause Code	A trend code utilized to facilitate binning (grouping) data.
Cause Determination Effort	The various levels of investigation required to determine the cause of the problem.
Cognitive Trend	The perception of multiple occurrences of undesired events or decline in performance without supporting evidence. Relying only on knowledge, attention, memory, and judgement.
Continuous Use	The document usage classification requiring the document to be in hand while conducting work and a place keeping method is used to track activity step completion.
Corrective Action	A measure taken and documented to reasonably prevent the occurrence of a problem or non-conformance based on the identified cause(s).

Corrective Action Plan	A plan of action(s) that corrects or is intended to correct one or more current conditions and/or future behaviours, actions, inactions, thus mitigating the risks or reducing the severity of potential adverse consequences.
Critical Step	A procedure step, series of steps, or action that, if performed improperly, will cause irreversible harm to plant equipment, people, the environment or have a significant impact on plant operations
Effectiveness Review	A formal review and evaluation of a corrective action plan to ensure action implementation addresses cause and will reasonably prevent recurrence.
Error-Likely Situation	Also referred to as Error Traps or Error Precursors. Unfavourable factors embedded in the job site that increases the probability of error during the performance of a specific task by a particular individual.
Event Code	A code used to facilitate binning (grouping) data based on the attributes of the event, problem or opportunity for improvement.
Event Free Tools	A set of discrete behaviours and techniques that assist employees to maintain positive control of a work task. When used thoroughly and rigorously, they minimize human error potential (i.e.) anticipate, prevent, or catch active errors before they cause harm to person, property, or environment.
Extent of Condition	The extent to which the actual condition(s) exist in other equipment, processes, or human performance.
Fact Finding	The process of collecting necessary information immediately after an unplanned/undesired event or condition.
Failure Mechanism	The process or sequence of events that caused a defect or failure.
Flawed Barrier	A procedure, process, or human performance tool designed to promote successful completion of an activity that has failed due to incorrect use or omission.
Human Performance	The outcomes of human behaviours and actions, in a specified environment, that reflect the ability of workers and management to meet a system's defined performance under the conditions in which the system will be employed.
Improvement Action (ImpAct)	ImpAct is an abbreviation of the words 'Improvement' and 'Action' and refers to CNL's problem identification tool which enables the formal documentation, monitoring and disposition of events,

	problems, non-conformances, opportunities for improvement and personnel injuries.
Information Use	The document usage classification that requires knowledge and adherence but does not need to be at the work location.
Initiating Action	The action which initiates an event; something that causes something else to happen; to actuate or set off.
Initiator	The individual who raises the ImpAct record first documenting the event.
Latent Organizational Weakness	Undetected deficiencies in organizational processes or values creating workplace conditions that may provoke error and degrade the integrity of defences.
Lessons Learned	Information originating within CNL and other industry sources that describe events, significant safety issues, equipment failures, guidelines and good practices that may represent opportunities to apply lessons to be learned to prevent events and/or improve processes within CNL. Insights and learnings discovered that should be communicated to the organization.
Near Miss	An unplanned event or situation that under the exact circumstances and less fortuitous conditions, had the potential to result in a highly consequential situation such as a severe personal injury or substantial damage to equipment, property, materials, the environment, or significant negative business impact.
ObservationWay	Observation and Coaching module designed to capture data from Observation and Coaching sessions.
Place Keeping	Physically marking steps in a procedure to prevent the omission or duplication of the steps to maintain an account of steps in progress, steps completed, steps not applicable, and steps not yet performed.
Post-Job Review	A discussion with the work team, intended to identify and capture lessons learned following performance of a task.
Pre-Job Brief	A dialogue with all involved staff regarding identified risks and control measures, specific to a job, prior to performing work.
Problem Statement	A description of an issue to be addressed or a condition to be improved upon. It identifies the gap between the current problem and goal.
Reference Use	The document usage classification that requires the document to be available at the work location.

Remedial Action	An action taken and documented to remedy the symptom of problems, events, incidents, or error likely situations. The action remedies the problem but does not address the cause(s).
Responsible Manager	An individual in a management role assigned overall responsibility for the resolution of an issue. The owner of the issue, responsible for the entire process from determining the significance level to correcting the problem or closing out the nonconformity.
Root Cause	The fundamental reason for the occurrence of a problem.
Root Cause Analysis	Analysis performed to determine the fundamental reason for the occurrence of a problem.
Safety Culture	An organization's values and behaviors, modeled by its leaders and internalized by its employees that serve to make safety the overriding priority.
Significance Level	One of four levels assigned to a problem (1 being most significant, 4 least significant) based on actual or potential and resulting in safety, environment or business consequences of the problem. There is a fifth level selection (0) available that is reserved for ImpActs raised in error or duplicate ImpAct items identifying the same event.
Stop and Seek-Out	A technique used in the face of uncertainty to evaluate and resolve a situation before proceeding.
The System	Refers to the framework around which work occurs. This includes the human infrastructure, the management infrastructure, and the physical infrastructure that all support work operations.
Trend Code	Alphabetic, numeric, or alphanumeric codes applied to ImpActs to bin (group) data to facilitate analysis.
Usage Classification	A classification that specifies the required frequency with which an individual will refer to a procedural document.

3.2 Acronyms

ACA	Apparent Cause Analysis
CAP	Corrective Action Plan
CARB	Corrective Action Review Board
CDE	Cause Determination Effort
CI	Continual Improvement
CM	Change Management

D-EFDR	Departmental Event Free Day Reset
DST	Dedicated Screening Team
EFDR	Event Free Day Reset
EFT	Event Free Tools
HU	Human Performance
ImpAct	Improvement Action
MMI	Maturity Model Indicator
MRM	Management Review Meeting
O&C	Observation and Coaching
OPEX	Operating Experience
RCA	Root Cause Analysis
RLMC	Rapid Learning Morning Call
RM	Responsible Manager
S-EFDR	Site Event Free Day Reset
SL	Significance Level
SMARTER	Specific, Measurable, Accountable, Reasonable, Timely, Effective and Reviewed
SSCA	Safety and Security Culture Assessment
STAR	Stop, Think, Act, Review

4. Roles and Responsibilities

4.1 Responsible Executive

In addition to the responsibilities of Responsible Executives identified in the *Canadian Nuclear Laboratories Management System Manual* [2], the Responsible Executive of the Performance Assurance Function is responsible for:

- Establishing and communicating the goals, vision and core values of the human performance program.
- Establishing and maintaining measures to promote a just culture, including implementation of problem identification and resolution processes that enable personnel to freely raise safety concerns.
- Encouraging feedback and suggestions for improvement from across the organization.

4.2 Functional Support Manager, Performance Assurance

In addition to the responsibilities of Functional Support Managers identified in the *Canadian Nuclear Laboratories Management System Manual* [2], the Performance Assurance Functional Support Manager (FSM) is responsible for:

- Establishing and implementing a systematic approach to managing human performance that supports safe and effective work for all workers.
- Establishing and implementing human performance processes and training to ensure factors that influence human performance are considered in continual improvement.
- Establishing and implementing the requirements for the identification and systematic analysis of factors related to human performance in the analysis of events.
- Establishing a Safety and Security Culture assessment framework to assess the maturity of cultural indicators throughout CNL.
- Promoting a just culture through the implementation and promotion of CNL's blameless problem identification and resolution processes.
- Establishing and maintaining performance indicators that measure the health of the Contractor Assurance System and delivering the Corporate Scorecard to Atomic Energy of Canada (AECL) in compliance with the requirements of the Site Operating Contract Agreement (SOCA).

4.3 Oversight Bodies

Oversight bodies of CNL's problem identification and resolution program include the Dedicated Screening Team (DST), Management Review Meeting (MRM) and the Corrective Action Review Board (CARB). Members of the affiliated Performance Assurance oversight bodies are responsible for:

- Ensuring application of a just and blameless culture through the screening and dispositioning of problem identification records by protecting workers who participate in the self-reporting of events or who highlight practises that need improvement.
- Identifying and sharing occurrences, results and knowledge across the organization so that the systemic nature of work is understood and leveraged.

4.4 Program Specialists

Program Specialists include roles and/or designations such as ImpAct Coordinator and Cause Analyst and are responsible for:

- Maintaining appropriate cause analysis training and qualification, as required.
- Acting as a Performance Assurance subject matter expert to the organization to ensure compliant and effective implementation of associated processes.

- Enabling continual improvement through collection of programmatic feedback, documentation of opportunities for improvement and dispositioning of applicable lessons learned.

4.5 Human Performance Officers

Human Performance Officers are responsible for:

- Championing the human performance program through promotion and training of human performance tools.
- Developing and delivering leadership training focused on supporting and improving human performance across the organization.
- Monitoring and evaluating the effectiveness of the human performance program by conducting periodic assessments that analyze key work activities to understand the gaps between tasks and activities.
- Implementing CNL's Safety and Security Culture assessment framework to assess the maturity of cultural indicators throughout CNL.

4.6 Line Management

Line Management is responsible for:

- When appropriate, assuming the role of Responsible Manager and ensuring problems are effectively and efficiently managed as per CNL's problem identification and resolution processes.
- Proposing and assisting in the development of metrics required to assess the ongoing health and effectiveness of the programs within their area of responsibility, and monitoring for trends.
- Implementing actions within their area of responsibility as required by CNL's problem identification and resolution processes, or as required to ensure employee, equipment and environmental safety as the immediate response to degraded conditions or problems.
- Capturing, documenting and sharing applicable lessons learned.
- Encouraging and cultivating a just culture through promotion of problem identification in a blameless manner.
- Promoting adherence to the Event Free Tools and embedding them within work processes where appropriate and applicable.
- Reinforcing standards of excellence, continually striving for improvement and intervening to correct performance at early signs of decline.

- Actively participating in event investigation processes as required, including reporting of events through the Rapid Learning Morning Call, execution of Fact Findings, and participation in cause analyses.

4.7 Employees

Employees are responsible for:

- The timely reporting and documentation of problems.
- Application and utilization of Event Free Tools to mitigate human performance errors.
- Identifying and applying lessons learned.
- Actively participating in CNL's problem identification and resolution processes through assisting in collection and documentation of facts and implementation of immediate actions to return to safe working conditions.

5. Functional Programs

The Performance Assurance Function supports CNL's responsibility to ensure the safety of its employees and the public, and to protect the environment from potential hazards by implementing four comprehensive programs which work collaboratively to establish a system that ensures worker safety and promotes continual improvement.

- Problem identification and resolution
- Measuring and monitoring
- Continual improvement
- Human performance

5.1 Problem Identification and Resolution

Problem identification and resolution is an established framework of processes which are utilized to report, identify, investigate, implement, and resolve problems and issues. At the conclusion of problem disposition is the capability to test for effectiveness to ensure appropriate and effective framework application and confirm implementation of suitable disposition and mitigation techniques.

The application of problem identification and resolution processes, as shown in Figure 1, can be iterative, so long as resolution is achieved.

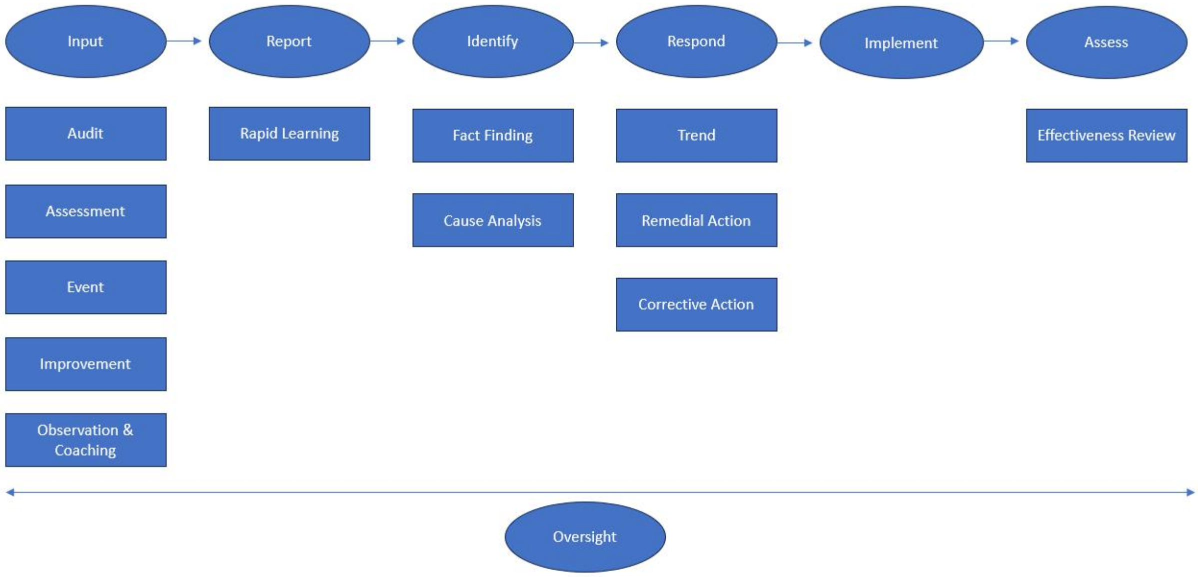

Figure 1: Problem Identification and Resolution

All issues, problems, opportunities for improvement and events are documented and tracked via an Improvement Action (ImpAct) record [3]. For each occurrence, an ImpAct record is raised to document details and important information, assign a Responsible Manager accountable for the remediation of the documented event or problem, and raise and monitor action completion. Each ImpAct receives management oversight to ensure adherence to established problem identification and resolution processes.

5.1.1 Rapid Learning Morning Call

Promptly upon discovery of problems, events, issues or opportunities for improvement, facts are shared with the organization via a centralized process to ensure early notification and involvement of necessary parties. The *Rapid Learning Morning Call (RLMC)* [4] provides a singular platform for the sharing of facts and information direct to a diverse employee group across the organization. The RLMC provides CNL, AECL and Canadian Nuclear Safety Commission (CNSC) staff the forum to deliver and receive swift notification of information which may affect or impact work activities and serves as a vehicle to ensure lessons learned are shared across the organization.

5.1.2 Fact Finding

Fact Finding [5] is executed in response to an event, issue or problem to enable gathering of pertinent information, artifacts and witness statements in a timely manner. Fact Finding will support the establishment of a timeline of events and serve as a means of assembling the appropriate staff needed to assist in event reconstruction. This process aids in the early development of corrective actions and supports the immediate implementation of remedial actions and compensatory measures to mitigate the risk of future occurrence of events arising from similar circumstances.

Fact Finding is intended to supplement the cause analyses and corrective action determination processes but not replace them. Completed Fact Finding Reports [6] are used to support cause analyses when the event significance level requires it, or when Fact Finding leaves unanswered questions regarding cause that need to be determined to prevent risk of reoccurrence.

5.1.3 Cause Analysis

Cause analyses are systematic approaches carried out to determine the cause of an issue or event. The type of cause analysis employed is determined using a graded approach, based on risk of recurrence and severity of the initial event. Determination of the appropriate cause analysis tool is aided by completion of initial investigation, such as *Fact Finding* [5]. The information gained from initial investigation is used to support the cause analysis process in determining the most probable, or root cause of an event.

5.1.3.1 Apparent Cause Analysis

The *Apparent Cause Analysis* [7] process establishes a systematic approach to identify the most probable causes of an issue and determine the corrective actions required to reduce or eliminate recurrence. This process is used for significance level 2 or 3 events where it is required to determine the most probable causes, but determination of root cause is not required. An apparent cause analysis (ACA) therefore, is carried out when the casual analysis effort is commensurate with the consequences of the event and the organization’s tolerance and/or risk of potential recurrence.

To ensure consistent analysis techniques are applied to correctly identify causes and develop effective corrective actions, ACAs are completed using the *Apparent Cause Analysis Report* [8] and receives management oversight and acceptance.

5.1.3.2 Root Cause Analysis

The Root Cause Analysis [9] process establishes a systematic approach to determine the underlying factor(s), identify the root cause, and document the corrective actions required to mitigate the risk of recurrence. A root cause analysis (RCA) is undertaken to find evidence-based facts, determine how their shared interactions caused the unplanned event, and use the learnings gleaned from the analysis to identify and implement effective solutions. An RCA is required for the highest significance events (significance level 1), but may be undertaken for significance level 2 events where determination of root cause is required due to risk and probability of recurrence.

To ensure consistent analysis techniques, adequate level of rigor commensurate with risk, accurate casual identification and effective corrective action development, the completed Root Cause Analysis Report [10] receives management oversight and acceptance.

5.1.4 Action Development

Action development and implementation is executed using a graded approach based on risk and problem/event severity.

Immediate actions are taken to ensure worker and system safety. These actions can be compensatory measures pending corrective action implementation, or they can standalone as sufficient in ensuring ongoing safe operations and conditions. Low significance events with no consequences or risk to safety may be closed without additional action; however, all problems identified and documented within CNL's issues management system will be used for trending purposes, ensuring that identified leading indicators are investigated and actioned before conditions create events.

Remedial actions are those taken to address the symptom of problems, events, incidents, or error-likely situations. The action remedies the problem but does not address the cause and is therefore implemented for low significance events, or to supplement corrective action implementation.

Corrective actions are those taken to reduce or eliminate the causes of an event and to reasonably prevent the recurrence of a problem or adverse condition based on the identified causes. Corrective actions are required for significance level 1, 2, and 3 events and are required to follow the SMARTER (Specific, Measurable, Accountable, Reasonable, Timely, Effective, Reviewed) criteria [3].

To ensure adherence to SMARTER criteria leading to effective action development, oversight is provided for all significance level 1 and 2 action plans, and selected Quality audit non-conformances. *The Corrective Action Review Board* [11] is a senior management forum chaired by the Chief Nuclear Officer that ensures findings are properly addressed, appropriate actions are identified, the plan has set priorities basked on risk, and effectiveness measures are established. The CARB provides oversight of the health and effectiveness of the corrective action program by ensuring senior management involvement with, commitment to, and accountability for significant event corrective actions.

5.1.5 Effectiveness Review

The Effectiveness Review [12] process describes the mechanism for monitoring and evaluating the effectiveness of the organization's corrective action plans to ensure all corrective actions will address and correct underlying causes and conditions, and to aid in the early intervention of potentially weak corrective actions that risk implementation of proper mitigation measures. Effectiveness reviews are required for corrective action plans developed to address significance level 1, 2, and 3 actions.

All effectiveness reviews are presented to CARB for approval. In the event the effectiveness review concludes that the original corrective action plan was insufficient in appropriately dispositioning the problem, additional actions will be developed and implemented until CARB is satisfied that all appropriate mitigation measures to prevent recurrence have been implemented.

5.1.6 Oversight Bodies

All ImpAct records raised receive screening and management oversight to ensure appropriate application of problem identification and resolution processes. Management oversight is applied in a graded approach based on significance level. All ImpAct records are evaluated by the Dedicated Screening Team and the Responsible Manager (RM); significance level 4 ImpActs where the cause determination effort and/or significance level was altered by the RM, as well as significance level 1, 2, and 3 ImpActs are reviewed by the Management Review Meeting; and the investigation and corrective actions for significance level 1 and 2 ImpActs are reviewed by CARB.

5.1.6.1 Dedicated Screening Team

All ImpAct records are screened in a timely and consistent manner by the *Dedicated Screening Team* [13]. The DST completes initial review and classification of ImpActs utilizing problem identification and resolution criteria to ensure program compliance and consistency. The DST is comprised of Performance Assurance personnel, a Quality Program representative, and subject matter experts and ImpAct Coordinators as required.

5.1.6.2 Management Review Meeting

Management Review Meetings [14] are mandated to ensure senior management level oversight and engagement in CNL's problem identification and resolution program. MRMs provide rigorous review of ImpAct records, cause analysis reports, corrective action plans, and effectiveness reviews.

MRM teams are comprised of a diverse representation of key functions of the business, that are tasked with reviewing events, near misses, problems and opportunities for improvement from a systemic prospective to gain a deeper understanding of systemic issues and move the organization towards proactive ways to promote efficiencies and improve safety.

The *Management Review Meeting* [14] Terms of Reference details requirements related to establishing meeting quorum, frequency, agenda items and roles and responsibilities.

5.1.6.3 Corrective Action Review Board

The CARB reviews and accepts all corrective action plans developed to address significance level 1 and 2 events to ensure the findings are properly addressed, appropriate actions are identified, the plan has set priorities based on risk, and effectiveness measures are established. To fulfill this mandate, the CARB reviews RCAs, ACAs and Effectiveness Reviews which support the significance level 1 or 2 event. At the discretion of the CARB Chair, significance level 3 events can be brought in front of the CARB for review and approval.

The *Corrective Action Review Board Terms of Reference* [11] details requirements related to CARB's organization and membership, mandate, meeting frequency and roles and responsibilities.

5.2 Measuring and Monitoring

Data from systematic and repeatable processes is monitored to identify trends, leading indicators and identify areas for performance improvement.

5.2.1 Trending

Through the ongoing and consistent monitoring of data, trends in performance can be readily identified. Repeatable process measures and trend code application ensure consistency in data and enable effective monitoring and measuring. Trends are identified, investigated, and dispositioned as per *Trend Analysis* [15].

5.2.2 Contractor Assurance System Scorecard

The Contractor Assurance System (CAS) scorecard is an interactive tool used to display organizational performance measures based on the requirements applicable to CNL. The CAS Scorecard is one of several tools used to measure the performance of the overall *Contractor Assurance System* [16]. Performance Assurance collects data from across the organization and plots it to show variance in performance and adherence to goals to allow for early intervention should an adverse trend appear.

5.2.3 Management Review

Management Review critically assesses the implementation of the management system to ensure its continuing suitability, adequacy and effectiveness. The review enables assessment of outputs of various management system assessment processes to ensure the management system's continued evolution remains aligned with company goals and objectives and enables safe, effective and efficient conduct of work that ultimately achieves planned and desired results.

Management Review [17] outlines the process of assembling the outputs of ongoing weekly, monthly, and quarterly assessment and monitoring activities for the fiscal year, in addition to fiscal year assessments and audits. Analysis is then completed utilizing a holistic view of data, including trends from various monitoring and measuring activities, to determine the impact against the company's performance measures and objectives. The completed analysis report and findings are received by the Executive Team. Should formal action be required to appropriately manage or disposition findings, CNL's problem identification and resolution process will be followed [3] to effectively manage action execution.

5.2.4 Program Review

In addition to ongoing assessments, program reviews are conducted for individual programs to analyze and assess data from a specified timeframe. Often an annual review, results are compared to previous years to enable a more wholesome analysis than routine data monitoring offers. While certain program reviews are required by regulation, any program can be assessed to determine:

- The effectiveness of the existing program in accomplishing its goals and objectives.
- The existence of any program design problems or gaps.
- If process documentation requires revision due to changing requirements, incorporation of industry best practice or opportunities for improvement.
- If actions from the previous program review have been dispositioned and remain effective.

Program reviews are documented, with formal actions raised as a result of findings in accordance with CNL's problem identification and resolution processes.

5.2.5 Safety and Security Culture Assessment

A healthy safety culture is an interpretation of how safety is integrated into everyday work and interactions. It is reinforced in how people, including leadership, work together to create a deeper understanding of the culture and its impacts on safety. Monitoring to understand safety culture forms the foundation for building systemic safety improvements over time. Safety culture monitoring is executed in alignment with CNL's *Safety and Security Culture Assessment Framework* [18] which sets out the basis for the systematic review of safety culture against a defined set of characteristics.

5.3 Continual Improvement

Continual improvement of the management system is embedded within various Performance Assurance processes including:

- *Benchmarking* [19]; a performance monitoring and improvement tool used to improve CNL's knowledge, skills and safety performance via review of other high-performing organizations.
- *Trend Analysis* [15]; a method to analyse performance data and identify trends before the onset of problems or events.
- *Change Management* [20]; a process to manage change communication and resistance, enabling stakeholder adoption of the change.
- *Management Review* [17]; a critical assessment of the implementation of the management system to ensure its continued suitability, adequacy, and effectiveness.
- *Process Improvement* [21]; a framework to help CNL functional support areas, business lines, and departments identify more strategically aligned opportunities, and execute those improvements in a sustainable way.

- Problem identification and resolution [3]; process for identifying, prioritizing, investigating, documenting, trending, tracking, preventing, and resolving problems and opportunities for improvement.
- Lessons learned/Operating Experience (OPEX) [22]; a process which promotes the identification and dissemination of operating experience and lessons to be learned from internal and external industry events in order to improve safety, reliability, and business processes, while reducing time at risk and improving the overall performance of CNL.

5.3.1 Lessons Learned

Lessons learned are identified, documented, and disseminated to ensure that knowledge gained from experience is leveraged. Lessons learned, or OPEX, rely on the accurate and timely reporting of events to enable prompt notification of learnings to the organization for the timely implementation of action(s) to prevent recurrence, improvement safety and business processes, and improve the overall performance of CNL.

Lessons learned are created and disseminated both internally and externally, ensuring that use of experience is shared with the organization and industry. Similarly, external lessons learned are shared with CNL. External lessons learned are reviewed for relevance and significance and shared to the appropriate CNL personnel for action.

5.3.2 Change Management

Change Management [20] promotes the successful implementation of changes impacting CNL workers through planning and implementing communications and resistance management activities that help transition employees from current state to future state. *Change Management* [20] provides a structured approach to communicating and managing resistance to change, and helps ensure the change is:

- Supported by the appropriate change activities (e.g. communications, engagement, training, etc.).
- Documented and communicated to stakeholders.
- Understood by stakeholders.
- Managed effectively through the planning and implementation of resistance mitigation strategies.

5.4 Human Performance

CNL's human performance program establishes a good practise set of practical methods and techniques for anticipating, preventing and catching active human errors, and identifying and mitigating latent errors attributable to organizational factors. When used effectively, the tools can improve human performance in the workplace; thus, reducing errors, and helping to eliminate events.

Human performance (HU) tools provide error-reduction methods supervisors and managers can use in their quest to identify organizational weaknesses or conditions that increase the likelihood or the consequences of error, such as:

- *Observation and Coaching* [23]; a process intended to drive safety culture improvements through proactive internal organizational learning. Observation and Coaching (O&C) enables managers and leaders to assess and interact with workers within the worker's environment. This enables managers to be a positive presence within the workers' environment and fosters a collaborative approach to verifying that work meets the requirements of the management system. It also enables managers and employees to collectively identify system error traps and deficiencies, and to implement system improvements and/or coaching if it does not.
- *Event Free Day Reset* [24]; a process which establishes the primary metric used to identify, track and trend human performance events and communicate findings to the organization. These indicators help identify HU organizational vulnerabilities and ensure focused reinforcement of targeted HU methodologies to promote a safer working environment.

The HU program also defines a set of discrete behaviours to help individuals and work teams anticipate, prevent, or catch errors before they cause harm to people, facilities, or the environment, such as:

- *Event Free Tools* [25]; a set of discrete behaviours and mentalities to be used by all workers to help reduce the rate of error while performing tasks. The Event Free Tools (EFT) help workers maintain positive control of a work situation to achieve the desired results. When used thoughtfully and rigorously, they minimize human error, and anticipate, prevent or catch active errors before they cause harm to person, property or environment.

6. Interfaces

6.1 Internal Interfaces

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Designated Representative of the Licensee (DROL)	Communicating with, and responsible to all licensing bodies for the function.	Email, meetings	Management System DROL
Quality	Acceptance of final dispositions of non-	Email, Management	Quality FSM

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
	conformances as identified in ImpAct records, member of the Dedicated Screening Team.	Review Meetings, Dedicated Screening Team meetings	
Management System	Assists with process implementation and review.	Email, meetings	Management System FSM
Training and Development	Assists with process implementation and administration of training.	Email, meetings	Training and Development FSM
Design Analysis and Design Engineering	Assessing operability concerns as per the Technical Operability Evaluation process when flagged in an ImpAct record.	Email, Management Review Meetings	Design Analysis and Design Engineering FSM
Compliance	Assessing reportability concerns when flagged in an ImpAct record.	Email, Management Review Meetings	Compliance FSM
Information Management	Embedding usage classification requirements within document templates, revising Program Requirements Document and Program Description Document templates as requested.	Email, meetings	Information Management FSM
Integrated Work Control	Embedding pre-job and post-job brief into Integrated Work	Email, meetings	Management System FSM

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
	Control documents and practices.		
Line Management	Provides metrics to be measured and monitored, provides feedback to assist with continual improvement and safety culture assessments, participates in event investigations and cause analyses, raises ImpActs and actions as per the problem resolution and identification process, participates in DST, MRM and CARB as required.	Email, issues management software, meetings	Responsible Managers, Line Management employees

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
AECL	Submission of the CAS Scorecard, audience member of the RLMC, receives and reviews the daily ImpAct Initiation Report.	Email, RLMC, SharePoint	AECL personnel
Candu Owners Group (COG)	Source of external OPEX.	Email, weekly screening meeting	Screening Team
DevonWay	Vendor of CNL’s issues management software.	Email	DevonWay personnel

7. References

[1] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions

[2] *Canadian Nuclear Laboratories Management System Manual*, 900-514100-MAN-001, 12489834.

[3] *Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004, 40772346.

[4] *Rapid Learning Morning Call (RLMC)*, 900-514000-TOR-004, 51306753.

[5] *Fact Finding,* 900-514000-MCP-015, 51258098.

[6] *Fact Finding Report,* 900-514000-FM-015, 51315877.

[7] *Apparent Cause Analysis,* 900-514000-MCP-005, 12497547.

[8] *Apparent Cause Analysis Report,* 900-514000-FM-005, 51861931.

[9] *Root Cause Analysis,* 900-514000-MCP-013, 48667847.

[10] *Root Cause Analysis (TMP),* 900-514000-TMP-003, 12497835.

[11] *Corrective Action Review Board*, 900-514000-TOR-003, 40815945.

[12] *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012, 12635073.

[13] *Dedicated Screening Team,* 900-514000-TOR-005, 56034019.

[14] *Management Review Meeting (MRM)*, 900-514000-TOR-001, 50797976.

[15] *Trend Analysis,* 900-514000-STD-001, 40780883.

[16] *Contractor Assurance System*, 900-514100-STD-004, 56311037.

[17] *Management Review*, 514100-STD-003, 52009631.

[18] *Safety and Security Culture Assessment Framework*, 900-514000-STD-004, 54199913.

[19] *Benchmarking*, 900-514000-MCP-008, 40848286.

[20] *Change Management*, 900-514000-MCP-016, 40865190.

[21] *Process Improvement*, 900-514000-STD-003, 52948967.

[22] *Processing Internal and External Operating Experience*, 900-514000-MCP-001, 12496502.

[23] *Observation and Coaching*, 900-514000-STD-002, 57756720.

[24] *Event Free Day Reset*, 900-514000-MCP-002, 12635086.

[25] *Event Free Tools*, 900-514000-STD-002, 51477237.

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Performance Assurance REV 3

900-514000-PRD-001

Revision 3.0

Information Use

Approved by:	Angela Coulas	2024/01/28
	Director, Oper Excellence	Date

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
3	2023/1/21	Issued as Approved for Use. Major changes include: - Updated template, addition of Applicability Matrix in Section 4. - Moving Requirements for Management Review from Management System. - Removing requirements for Self-assessment. These were moved to Quality. - Updated the Licence Conditions Handbooks to latest revisions. - Added clauses from: o REGDOC-2.2.1 o REGDOC-2.4.3 o CSA N286.6-98 o CSA N292.0-19	S. Mackie	A. Coulas	A. Coulas
3D1	2023/11/24	Issued for Review and Comment.	S. Mackie	A. Dash K. Leroux A. Rehman N. Deighton D. Cram K. Erlandson L. Theil	
2	2020/09/28	Issued as “Approved for Use”. Minor changes: Changed Self-Assessment references to 900-514000-MCP-003.	A. Chapman	A. Rehman	A. Rehman
1	2020/08/25	Issued as “Approved for Use”.	A. Chapman	A. Rehman	A. Rehman
1D1	2020/07/29	Issued for “Review and Comment”. Major changes include: Removal of WANO/INPO membership activities.	A. Chapman	T. Beres C. Ball A. Rehman	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		Updated to latest version of the Licence Conditions Handbook for Chalk River. Updated latest CSA and ISO industry Standards references. Removal of Operational Decision Making and Non-conformance activities to Conduct of Operations and Quality Functional Support Areas. Added CSA N286.7-16, ASME NQA-1 and CSA N299. Closes document lien 900-514000-DLF-000 (2017/10/21). Note: Periodic Document Review, 156-514000-290-000, (2019/06/07) postponed required update until 2020.			
0	2016/12/23	Issued as “Approved for Use”.	M. Campbell A. Chapman	K. Summers	K. Summer
D1	2016/12/08	Issued for “Review and Comment”.	M. Campbell A. Chapman	T. Beres for (A. Rehman) J. Betteridge S. Celovsky A. Coulas P. Daly G. Dolinar Y. Dubé L. Fleury G. Garrett J. Gibb C. Hebert 1 K. Leroux	

Table of Contents

1. Scope and Applicability

This company-wide document applies to all activities unique to Performance Assurance performed by Canadian Nuclear Laboratories' employees, contractors, and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

2. Purpose

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment, and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

- *Quality Assurance Requirements for Nuclear Facility Applications*, NQA-1-2015, American Society of Mechanical Engineers, February 20, 2015.
- *Safety Culture,* REGDOC-2.1.2, Canadian Nuclear Safety Commission, April 2018.
- *Human Factors*, REGDOC-2.2.1, Canadian Nuclear Safety Commission, July 2019.
- *Nuclear Criticality Safety, Version 1.1,* REGDOC-2.4.3, Canadian Nuclear Safety Commission, September 2020.
- *Environmental management systems - Requirements with guidance for use*, CAN/CSA-ISO 14001:16 (ISO 14001:2015, IDT), Canadian Standards Association, February 2016.
- *Quality management systems - Requirements*, CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Canadian Standards Association, February 2016.
- *Decommissioning Quality Assurance for Nuclear Power Plants*, CSA N286.6-98 (R2003), Canadian Standards Association, September 1998.
- *Management system requirements for nuclear facilities*, CSA N286-12 (R2022), Canadian Standards Association, June 2012.
- *Quality Assurance of analytical, scientific, and design computer programs for nuclear power plants*, CSA N286.7-16, Canadian Standards Association, January 2016.
- *General principles for the management of radioactive waste and irradiated fuel*, CSA N292.0-19, Canadian Standards Association, March 2019.
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1*, CSA N299.1-16, Canadian Standards Association, 2016.
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2*, CSA N299.2-16, Canadian Standards Association, 2016.
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 3*, CSA N299.3-16, Canadian Standards Association, 2016.
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 4*, CSA N299.4-16, Canadian Standards Association, 2016.

- *Agreement for the Work to be Undertaken on a Target Cost Basis in order to Effect the Closure of the Nuclear Power Demonstration Reactor*, NPD Agreement (NPD TCA), 2015.
- *Agreement for the Work to be Undertaken on a Target Cost Basis in order to Effect the Closure of the Whiteshell Laboratories*, WL Agreement (WL TCA), 2015.
- *Agreement for the Management and Operation of Certain Properties and Assets that are the Responsibilities of Atomic Energy of Canada Limited*, SOC Agreement (SOCA), 2015.
- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-8.00/2024*, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-HBK-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023.
- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028*, Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023.
- *Prototype Waste Facilities – Waste Facility Decommissioning License, Gentilly-1 Waste Facility*, WFDL-W4-331.00/2034, Licence Conditions Handbook, WFDL-LCH-W4-331.00/2034 Revision 1/61-00580-HBK-001, Revision 0, Canadian Nuclear Safety Commission, July 15, 2019.
- *Prototype Waste Facilities – Waste Facility Decommissioning Licence Douglas Point Facility WFDL-W4-332.03/2030*, Licence Conditions Handbook, WFDL-LCH-W4-332.03/2030 Revision 1/22-508760-HBK-002, Revision 0, Canadian Nuclear Safety Commission, June 11, 2021.
- *Nuclear Power Demonstration Waste Facility Prototype Waste Facilities – Waste Facility Decommissioning Licence WFDL-W4-342.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-342.00/2034 Revision 2/64-508760-HBK-001, Revision 2, Canadian Nuclear Safety Commission, August 15, 2023.

Table 1: Quality Assurance Requirements for Nuclear Facility Applications, ASME NQA-1

Quality Assurance Requirements for Nuclear Facility Applications, ASME NQA-1		
Section and Title	**Description**	**Implementing Document(s)**
Requirement 16 - Corrective Action	100 GENERAL Conditions adverse to quality shall be identified promptly and corrected as soon as practicable. In the case of a significant condition adverse to quality, the cause of the condition shall be determined and corrective action taken to preclude recurrence. The identification, cause, and corrective action for significant conditions adverse to quality shall be documented and reported to appropriate levels of management. Completion of corrective actions shall be verified.	*Improvement Action (ImpAct) Corrective Action Program,* 900-514000-MCP-004 *Management Review Meeting,* 900-514000-TOR-001

Table 2*: Safety Culture*, REGDOC-2.1.2

***Safety Culture*, REGDOC 2.1.2**		
Section and Title	**Description**	**Implementing Document(s)**
All applicable clauses	Provides a framework for Safety Culture and how to measure and monitor is at a company.	*Safety and Security Culture Assessment Framework,* 900-514000-STD-004 *Performance Assurance,* 900-514000-PDD-001

Table 3*: Human Factors*, REGDOC-2.2.1

***Human Factors*, REGDOC-2.2.1**		
Section and Title	**Description**	**Implementing Document(s)**
All applicable clauses	This document outlines the CNSC's Human Factors program. This is currently a guidance only document for CNL.	*Performance Assurance,* 900-514000-PDD-001

Table 4: *Nuclear Criticality Safety*, REGDOC-2.4.3

***Nuclear Criticality Safety*, REGDOC-2.4.3**		
Section and Title	**Description**	**Implementing Document(s)**
2.3.2.7 Operational control	Deviations from procedures and unforeseen alterations in process conditions that affect nuclear criticality safety shall be reported to management and shall be investigated promptly. When available, the information about incidents and events in other installations of the same type shall also be investigated and lessons learnt shall be considered. Possible improvements in criticality safety practices or equipment shall be considered and action shall be taken to prevent recurrence.	*Improvement Action (ImpAct) Corrective Action Program,* 900-514000-MCP-004 *Processing Internal and External Operating Experience*, 900-514000-MCP-001
3.5.5 Corrective action	When tests reveal inadequate performance, corrective action shall be taken without unnecessary delay.	*Improvement Action (ImpAct) Corrective Action Program,* 900-514000-MCP-004
3.5.7 Records	Records of tests and corrective actions for each system shall be maintained. These records provide information on system operability and help identify sources of failure.	*Improvement Action (ImpAct) Corrective Action Program,* 900-514000-MCP-004

Table 5: *Environmental management systems - Requirements with guidance for use*, ISO 14001:2015

***Environmental management systems - Requirements with guidance for use*, ISO 14001:2015**		
Section and Title	**Description**	**Implementing Document(s)**
5.3 Organizational roles, responsibilities and authorities	Top management shall ensure that the responsibilities and authorities for relevant roles are assigned and communicated within the organization. Top management shall assign the responsibility and authority for:	*Performance Assurance*, 900-514000-PDD-001

Environmental management systems - Requirements with guidance for use, **ISO 14001:2015**		
Section and Title	**Description**	**Implementing Document(s)**
	b) Reporting on the performance of the environmental management system, including environmental performance, to top management.	
9.1.1 General	The organization shall monitor, measure, analyse and evaluate its environmental performance. The organization shall determine: a) what needs to be monitored and measured; b) the methods for monitoring, measurement, analysis and evaluation, as applicable, to ensure valid results; c) the criteria against which the organization will evaluate its environmental performance, and appropriate indicators; d) when the monitoring and measuring shall be performed; and e) when the results from monitoring and measurement shall be analysed and evaluated. The organization shall ensure that calibrated or verified monitoring and measurement equipment is used and maintained, as appropriate. The organization shall evaluate its environmental performance and the effectiveness of the environmental management system. The organization shall communicate relevant environmental performance information both internally and externally, as identified in its communication process(es) and as required by its compliance obligations.	*Performance Assurance*, 900-514000-PDD-001

Environmental management systems - Requirements with guidance for use, ISO 14001:2015		
Section and Title	**Description**	**Implementing Document(s)**
	The organization shall retain appropriate documented information as evidence of the monitoring, measurement, analysis and evaluation results.	
9.3 Management review	Top management shall review the organization's environmental management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness. The management review shall include consideration of: a) the status of actions from previous management reviews; b) changes in: 1) External and internal issues that are relevant to the environmental management system. 2) The needs and expectations of interested parties, including compliance obligations. 3) Its significant environmental aspects. 4) Risks and opportunities. c) the extent to which environmental objectives have been achieved; d) information on the organization's environmental performance, including trends in: 1) Nonconformities and corrective actions. 2) Monitoring and measurement results. 3) Fulfilment of its compliance obligations. 4) Audit results. e) adequacy of Resources; f) relevant communication(s) from	*Management Review*, 900-514100-STD-003

***Environmental management systems - Requirements with guidance for use*, ISO 14001:2015**		
Section and Title	**Description**	**Implementing Document(s)**
	interested parties, including complaints; and g) opportunities for continual improvement. The outputs of the management review shall include: — conclusions on the continuing suitability, adequacy and effectiveness of the environmental management system; — decisions related to continual improvement opportunities; — decisions related to any need for changes to the environmental management system, including Resources; — actions, if needed, when environmental objectives have not been achieved; — opportunities to improve integration of the environmental management system with other business processes, if needed; — any implications for the strategic direction of the organization. The organization shall retain documented information as evidence of the results of management reviews.	
10.1 General	The organization shall determine opportunities for improvement (see 9.1, 9.2 and 9.3) and implement necessary actions to achieve the intended outcomes of its environmental management system.	*Process Improvement,* 900-514000-STD-003

Table 6: *Quality Management Systems – Requirements*, CSA ISO 9001:2015

***Quality Management Systems – Requirements*, CSA ISO 9001:2015**		
Section and Title	**Description**	**Implementing Document(s)**
4.4.1 a)	The organization shall determine the processes needed for the quality management system and their application throughout the organization, and shall: a) determine the inputs required and the outputs expected from these processes;	*Trend Analysis*, 900-514000-STD-001 *Process Improvement*, 900-514000-STD-003
4.4.1 g)	The organization shall determine the processes needed for the quality management system and their application throughout the organization, and shall: g) evaluate these processes and implement any changes needed to ensure that these processes achieve their intended results;	*Process Improvement,* 900-514000-STD-003 *Management Review,* 900-514100-STD-003
4.4.1 h)	The organization shall determine the processes needed for the quality management system and their application throughout the organization, and shall: h) improve the processes and the quality management system.	*Process Improvement*, 900-514000-STD-003
5.3 Organizational roles, responsibilities and authorities	Top management shall assign the responsibility and authority for: b) ensuring that the processes are delivering their intended outputs;	*Management Review*, 900-514100-STD-003
6.1.1	When planning for the quality management system, the organization shall consider the issues referred to in 4.1 and the requirements referred to in 4.2 and determine the risks and opportunities that need to be addressed to:	*Management Review*, 900-514100-STD-003

Quality Management Systems – Requirements, **CSA ISO 9001:2015**		
Section and Title	**Description**	**Implementing Document(s)**
	a) give assurance that the quality management system can achieve its intended result(s); b) enhance desirable effects; c) prevent, or reduce, undesired effects; and d) achieve improvement.	
6.3 Planning of changes	When the organization determines the need for changes to the quality management system, the changes shall be carried out in a planned manner (see 4.4).	*Change Communication and Resistance Management Planning*, 900-514000-MCP-016
7.1.6 Organizational knowledge	The organization shall determine the knowledge necessary for the operation of its processes and to achieve conformity of products and services.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001 *Benchmarking*, 900-514000-MCP-008
9.1.1 General	The organization shall determine: a) what needs to be monitored and measured; b) the methods for monitoring, measurement, analysis and evaluation needed to ensure valid results; c) when the monitoring and measuring shall be performed; The organization shall evaluate the performance and the effectiveness of the quality management system. The organization shall retain appropriate documented information as evidence of the results.	*Performance Assurance*, 900-514000-PDD-001 *Trend Analysis,* 900-514000-STD-001
9.1.3 Analysis and evaluation	The organization shall analyse and evaluate appropriate data and	*Corrective Action Effectiveness Review*

Quality Management Systems – Requirements, CSA ISO 9001:2015		
Section and Title	**Description**	**Implementing Document(s)**
	information arising from monitoring and measurement. The results of analysis shall be used to evaluate: a) conformity of products and services; b) the degree of customer satisfaction; c) the performance and effectiveness of the quality management system; d) if planning has been implemented effectively; e) the effectiveness of actions taken to address risks and opportunities; f) the performance of external providers;	*Process*, 900-514000-MCP-012 *Performance Assurance*, 900-514000-PDD-001
9.3.2 Management review inputs	The management review shall be planned and carried out taking into consideration: a) the status of actions from previous management reviews;	*Management Review*, 900-514100-STD-003
9.3.3 Management review outputs	The outputs of the management review shall include decisions and actions related to: a) opportunities for improvement; b) any need for changes to the quality management system; c) resource needs. The organization shall retain documented information as evidence of the results of management reviews.	*Management Review*, 900-514100-STD-003
10.1 General	The organization shall determine and select opportunities for improvement and implement any necessary actions to meet customer requirements and enhance customer satisfaction. These shall include:	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Management Review*, 900-514100-STD-003

Quality Management Systems – Requirements, CSA ISO 9001:2015		
Section and Title	**Description**	**Implementing Document(s)**
	a) improving products and services to meet requirements as well as to address future needs and expectations; b) correcting, preventing or reducing undesired effects; c) improving the performance and effectiveness of the quality management system.	

Table 7: *Decommissioning Quality Assurance for Nuclear Power Plants*, CSA N286.6-98 (R2003)

Decommissioning Quality Assurance for Nuclear Power Plants, CSA N286.6-98 (R2003)		
Section and Title	**Description**	**Implementing Document(s)**
3 Basic Requirements – 3.5 Accountability	Management of the decommissioning organization shall ensure that (a) expected results are defined and communicated; and (b) actual results are measured and performance is judged against expected results.	*Performance Assurance, 900-514000-PDD-001*
3 Basic Requirements – 3.6 Communication	3.6.2 Procedures shall be implemented to (a) identify and manage essential information; (b) identify what information is required and who needs it; (c) ensure that information is current and correct; and (d) ensure that all users receive timely and consistent information.	*Event Free Tools*, 900-514000-STD-002 *Briefing Package*, 900-514100-MCP-008
3 Basic Requirements – 3.7 Use of Experience	Information gained from experience in the operational phase and from previous and ongoing decommissioning shall be assessed for use in establishing and improving decommissioning requirements.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001 *Improvement Action (ImpAct) Corrective Action*

Decommissioning Quality Assurance for Nuclear Power Plants, CSA N286.6-98 (R2003)		
Section and Title	**Description**	**Implementing Document(s)**
		Program, 900-514000-MCP-004 *Benchmarking*, 900-514000-MCP-008
3 Basic Requirements – 3.10 Verification	Work requiring specific independent in-field inspection, to confirm that results meet requirements, shall be identified. The extent of inspection may vary depending upon the complexity of the work and the potential impact on safety.	*Event Free Tools*, 900-514000-STD-002
3 Basic Requirements – 3.11 Non-conformance	Items, documents, services, and activities that do not conform to requirements shall be (a) identified, documented, and reported; (b) reviewed and remedial actions determined, executed, verified, and recorded; and (c) controlled to prevent unauthorized use or implementation.	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004
3 Basic Requirements – 3.12 Corrective Action	3.12.1 Significant events and recurring or serious deficiencies shall be (a) analyzed to determine their causes; and (b) corrected to prevent recurrence. 3.12.2 Corrective action shall be documented and communicated to appropriate levels of management and monitored for effectiveness. 3.12.3 Responsibilities for the review of nonconformances and their causes, and for developing acceptable dispositions, shall be identified.	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012 *Root Cause Analysis*, 900-514000-MCP-013? Apparent Cause Analysis, 900-514000-MCP-005

***Decommissioning Quality Assurance for Nuclear Power Plants*, CSA N286.6-98 (R2003)**		
Section and Title	**Description**	**Implementing Document(s)**
3 Basic Requirements – 3.13 Change Control	3.13.1 A process for change control shall be established. 3.13.2 Changes to plans, items, processes, and practices shall be (a) documented; and (b) reviewed and approved before they are implemented by persons who have full knowledge of the original and current intent and requirements. "	*Change Communication and Resistance Management Planning*, 900-514000-MCP-016
3 Basic Requirements – 3.16 Program Assessment – 3.16.1 Management Self-Assessment	3.16.1.1 The line management of the decommissioning organization shall conduct ongoing self-assessments, to evaluate its effectiveness in achieving organizational goals. Organization goals should be results-based such that opportunities for improvement are revealed and deficiencies in the management process can be identified and corrected. 3.16.1.2 These self-assessments shall conclude with a formal review of the effectiveness of the decommissioning quality assurance program. The decommissioning manager shall lead and coordinate the formal review process. 3.16.1.3 In addition to these ongoing self-assessments, the decommissioning manager shall conduct annually a formal review of the effectiveness of the quality assurance program. 3.16.1.4 Corrective actions or proposed improvements arising from the self-assessments shall be implemented.	*Management Review*, 900-514100-STD-003 *Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004

***Decommissioning Quality Assurance for Nuclear Power Plants*, CSA N286.6-98 (R2003)**		
Section and Title	**Description**	**Implementing Document(s)**
3 Basic Requirements – 3.16 Program Assessment – 3.16.2 Independent Assessments	3.16.2.1 Independent assessments of the quality assurance program shall be conducted for management to determine its effectiveness in obtaining satisfactory performance. 3.16.2.2 The assessment frequency shall be sufficient to confirm that all requirements continue to be met. 3.16.2.3 The person(s) responsible for independently assessing the effectiveness of the quality assurance program shall (a) have access to the plant, personnel, work activities, documents, and records as necessary to assess the program; (b) be independent of cost and schedule considerations; and (c) have neither performed nor verified the activities being assessed. 3.16.2.4 The results of independent assessments shall be documented and reported to a level of management having sufficient breadth of responsibility to resolve any identified problems.	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012 *Management Review*, 900-514100-STD-003
4 Requirements for Decommissioning – 4.2 Decommissioning Documents	4.3.4 Procedure Implementation The manner shall be identified in which procedures shall be implemented. For example, activities shall be identified for which the written procedure shall be at hand (eg, as a hard copy or as a video display) and be followed step by step while the task is being performed. Procedures shall be available to control (a) extensive or complex activities when reliance on memory cannot be trusted; or (b) infrequently performed tasks. When the procedure	*Event Free tools,* 900-514000-STD-002

Decommissioning Quality Assurance for Nuclear Power Plants, CSA N286.6-98 (R2003)		
Section and Title	**Description**	**Implementing Document(s)**
	requires documentation of an action or recording of data, the necessary information shall be recorded as the task is performed	
4 Requirements for Decommissioning – 4.8 Communication	4.8.1 Communications shall be transmitted and received in an effective manner. 4.8.2 Messages, whether oral or written, regarding equipment operation shall be (a) specific, using approved equipment identification; (b) free of ambiguity and slang; (c) conducted in a professional manner; and (d) acknowledged by the receiver.	*Event Free Tools*, 900-514000-STD-002 *Observation and Coaching,* 900-514000-MCP-006

Table 8: *Quality Assurance of analytical, scientific, and design computer programs*, CSA N286.7-16

Quality Assurance of analytical, scientific, and design computer programs, CSA N286.7-16		
Section and Title	**Description**	**Implementing Document(s)**
4.3 Use of experience	Experience gained within the business and other businesses shall be a) identified and collected; b) reviewed for relevance and significance; c) implemented through actions to prevent the recurrence of significant industry problems; and d) used to initiate improvement. Experience within the business shall be made available to others based on its sensitivity.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001

Table 9: *Management System Requirements for Nuclear Facilities*, CSA N286-12 (R2022)

***Management System Requirements for Nuclear Facilities*, CSA N286-12 (R2022)**		
Section and Title	**Description**	**Implementing Document(s)**
4.2 Safety culture	Management shall use the management system to understand and promote a safety culture by (b) defining and implementing practices that contribute to excellence in worker performance; (c) providing the means by which the business supports workers in carrying out their tasks safely and successfully, by taking into account the interactions between individuals, technology, and the organization; and (d) monitoring to understand and improve the culture.	*Performance Assurance*, 900-514000-PDD-001 *Event Free Tools*, 900-514000-STD-002 *Observation and Coaching*, 900-514000-MCP-006 *Safety and Security Culture Assessment Framework*, 900-514000-STD-004
4.6 Communication	Processes shall be in place to ensure effective communication. Workers shall be made aware of the relevance and importance of their work related to the objectives.	*Observation and Coaching*, 900-514000-MCP-006 *Event Free Tools*, 900-514000-STD-002
4.9 Problem identification and Resolution	When problems arise, they shall be (a) immediately controlled, if required; (b) documented; (c) evaluated for significance and for underlying cause if deemed by management to be systemic or having impact on meeting business objectives; and (d) accepted. Actions employed to resolve problems shall be reviewed for effectiveness.	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012
4.10 Change	Required changes shall be (a) identified, including reason for change; (b) justified; (c) subject to review by relevant stakeholders; (d) reviewed by persons with knowledge or original	*Change Communication and Resistance Management Planning, 900-514000-MCP-016*

***Management System Requirements for Nuclear Facilities*, CSA N286-12 (R2022)**		
Section and Title	**Description**	**Implementing Document(s)**
	intent and requirements; (e) approved for implementation; (f) implemented in accordance with the plan; and (g) reviewed for effectiveness.	
4.12 Use of experience	Experience gained within the business and other businesses shall be (a) identified and collected; (b) reviewed for relevance and significance; (c) implemented through actions to prevent the recurrence of significant industry problems; and (d) used to initiate improvement. Experience within the business shall be made to others based on its sensitivity.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001
4.13 Continual improvement	Management shall continually improve the management system. The following shall be carried out: (a) trend analysis of causes and problems; (b) periodically critically assessing the effectiveness of the management system to achieve the planned results; (c) benchmarking the performance and experience of others where practicable; (d) maintaining the awareness of changes in its business environment; and (e) seeking opportunities to improve processes.	*Management Review*, 900-514100-STD-003 *Benchmarking*, 900-514000-MCP-008 *Change Communication and Resistance Management Planning, 900-514000-MCP-016* *Trend Analysis*, 900-514000-STD-001 *Process Improvement*, 900-514000-STD-003
7.9.6 Procedure use and adherence	Plant operations shall be performed in accordance with procedures that contain information and direction for operating workers on understanding and performing their work. Use and	*Event Free Tools*, 900-514000-STD-002

Management System Requirements for Nuclear Facilities, CSA N286-12 (R2022)		
Section and Title	**Description**	**Implementing Document(s)**
	adherence direction shall be provided to the operating workers. Temporary procedures may be issued when existing permanent procedures do not apply to the work being planned. Temporary procedures shall be periodically reviewed for applicability and cancelled when no longer required.	

Table 10: *General principles for the management of radioactive waste and irradiated fuel,* CSA N292.0-19

***General principles for the management of radioactive waste and irradiated fuel*, CSA N292.0-19**		
Section and Title	**Description**	**Implementing Document(s)**
4.10.1.5	Processes should be put in place to allow for the feedback from and analysis of operating experience, including	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Processing Internal and External Operating Experience*, 900-514000-MCP-001

Table 11: *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1*, CSA N299.1-16

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1*, CSA N299.1-16**		
Section and Title	**Description**	**Implementing Document(s)**
4.7 Safety culture	Management of the supplier's business shall use the QA program to understand and promote a safety culture by	*Performance Assurance*, 900-514000-PDD-001 *Event Free Tools*, 900-514000-STD-002

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1*, CSA N299.1-16**		
Section and Title	**Description**	**Implementing Document(s)**
	a) issuing a statement committing workers to adherence to the QA program; b) defining and implementing practices that contribute to excellence in worker performance; c) providing the means by which the business supports workers in carrying out their tasks safely and successfully, by taking into account the interactions between individuals, technology, and the organization; and d) monitoring to understand and improve the culture.	*Observation and Coaching*, 900-514000-MCP-006 *Safety and Security Culture Assessment Framework*, 900-514000-STD-004.
5.5.17 Use of experience	Experience gained within the supplier’s business, by other suppliers, and by customers shall be a) identified and collected; b) reviewed for relevance and significance; c) implemented through action to prevent the recurrence of significant industry problems; and d) used to initiate improvement. Experience within the supplier’s business should be made available to others based on its sensitivity.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001
7.18 Corrective Action	The supplier shall a) Identify, plan, develop, and promptly implement corrective actions to i) address the actual or potential causes of the nonconformances; and ii) preclude recurrence and prevent potential occurrence of nonconformances or undesirable situations;	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1*, CSA N299.1-16**		
Section and Title	**Description**	**Implementing Document(s)**
	b) initiate corrective action when notified by the customer's representative of the existence of a potential or actual non-conformance, or an ineffective control; c) assess and confirm that corrective actions taken are effective, and follow up to ensure continued effectiveness; and e) document the corrective action records taken.	

Table 12: *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2*, CSA N299.2-16

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2*, CSA N299.2-16**		
Section and Title	**Description**	**Implementing Document(s)**
4 General requirements – 4.1 Contractual requirements, Resources, and schedule	4.1.1 The supplier shall a) document, implement, and maintain a QA program that assures all activities for quality are integrated and executed effectively; and b) conform to all customer requirements, including those for all outsourced processes, items, or services. 4.1.2 The supplier shall review the contractual requirements, Resources, and schedule required to assure item or service quality prior to submission of a bid, and the review shall include a) identifying, and providing or updating, the special process controls and requirements for delivery and post-delivery activities; b) the requirements of the AHJ applicable to the item or service; c) equipment, including measuring and testing	*Performance Assurance*, 900-514000-PDD-001 *Event Free Tools*, 900-514000-STD-002 *Observation and Coaching*, 900-514000-MCP-006

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2*, CSA N299.2-16**		
Section and Title	**Description**	**Implementing Document(s)**
	equipment; d) the personnel skills and qualifications; and e) any additional requirements considered necessary by the supplier.	
5.5.17 Use of experience	Experience gained within the supplier's business, by other suppliers, and by customers shall be a) identified and collected; b) reviewed for relevance and significance; c) implemented through action to prevent the recurrence of significant industry problems; and d) used to initiate improvement. Experience within the supplier's business should be made available to others based on its sensitivity.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001
7.18 Corrective Action	The supplier shall a) identify, plan, develop, and promptly implement corrective actions to i) address the causes of nonconformance; and ii) preclude recurrence and prevent potential occurrence of nonconformances or undesirable situations; b) initiate corrective action when notified by the customer's representative of the existence of a nonconformance, or an ineffective control; c) assess and confirm that corrective actions taken are effective, and follow up to ensure continued effectiveness; and	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2*, CSA N299.2-16**		
Section and Title	**Description**	**Implementing Document(s)**
	e) document the corrective action records taken	

Table 13: *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 3*, CSA N299.3-16

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 3*, CSA N299.3-16**		
Section and Title	**Description**	**Implementing Document(s)**
5.5.17 Use of experience	Experience gained within the supplier's business, by other suppliers, and by customers shall be a) identified and collected; b) reviewed for relevance and significance; and c) implemented through action to prevent the recurrence of significant industry problems.	*Processing Internal and External Operating Experience*, 900-514000-MCP-001
7.18 Corrective Action	The corrective action process shall be promptly implemented, as follows: a) determine the need for any prompt actions and implement corrective action, as required; b) initiate corrective action when notified by the customer's representative of the existence of a nonconformance, or an ineffective control; c) plan, develop, and implement corrective actions; d) assess and confirm that corrective actions taken are effective (note on a category 4 assess and confirm that the corrective actions taken are effective); and	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012

***Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 3*, CSA N299.3-16**		
Section and Title	**Description**	**Implementing Document(s)**
	f) document the corrective action records taken.	

Table 14: *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 4*, CSA N299.4-16

Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 4, CSA N299.4-16		
Section and Title	**Description**	**Implementing Document(s)**
7.18 Corrective Action	The corrective action process shall be promptly implemented, as follows: a) determine the need for any prompt actions and implement corrective action, as required; b) initiate corrective action when notified by the customer's representative of the existence of a nonconformance, or an ineffective control; c) plan, develop, and implement corrective actions; d) assess and confirm that corrective actions taken are effective (note on a category 4 assess and confirm that the corrective actions taken are effective); and f) document the corrective action records taken.	*Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004 *Corrective Action Effectiveness Review Process*, 900-514000-MCP-012

Table 15: Nuclear Power Demonstrator Target Cost Agreement (NPD TCA)

Nuclear Power Demonstrator Target Cost Agreement (NPD TCA)		
Section and Title	**Description**	**Implementing Document(s)**
2.3 Standard of Care	(a) CNL shall perform the Work in accordance with Good Industry Practice and: (iii) in a manner that reflects ongoing identification, evaluation and implementation of Good Industry Practice; (iv) in continuous pursuit of improvements in aspects of performance of the Work where cost-effective and efficient improvements can reasonably be achieved.	*Benchmarking*, 900-514000-MCP-008 *Process Improvement*, 900-514000-STD-003
3.1 AECL Oversight	(b) CNL shall self-assess its performance of all of the Work, including its compliance with its obligations under this Agreement, identify deficiencies and implement required improvements in accordance with the terms and conditions of this Agreement, regardless of whether AECL has evaluated CNL's performance in any area of this Agreement. AECL's oversight shall not relieve CNL from its obligation to assess its performance, which obligation is independent of AECL's oversight role. Without limiting the generality of the foregoing, CNL shall develop a contractor assurance system that is executed by Contractor in accordance with the requirements of the Contractor Contract and implemented throughout CNL's organization. The contractor assurance system shall be based on	*Performance Assurance,* 900-514000-PDD-001

Nuclear Power Demonstrator Target Cost Agreement (NPD TCA)		
Section and Title	**Description**	**Implementing Document(s)**
	an earned value management system consistent with the Earned Value Management Plan and, at a minimum, shall include the following key attributes: (i) risk-based self-assessments and associated corrective action plans; (ii) identification and correction of negative performance or compliance trends before they become significant issues; (iii) metrics and targets to assess performance, and processes for developing metrics and targets that result in efficient and cost effective performance by CNL; (iv) continuous feedback and performance improvement; and (v) timely and appropriate communications to the Contracting Officer, including electronic access by the Contracting Officer, of assurance-related information. AECL may revise its level or mix of oversight of this Agreement when the Contracting Officer determines that CNL's contractor assurance system is or is not operating effectively.	

Table 16: *Site Operating Contract Agreement* (SOCA)

***Site Operating Contract Agreement* (SOCA)**		
Section and Title	**Description**	**Implementing Document(s)**
2.3 Standard of Care	(a) CNL shall perform the Work in accordance with Good Industry Practice and: (iii) in a manner that reflects ongoing identification, evaluation and implementation of	*Benchmarking*, 900-514000-MCP-008 *Process Improvement*, 900-514000-STD-003

Site Operating Contract Agreement (SOCA)		
Section and Title	**Description**	**Implementing Document(s)**
	Good Industry Practice; (iv) in continuous pursuit of improvements in aspects of performance of the Work where cost-effective and efficient improvements can reasonably be achieved.	
3.1 AECL Oversight	(b) CNL shall self-assess its performance of all of the Work, including its compliance with its obligations under this Agreement, identify deficiencies and implement required improvements in accordance with the terms and conditions of this Agreement, regardless of whether AECL has evaluated CNL's performance in any area of this Agreement. AECL's oversight shall not relieve CNL from its obligation to assess its performance, which obligation is independent of AECL's oversight role. Without limiting the generality of the foregoing, CNL shall develop a contractor assurance system that is executed by Contractor in accordance with the requirements of the Contractor Contract and implemented throughout CNL's organization. The contractor assurance system, at a minimum shall include the following key attributes: (i) a comprehensive description of the contractor assurance system with processes, key activities and accountabilities clearly identified (ii) a method for verifying and ensuring effective contractor assurance system processes, such as third party audits,	*Performance Assurance,* 900-514000-PDD-001

Site Operating Contract Agreement (SOCA)		
Section and Title	**Description**	**Implementing Document(s)**
	peer reviews, independent assessment and external certification; (iii) timely notification to the Contracting Officer of significant contractor assurance system changes prior to the implementation of such changes; (iv) rigorous, risk-based, credible self-assessments, and feedback and improvement activities, including utilization of nationally recognized experts, and other independent reviews to assess and improve CNL's work process and to carry out independent risk and vulnerability studies; (v) identification and correction of negative performance or compliance trends before they become significant issues; (vi) integration of the contractor assurance system with CNL's other management systems; (vii) metrics and targets to assess performance, and processes for developing metrics and targets that result in efficient and cost effective performance by CNL; (viii) continuous feedback and performance improvement (ix) an implementation plan that considers and mitigates risks; and (x) timely and appropriate communications to the Contracting Officer, including electronic access by the Contracting Officer, of assurance-related information. The initial contractor assurance system description shall require the approval of the Contracting Officer. AECL may revise	

Site Operating Contract Agreement (SOCA)		
Section and Title	**Description**	**Implementing Document(s)**
	its level or mix of oversight of this Agreement when the Contracting Officer determines that CNL's contractor system is or is not operating effectively.	
A5.1 General	A5.1.3 CNL shall integrate the concept of continuous improvement into all Work performed in supporting DWM and S&T programs and continuously challenge laboratory practices and policies that do not provide a favourable cost-benefit return to those programs.	*Process Improvement,* 900-514000-STD-003

Table 17: *Whiteshell Target Cost Agreement*, WL TCA

Whiteshell Target Cost Agreement, WL TCA		
Section and Title	**Description**	**Implementing Document(s)**
2.3 Standard of Care	(a) CNL shall perform the Work in accordance with Good Industry Practice and: (iii) in a manner that reflects ongoing identification, evaluation and implementation of Good Industry Practice; (iv) in continuous pursuit of improvements in aspects of performance of the Work where cost-effective and efficient improvements can reasonably be achieved.	*Benchmarking,* 900-514000-MCP-008 *Process Improvement*, 900-514000-STD-003
3.1 AECL Oversight	(b) CNL shall self-assess its performance of all of the Work, including its compliance with its obligations under this Agreement, identify deficiencies and implement required improvements in	*Performance Assurance,* 900-514000-PDD-001

Whiteshell Target Cost Agreement, WL TCA		
Section and Title	**Description**	**Implementing Document(s)**
	accordance with the terms and conditions of this Agreement, regardless of whether AECL has evaluated CNL's performance in any area of this Agreement. AECL's oversight shall not relieve CNL from its obligation to assess its performance, which obligation is independent of AECL's oversight role. Without limiting the generality of the foregoing, CNL shall develop a contractor assurance system that is executed by Contractor in accordance with the requirements of the Contractor Contract and implemented throughout CNL's organization. The contractor assurance system shall be based on an earned value management system consistent with the Earned Value Management Plan and, at a minimum, shall include the following key attributes: (i) risk-based self-assessments and associated corrective action plans; (ii) identification and correction of negative performance or compliance trends before they become significant issues; (iii) metrics and targets to assess performance, and processes for developing metrics and targets that result in efficient and cost effective performance by CNL; (iv) continuous feedback and performance improvement; and (v) timely and appropriate communications to the Contracting Officer, including electronic access	

***Whiteshell Target Cost Agreement*, WL TCA**		
Section and Title	**Description**	**Implementing Document(s)**
	by the Contracting Officer, of assurance-related information. AECL may revise its level or mix of oversight of this Agreement when the Contracting Officer determines that CNL's contractor assurance system is or is not operating effectively.	

Table 18: *Whiteshell Laboratories Nuclear Research & Test Establishment Decommissioning Licence*, NRTEDL-LCH-08.00/2024

***Whiteshell Laboratories Nuclear Research & Test Establishment Decommissioning Licence*, NRTEDL-LCH-08.00/2024**		
Section and Title	**Description**	**Implementing Document(s)**
2.1: Human Performance Program	The licensee shall implement and maintain a human performance program.	*Performance Assurance*, 900-514000-PDD-001

Table 19: *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence*, NRTEOL-LCH-01.00/2028

***Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence*, NRTEOL-LCH-01.00/2028**		
Section and Title	**Description**	**Implementing Document(s)**
2.1 Human Performance Program	The licensee shall implement and maintain a human performance program.	*Performance Assurance*, 900-514000-PDD-001

Table 20: *Gentilly-1 Licence Condition Handbook*, WFDL-LCH-W4-331.00/2034

***Gentilly-1 Licence Condition Handbook*, WFDL-LCH-W4-331.00/2034**		
Section and Title	**Description**	**Implementing Document(s)**
4.1 Human Performance Program	The licensee shall implement and maintain a human performance program.	*Performance Assurance*, 900-514000-PDD-001

Table 21*: Douglas Point Waste Facility*, WFDL-LCH-W4-332.03/2030

***Douglas Point Waste Facility*, WFDL-LCH-W4-332.03/2030**		
Section and Title	**Description**	**Implementing Document(s)**
2.1 Human Performance Program	The licensee shall implement and maintain a human performance program.	*Performance Assurance*, 900-514000-PDD-001

Table 22: *Nuclear Power Demonstration Waste Facility*, WFDL-LCH-W4-342.00/2034

***Nuclear Power Demonstration Waste Facility*, WFDL-LCH-W4-342.00/2034**		
Section and Title	**Description**	**Implementing Document(s)**
4.1 Human Performance Program	The licensee shall implement and maintain a human performance program.	*Performance Assurance,* 900-514000-PDD-001

4. Requirements Applicability

Table 23: Requirements Applicability across CNL Sites

	Site								
Requirement	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Offices**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
NQA-1 2015	x	x	x	x	x	x	x	x	x
REGDOC-2.1.2	x	x	x	x	x	x	x	x	x
REGDOC-2.2.1	x		x						
REGDOC-2.4.3	x					x			
ISO 14001:16	x					x			
ISO 9001:15	x	x							
CSA N286.6-98 (R2003)						x			
CSA N286-12 (R2022)	x	x	x	x	x	x	x	x	x

	Site								
Requirement	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Offices**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
CSA N292.0-19	x	x	x	x		x			x
CSA N299.1-16	x	x	x	x	x	x	x	x	x
CSA N299.2-16	x	x	x	x	x	x	x	x	x
CSA N299.3-16	x	x	x	x	x	x	x	x	x
CSA N299.4-16	x	x	x	x	x	x	x	x	x
NPD TCA			x						
SOCA	x	x		x	x		x	x	x
WL TCA						x			
WL LCH						x			

	Site								
Requirement	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Offices**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
CRL LCH	x								
G-1 LCH									x
Douglas Point LCH				x					
NPD LCH			x						

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment.

Table 24: *Safety Culture*

Safety Culture			
Source, Section, and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
Safety Culture, REGDOC-2.1.2 3. Safety Culture Assessments	Licensees shall conduct comprehensive, systematic and rigorous safety culture assessments at least every five years.	5 years	Self-assessment as per *Safety and Security Culture Assessment Framework*, 900-514000-STD-004.

Table 25: *Management Review*

Management Review			
Source, Section, and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
Environmental management systems - Requirements with guidance for use, ISO 14001:2015 9.3 Management review	Top management shall review the organization's environmental management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness...	Annually	*Management Review*, 900-514100-STD-003
Quality Management Systems – Requirements, CSA ISO 9001:2015 9.3.2	The management review shall be planned and carried out taking into consideration…	Annually	*Management Review,* 900-514100-STD-003

Management Review			
Source, Section, and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
Management System Requirements for Nuclear Facilities, CSA N286-12 (R2022) 4.13 Continual Improvement	Management shall continually improve the management system. The following shall be carried out: (b) periodically critically assessing the effectiveness of the management system to achieve the planned results.	Annually	*Management Review*, 900-514100-STD-003

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Training and Development (PDD)
REV 5

900-510200-PDD-001

Information Use

Approved by	Title	Date
Nicole Deighton	Acting, Manager Human Performa	2023/07/24

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
5	2023/07/24	Issued as “Approved for Use”.	E. Whyte	H. Simpson	N. Deighton

5D1	2023/03/09	Issued for “Review and Comment”. Major changes include:
		• Updated to new formal document template.
		• Section 1, Scope and Applicability – added scope statement.
		• Section 3.1, Definitions – corrected definition for “Qualification”, added definitions for “Specialized Training” and “Training Developer”.
		• Section 4.11, Roles and Responsibilities
		  - Merged FSM & Manager roles
		  - Added Training Steering Committee
		• Section 5, Functional Programs – added new Figure 1: Process Flowchart – When to use SAT versus CNL Learning and Development Process.
			E. Whyte	J. Baschuk
				A. Bilton
				M. Boileau
				S. Brooks
				G. Burton
				S. Campbell
				Y. Chin
				C. Clark
				R. Corby
				D. Cram
				A. Dash
				N. Deighton
				J. deRuiter
				A. El Aghoury
				S. Ehmke
				C. Gallagher
				D. Garrick
				T. Gazarek
				K. Ibrahim
				K. Leroux
				D. Meldrum
				H. Simpson
				G. Snell	

4	2022/02/17	Issued as “Approved for Use”. Minor change - Updated to new PDD template.	E. Whyte	N. Deighton J. Luckasavitch	C. Bennett
4D1	2021/12/21	Issued for “Review & Comment”. Major changes include: • Section 2, Purpose statement updated. • Section 3, Definitions and Acronyms – new and alignment of existing definitions to be consistent with REGDOC2.2.2 and associated standards. New definitions for “positions” and “roles” agreed upon with Management Systems. • Section 4, Roles and Responsibilities aligned with	E. Whyte	N. Deighton J. Luckasavitch C. Bennett A. Dash D. Cram T. Beres	

		updates to associated standards. • Section 5, Process Descriptions language updated: includes new CNL Learning and Development instructional design process for non-List positions. Added new subsection for oversight of Training and Development program. • Section 6, Interfaces updated to more accurately reflect internal and external interfaces.			
3	2020/03/31	Issued as “Approved for Use”. Minor Changes: - Removed Facilities Training Lead - Added: Safety Function definition - Included reference to “Application of SAT at CNL Controlled List” - Updated ‘Process Description’ - No R&C required	M. MacCormack	C. Bennett	C. Bennett
2	2019/03/27	Issued as “Approved for Use”. Minor change to update the Pilot Delivery definition incorrectly entered in revision 1.	D. Kilby		R. McNamara
1	2018/03/21	Updated to align terminology and process description based on revisions to SAT process documents issued as new Standards. Minor changes. No R&C required	T. Shorter		R. McNamara
0	2016/12/20	Issued as “Approved for Use”. Cancels and Supersedes: CW-510000-MAN-001, *AECL Systematic Approach to Training (SAT)*.	T. Shorter		T. Shorter
D1	2016/11/30	Issued for “Review and Comment”.		A. Bakewell C. Bennett A. Coulas J. DeRuiter R. Hardin	T. Shorter

				T. Ready B. Sanderson L. Schryer L. Theil S. Karivelil	

Table of Contents

1. Scope and Applicability

This Program Description Document (PDD) describes Canadian Nuclear Laboratories' (CNL) Training and Development Functional Support Are (FSA) program. The PDD also establishes program boundaries and describes oversight, compliance and services for training and development activities.

This Company-wide Interpretation document applies to all activities unique to Training and Development performed by Canadian Nuclear Laboratories (CNL) across all sites.

2. Purpose

Training and Development supports the Organization's operational capabilities by ensuring that workers are effectively and efficiently trained to safely and competently perform their position or role.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [1] contains specific meanings for those words that require further clarification.

3.1 Definitions

Acceptable Level of Performance (ALP)	The required level of achievement during an assessment process that determines trainee's success/failure.
Assessment	A process to observe, evaluate and document trainee progress, confirm learning objectives have been met, and confirm trainee competence.
Authorization/Authorized (Personnel)	The granting of written permission to perform the duties and responsibilities accompanying a position on the basis of demonstrated and verified competence for the position.
Certification	A written attestation from an external body that a person meets the qualification requirements for a position as required by regulation.
CNL Learning and Development Model	A flexible framework for the analysis, design, development, implementation, and evaluation of training at both the course and program level.
Competence	The ability to perform the duties and responsibilities of a position in a safe, effective and efficient manner.

Continuing Training	Training that maintains and enhances the competence of an individual who has been previously qualified. Update training, refresher training and just-in-time training are considered continuing training.
Course Code	An alpha numeric identifier of a course in the learning management system (LMS).
Course Description	A broad statement that describes the overall purpose of the training and/or identifies the gap the training.
Field Checkout (FCO)	A formal evaluation conducted in the job setting evaluating actual task performance involving skill demonstration and oral questioning to ensure that the knowledge and skills associated with a task performance have been learned.
Formative Assessment	Formative assessments are used during the conduct of training to provide ongoing feedback to both Trainers and Trainees on the progress being made towards achieving learning objectives.
Fully Qualified	A person who has achieved all of the qualification requirements (knowledge, skill and experience) of a position or role. This is also known as SQEP (suitably qualified and experienced personnel).
Gap Analysis	A gap analysis is a process used to examine the delta between the actual state and the desired state (e.g. industry recognized standard of excellence, performance standard, licensing/SAT requirements).
Initial Training	The training delivered to address gaps in knowledge, skills and/or performance leading to initial qualification on a task.
Instructional Design	The process of analysing, designing, developing, implementing, and evaluating training (used in reference to CNL's Learning and Development Process).
Job	The work performed by an incumbent(s) in a position or role.
Job Analysis	A process to identify the job functions or tasks of a specific position or role.
Just-in-time Training (JITT)	Initial or continuing training that is delivered prior to task performance to address a knowledge, skill or performance gap.
Learning Management System (LMS)	CNL's software system used for the planning, administration, documentation, tracking, reporting and delivery of training.

Learning Objective	A statement that describes the topic and/or content that will be covered in training (whether at a course or program level). A Learning objective is also referred to as an enabling objective.
Learning Outcome	A statement of what the trainee will be able to do upon successful completion of training (whether at a course or program level). It is written from the trainee's perspective and describes the action that is to be performed, the conditions under which it is to be completed, and the standard for measuring performance. A learning outcome is also referred to as a terminal objective.
Lesson Plan	An outline that guides the conduct of a training activity to ensure that all learning objectives as defined in the training requirements are met.
Performance Support	Job aids that are easily accessible in the moment of need that are used to improve and increase on-the-job performance and productivity (e.g. reference guides, infographics, process maps, checklists, on-demand video tutorials, wallet cards, FAQ sheets, etc.)
Person Analysis	A process to examine an individual's current knowledge, skills and experience against a defined training program or job profile.
Pilot Delivery	Trial run of a training activity for the purpose of validating duration, training method, content, materials and logistics.
Position	A position is identified by a business title and is a worker's primary function for which they were hired to perform as per Line Management.
Practical Training	Training that is conducted in a job setting demonstrating actual, or simulated, task performance and using supporting equipment and documentation to prepare for formal task performance evaluation (e.g. on-the-job training (OJT), just-in-time training (JITT), practical skills training, etc.)
Qualification	A recognized level of mastery of task performance, which is normally acquired through successful completion of training. It involves mastery of all the knowledge, skills, and safety-related attributes required for successful task performance on the job.
Refresher Training	Training identified as requiring, on a scheduled basis, a refresher to ensure qualified workers maintain knowledge of fundamental knowledge and skills.

Remedial Training	Training used to correct identified knowledge, skill and/or performance gaps.
Role	Functional duties and assignments, in addition to their existing position, that any CNL employee performs in order to facilitate delivery of a process.
SAT-Listed Positions and Roles	A list of positions and roles at CNL that require a Systematic Approach to Training (SAT) compliant program. These positions and roles are identified in the *Application of the Systematic Approach to Training (SAT) at CNL* [2], which is commonly referred to as “the List”.
Skill	A mental and/or physical activity that requires a measured degree of proficiency. The words "skill" and "ability" are often used interchangeably.
Specialized Training	Training for tasks that are unique in nature and only performed by select individuals. Line Supervisors/Managers determine which individuals are assigned to complete specialized training.
Summative Assessments	Summative assessments are used upon completion of a training activity to assess a Trainee’s mastery of the learning objectives against the identified success criteria and/or acceptable level of performance (ALP).
Systematic Approach to Training (SAT)	A phased approach to training consisting of: • An analysis phase, which is the identification of the competencies in terms of knowledge and skills required by a position and determines the scale and scope of the training required. • A design and development phase, which is the conversion of competency requirements into Learning Outcomes and Learning Objectives followed by preparation of the training material to support their achievement. • A conduct phase, which is conducting the training using the material developed. • An evaluation phase, which analyzes feedback on training program elements and job performance to assess training efficiency and effectiveness, and identify appropriate improvement actions.
Task	A measurable, well-defined unit of work, with an identifiable beginning and end. Typically defined in a verb-noun format.

Task Analysis	A process to examine a job task to identify knowledge and skills required for its performance.
Trainer	Personnel that have been assigned to instruct or lead a training activity and have been qualified to do so (e.g. instructor, facilitator, etc.).
Training	A process by which knowledge and skills for a position or role are identified, delivered, and acquired.
Training Activity(ies)	A training activity can be either a single course or multiple courses that, in combination, create a training program.
Training Assessor	An individual who has the technical expertise to assess if the acceptable level of performance has been met
Training Developer	An individual who is assigned to lead the instructional design process. For SAT-Listed positions or roles, this individual is a Training Consultant. For positions or roles not on the List, this individual can be a subject matter expert assigned by Line Management who consults with a Training Consultant.
Training Plan	The compilation of all training requirements (initial, continuing, and/or specialized) for a position or role, typically identified through a training analysis.
Training Program	The compilation of all training analyses, plans, and materials that support the training required for a given position or role.
Training Program Owner	The individual, as defined in a facility or organization's governing documentation, with the overall responsibility for the training requirements of a specific training program. This can include responsibility for a training program to qualify for a position (e.g. Line Manager), or responsibility for a training program area (e.g. Nuclear Criticality Safety Functional Support Manager)
Training Qualification Card (TQC)	A format to document and track the progressive completion of the training qualification requirements for a task or position including the process for assessment.
Training Requirements Analysis	A process to analyze new requirements, performance gaps or problems, identify causes, and determine whether training is the appropriate solution.
Transfer of Learning	The effective post-training application of knowledge and skills learned through training resulting in genuine behavioural change in the workplace.

Update Training	Continuing training that is delivered as required to address significant regulatory, procedural, process and/or equipment changes.

3.2 Acronyms

ALP	Acceptable Level of Performance
CRC	Curriculum Review Committee
DIF	Difficulty, Importance, Frequency Analysis
FCO	Field Check Out
JITT	Just-in-time Training
LMS	Learning Management System
OJT	On-the-job Training
PLA	Lesson Plan
SAT	Systematic Approach to Training
TOC	Training Oversight Committee
TQC	Training Qualification Card

4. Roles and Responsibilities

4.1 Responsible Executive

The Responsible Executive is responsible for:

- Ensuring the development, implementation and effectiveness of the Training and Development Function.
- Ensuring that adequate resources are provided for the development, implementation and maintenance of the Training and Development function requirements.
- Appointing a Designated Recipient.
- Reviewing the Training and Development functions performance through Executive Committee Meetings, AECL client meetings, and/or other Management meetings.
- Supporting all other Responsible Executives in the successful implementation of Training programs within their organizational units.

4.2 Functional Support Manager, Training and Development

The Functional Support Manager is responsible for:

- Ensuring that all Training and Development Management System Documentation is developed and maintained in compliance to applicable requirements.

- Providing a structured, documented and auditable set of training processes that, when implemented, provide management with assurance that personnel are trained and qualified for the work they do and that training programs meet licence requirements.
- Directing the overall implementation of CNL's training program and interpretation of both the SAT-based training framework and the CNL Learning and Development process.
- Ensuring SAT operates within the overall context of CNL's Management System framework.
- Providing direction and advice to Line Management responsible and accountable for personnel competence within their respective organization.
- Ensuring the development of training programs for all CNL business and licence-compliance programs, line organizations in all nuclear facilities, laboratories and supporting facilities including the following:
    - Ensuring that the controlled list of positions and roles requiring SAT compliant training programs, as identified in the *Application of the Systematic Approach to Training (SAT) at CNL* [20] (hereafter, "the List"), is maintained.
    - Ensuring that SAT is applied to all positions and roles on the List [2] in order to comply with regulatory requirements as defined in CNL's operating licences.
    - Leading and supporting the Training and Development function by providing oversight, including CNL's Training Oversight Committee (TOC) structure.
    - Ensuring CNL's Learning Management System (LMS) is configured and maintained to enable training compliance and management of training records.
    - Ensuring improvement opportunities to training programs identified through evaluations, audits, inspections, operating experience and lessons learned are addressed.
    - Supporting CNL's transitional projects including change management and training of all affected personnel to support integration of new or different processes.
    - Ensuring training is scheduled, tracked and recorded in accordance with requirements.

4.3 Training Consultants

Training Consultants are responsible for:

- Leading the analysis, design, development, conduct and evaluation of CNL training programs utilizing the SAT process or the CNL Learning and Development process.
- Supporting the implementation of training program improvements identified through evaluations, audits, inspections, operating experience, and lessons learned.

4.4 Training Compliance Analyst

Training Compliance Analysts are responsible for:

- Partnering with Training Consultants and line management to ensure employee required training compliance.
- Analyzing data to support oversight of training program performance, improvements and corrective actions.

4.5 Technical Trainer

Technical Trainers are responsible for:

- Completing training requirements and maintaining qualification as a CNL Trainer as per the *CNL Trainer Training Analysis and Training Requirements* [3] Training Analysis.
- Facilitating training to CNL workers, primarily on the safe operation of tools and equipment.
- Identifying improvements and collaborating with Training and Development Personnel to ensure training programs are maintained.
- Maintaining knowledge of CNLs safety standards and management control procedures.

4.6 Training Coordinators

Training Coordinators are responsible for:

- Providing front-line customer service for the delivery of training programs, including procurement, scheduling, reporting, and recording of training.

4.7 Training Program Owners

Training Program Owners are responsible for:

- Approving training program requirements.
- Collaborating with Training and Development to ensure training programs are compliant with requirements.
- Collaborating with Training and Development to identify positions or roles to be included on the List [2].
- Ensuring adequate resources are available to enable successful development and implementation of training programs.

Note: The FSM or Line Manager sometimes fulfills the role of the Training Program Owner.

4.8 Line Managers

Line Managers are responsible for:

- Ensuring workers are qualified to perform their assigned tasks.
- Collaborating with Training and Development to ensure training programs are compliant with requirements.

- Collaborating with Training and Development to identify positions or roles to be included on the List [2].
- Ensuring adequate resources are available to enable successful development and implementation of training programs.

4.9 Trainers

The role of Trainer can be fulfilled by any employee at CNL. Trainers are responsible for:

- Completing training requirements and maintaining qualification as a CNL Trainer as per the *CNL Trainer Training Analysis and Training Requirements* [3] Training Analysis.
- Facilitating training to CNL workers.
- Identifying improvements and collaborating with Training and Development personnel to ensure training programs are maintained.
- Maintaining knowledge of relevant CNL standards and management control procedures.

4.10 Training Oversight Committee (TOC)

The Training Oversight Committee (TOC) is responsible for:

- Providing oversight of CNL's training strategy and direction.
- Reviewing and approving changes to training program requirements that have a company-wide impact.

4.11 Training Steering Committee

Mission-specific Training Steering Committees are responsible for:

- Ensuring that a Systematic Approach to Training is applied within the mission-area as determined by *Application of Systematic Approach to Training at CNL* [2].
- Ensuring that *CNLs Learning and Development* [4] standard is applied within the mission-area for positions, roles and training activities not requiring the full application of SAT.
- Ensuring that training program activities align with the mission/company vision, values, and strategic direction.
- Endorsing and recommending priorities for training development action plans.
- Allocating training resources based on priority and action plans.
- Reviewing worker performance and making training recommendations in order to address performance gaps.
- Reviewing training conduct and training compliance against existing position-specific training plans and pre-approving the implementation of training affecting large audiences.

- Identifying areas for training program improvement utilizing training evaluation methods such as self-assessments, audits, inspections, impacts, or other feedback mechanisms.

5. Functional Programs

CNL maintains a list of positions and roles that require a Systematic Approach to Training (SAT) compliant program. These positions and roles are identified in the *Application of the Systematic Approach to Training (SAT) at CNL* [2] (hereafter, "the List"). The process used to identify and update positions and roles included on the List is described in CNL's *Training Analysis* [5] standard. For non-List positions, the *CNL Learning and Development* [4] standard provides guidance on the instructional design of training programs.

The process flow chart in Figure 1 illustrates when to use CNL's SAT process versus the CNL Learning & Development process.

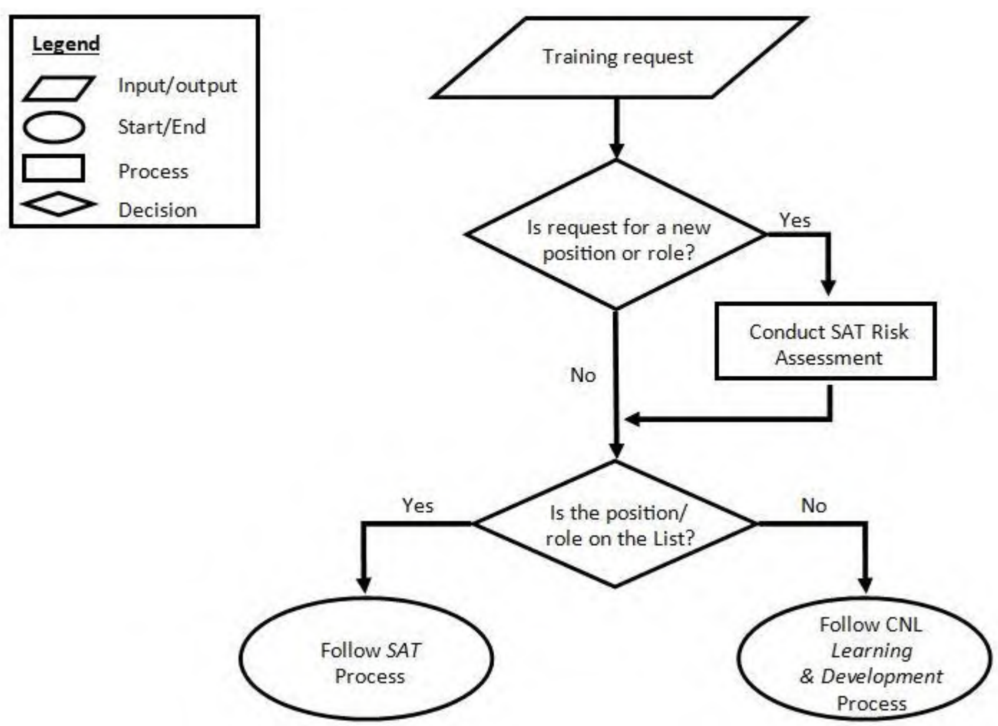

Figure 1: Process Flow Chart- When to use SAT versus CNL Learning & Development

6. Systematic Approach to Training (SAT)

CNL's Systematic Approach to Training (SAT) process provides a standardized approach to training and qualification used to ensure that CNL is in compliance with conditions in the applicable license. It provides Management with the assurance that personnel are trained, competent and qualified for the work they are assigned to do.

A SAT program systematically analyzes [5], designs and develops [6], conducts [7] and evaluates [8] training.

Figure 2: Overview of the Systematic Approach to Training Process (Diagram)

7. CNL Learning and Development Model

For positions and roles that are not on the List, the *CNL Learning and Development* [4] standard is a model that provides a flexible framework for the analysis, design, development, implementation, and evaluation of training (hereafter, "instructional design") at both the course and program level.

The *CNL Learning and Development* [4] model is a non-linear instructional design process that includes a number of recommended inputs (see Figure 3 below). These inputs offer flexibility in the methods used and the sequence in which they occur while ensuring that training programs are designed and implemented in a structured manner, using industry best practice

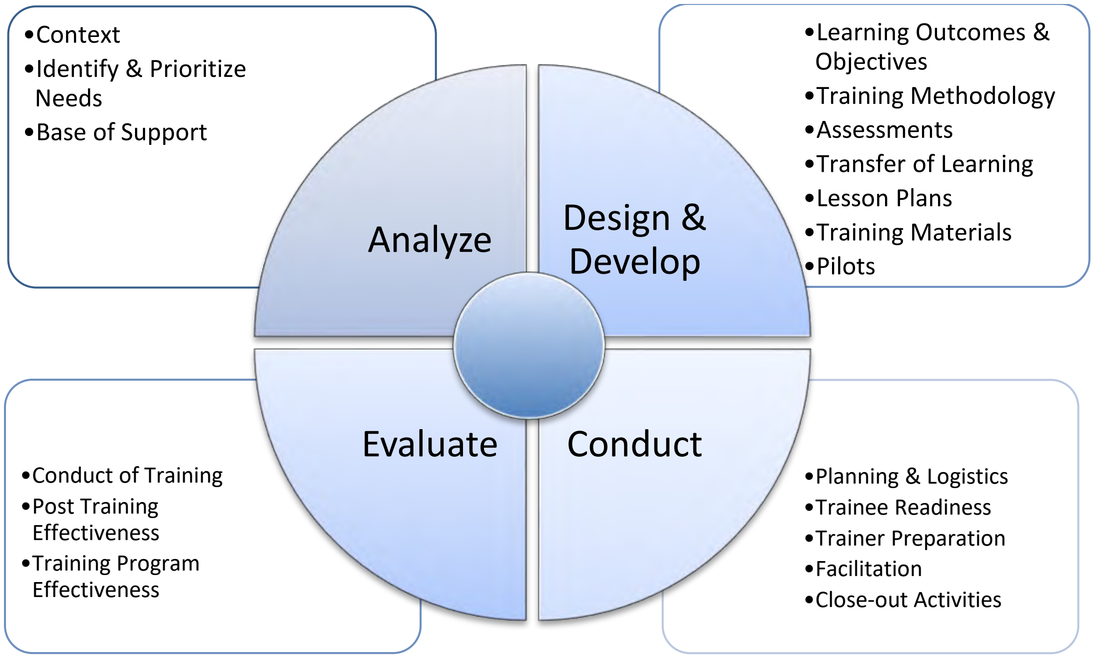

Figure 3: CNL Learning and Development Model for Instructional Design

8. Training Oversight

CNL provides oversight for the Training and Development program through various committees. The primary committees used for SAT compliant training programs are the:

- Training Oversight Committee
- Training Steering Committee
- Curriculum Review Committee

The Training Oversight Committee (TOC) provides a company-wide oversight to ensure that training aligns with CNL's mission, vision and goals. The function of the TOC is described in *Training Oversight Committee Terms of Reference* [9].

Training Steering Committees provide oversight of organizational divisions and evaluate how well training is addressing the mission's business needs and improves employee performance, while making training recommendations based on the findings of these assessments. The Training Steering Committee establishes program health requirements and monitoring of training compliance across mission areas. The function of the Training Steering Committee is described in its mission-specific terms of reference [10].

Curriculum Review Committees (CRC) are used at the line organization level to provide training oversight of individual training programs supporting line organizations and associated positions. Guidance on the CRC's mandate, membership, meeting frequency, process and standing agenda items is described in the *CNL Training Curriculum Review Committee* [11] terms of reference.

9. Interfaces

9.1 Internal Interfaces

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Line Management	Licensing requirements. Training records/ transcripts Training compliance reports Training materials Resource requirements Action plans Audit/Inspection reports ImpActs	ServiceCNL tickets, CRCs, TOC, Management Review Meetings (MRM), Training Documentation	Facility Authorities Training Program Owner Facility Managers Line Managers SMEs Trainers Training Coordinators
Functional Authority	Licensing requirements. Training records/ transcripts Training compliance reports Training materials Resource requirements Action plans Audit/Inspection reports ImpActs	ServiceCNL tickets, CRCs, TOC, MRM, Management System Documents	Functional Support Managers DROLS SMEs

9.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
AECL	Provides contractual expectations for training	Contract	Executive counterparts
CNSC	Compliance requirements Inspection correspondence Industry benchmarking (CTAG)	Inspections, meetings, reports, memos, letters	Inspectors CNSC contract officers Administrators
Utilities (Bruce Power, Ontario Power Generation, Point Lepreau NB Power)	Benchmarking OPEX Sharing of training materials Training	Candu Owner's Group (COG) meetings, classroom, site visits	Training Vice Presidents, Directors, Managers, Consultants, Trainers
External Vendors	Contract requirements/ logistics Development of training materials Facilitation of training Training/certification records Certification process	Purchase orders, invoices, training authorization forms, certificates, contracts, classroom, and meetings.	Supply Chain Representatives CNL Contract Representative (CCR) Vendor Representatives Vendor Trainers Training Coordinators CNL Managers

10. References

[1] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions

[2] *Application of the Systematic Approach to Training (SAT) at CNL*, 900-510200-LST-001, 51881481

[3] *CNL Trainer Training Analysis and Training Requirements*, CW-510200-TA-001, 41552258

[4] *CNL Learning and Development Standard*, 900-510200-STD-005, 57096659

[5] *Training Analysis Standard*, 900-510200-STD-001, 41557836

[6] *Training Design and Development,* 900-510200-STD-002, 47660385

[7] *Conducting Training,* 900-510200-STD-003, 41557860

[8] *Training Evaluation Standard,* 900-510200-STD-004, 40827476

[9] *Training Oversight Committee Terms of Reference,* 900-510200-TOR-001, 50078798

[10] *ERM Training Steering Committee,* 146-510200-TOR-001, 61676584

[11] *CNL Training Curriculum Review Committee*, CW-510200-TOR-002, 53074642

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Information Use

Approved by	Title	Date
Nicole Deighton	Acting, Manager Human Performa	2023/08/21

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
5	2023/08/11	Issued as “Approved for Use”.	E. Whyte	S. Toelly	N. Deighton
5D1	2023/03/09	Issued for “Review and Comment”. Major and minor changes include: • Formatted to Rev 8 of PRD template (including the removal of Definitions and Acronyms section, Table title formatting, and reference formatting). • New section titled *Requirements Applicability* (Section 4). *Requirements Specifying Assessment Activities* is now Section 5. • Section 3 changes: – CRL reference updated to include new Licence Condition Handbook. – PHAI reference updated to include new Licence and Licence Condition Handbook. – NPD reference updated to include new Licence Condition Handbook – WL reference updated to include new Licence and Licence Condition Handbook. – Removed Port Granby Waste Nuclear Substance	E. Whyte	J. Baschuk A. Bilton S. Brooks G. Burton S. Campbell Y. Chin C. Clark R. Corby A. Coulas D. Cram R. Dufour N. Deighton J. deRuiter S. Ehmke A. El Aghoury C. Gallagher D. Garrick T. Gazarek M. Hughey K. Ibrahim K. Leroux D. Meldrum K. Schruder B. Scott G. Snell S. Toelly	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		Licence (WNSL-W1-2311.00/2022) and Pine Street Extension Temporary Storage Site Licence (WNSL-W1-182.0/2022) as both licences and their associated LCHs have been rolled into the new PHAI licence and LCH. − NPD and Gentilly-1 references updated with minor editorial corrections to License and LCH numbers. − DP reference updated to include new licence and Licence Condition Handbook. − Added additional requirements and editorial corrections to Table 9 for RegDoc-2.4.3, Table 11 for RegDoc-2.2.2, Table 13 for SOR/86-304, and Table 16 for RegDoc-2.2.4 VII based on findings from CRL Training Focused Self-Assessment. − Added new requirements to flowdown and tables for N209, CSA N286.6-98, SOR/2000-202, SOR/2000-204, and SOR/2000-207. − Table 10 updated to align with changes made to flowdown reference.			

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
4	2022/02/07	Issued as "Approved for Use".	E. Whyte	S. Toelly	C. Bennett
4D1	2021/12/21	Issued for "Review and Comment". Major and minor changes to update into new formal document template and align with PRD template (as documented in the Training Change Request Form ATOM ID: 56095232 Additional major changes made as part of external stakeholder R&C: • N393-13 – new requirements added • WNSL-W2-2202.0/2026 – added requirements • Removed LLRWMO-508760-LBD-01001 as training requirements are addressed in *WNSL-W1-182.0/2022* (within Table 10) • New requirements table added for REGDOC-2.2.4 Fitness for Duty: Managing Worker Fatigue and Volume II: Managing Alcohol and Drug Use	E. Whyte	N. Deighton J. Luckasavitch C. Bennett A. Dash D. Cram T. Beres S. Toelly	
3	2020/09/28	Issued as "Approved for Use".	M. MacCormack	C. Ball	C. Bennett
3D1	2020/06/12	Issued for "Review and Comment".	M. MacCormack	C. Bennett C. Ball D. Chapman L. Nel	D. Cram C. Gallagher W. Graydon Y. Dube J. Turcotte
2	2019/03/27	Issued as "Approved for Use". Minor changes to update the PRD into the	D. Kilby		R. McNamara

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		new template and add page breaks so the tables are on separate pages.			
1	2018/03/27	Issued as “Approved for Use”.	K. Hughes	C. Bennett	R. McNamara
1D1	2018/03/15	Revised to update and align with SAT document revisions and new PRD template requirements.	K. Hughes	C. Bennett C. Ball	
0	2016/12/20	Issued as “Approved for Use”.	K. Hughes	T. Shorter	T. Shorter
D1	2016/11/30	Issued for “Review and Comment”.	K. Hughes	A. Bakewell C. Bennett A. Coulas J. DeRuiter D. Garrick R. Harding S. Karivelil T. Ready B. Sanderson S. Schryer L. Theil	T. Shorter

Table of Contents

Section **Page**

1. Scope and Applicability

This company-wide document applies to all activities unique to Training and Development performed by Canadian Nuclear Laboratories (CNL) across all sites.

2. Purpose

This document maps the requirements that inform the Training and Development function and demonstrates compliance to those requirements. The following is a mapping of requirement source documents to the Training and Development Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

The following requirements are applicable to Training and Development (Table 1 to Table 16 show how CNL meets each of these requirements documents):

- *Management system requirements for nuclear facilities*, N286-12 (R2022), Canadian Standards Association, June 2012. (Table 1).
- *General principles for the management of radioactive waste and irradiated fuel*, N292.0-19, Canadian Standards Association, March 2019. (Table 2).
- *Quality management systems - requirements*, CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Canadian Standards Association, February 2016. (Table 3).
- *Environmental management systems - requirements with guidance for use*, CAN/CSA-ISO 14001:16 (ISO 14001:2015, IDT), Canadian Standards Association, February 2016. (Table 4).
- *Fire protection for facilities that process, handle, or store nuclear substances*, N393-13 (reaffirmed 2018), Canadian Standards Association, December 2013. (Table 5).
- *Environmental monitoring programs at class I nuclear facilities and uranium mines and mills,* N288.4-10 (reaffirmed 2015), Canadian Standards Association, May 2010. (Table 6).
- *Effluent monitoring programs at class I nuclear facilities and uranium mines and mills,* N288.5-11 (reaffirmed 2021), Canadian Standards Association, April 2011. (Table 7).
- *Groundwater protection programs at class I nuclear facilities and uranium mines and mills,* N288.7-15 (reaffirmed 2022), Canadian Standards Association, June 2015. (Table 8).
- *Nuclear criticality safety*, Version 1.1, REGDOC-2.4.3, Canadian Nuclear Safety Commission, September 2020. (Table 9).
- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028,* Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision

3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023. (Table 10).

- *Port Hope Area Initiative Waste Management Project Waste Nuclear Substance Licence WNSL-W1-2310.00/2032,* Licence Conditions Handbook, LCH-WNSL-W1-2310.00/2032, Revision 0/4500-508760-HBK-001 Revision 0, Canadian Nuclear Safety Commission, January 1, 2023. (Table 10).
- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-8.00/2024,* Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-HBK-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023. (Table 10).
- *Nuclear Power Demonstration Waste Facility Prototype Waste Facilities – Waste Facility Decommissioning Licence WFDL-W4-342.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-342.00/2034 Revision 2/64-508760-HBK-001, Revision 2*,* Canadian Nuclear Safety Commission, August 15, 2023. (Table 10).
- *Prototype Waste Facilities – Waste Facility Decommissioning License, Gentilly-1 Waste Facility, WFDL-W4-331.00/2034,* Licence Conditions Handbook, WFDL-LCH-W4-331.00/2034 Revision 1/61-00580-HBK-001, Revision 0, Canadian Nuclear Safety Commission, July 15, 2019. (Table 10).
- *Prototype Waste Facilities – Waste Facility Decommissioning Licence Douglas Point Facility WFDL-W4-332.03/2030,* Licence Conditions Handbook, WFDL-LCH-W4-332.03/2030 Revision 1/22-508760-HBK-002, Revision 0, Canadian Nuclear Safety Commission, June 11, 2021. (Table 10).
- *Waste Nuclear Substance Licence Low-Level Radioactive Waste Management Office,* WNSL-W2-2202.0/2026, Revision 0, Canadian Nuclear Safety Commission, November 28, 2016. (Table 10).
- *Personnel training,* Version 2*,* REGDOC-2.2.2, Canadian Nuclear Safety Commission, December 2016*.* (Table 11).
- *Canada Labour Code*, R.S.C., 1985, c. L-2. (Table 12).
- *Canada Occupational Health and Safety Regulations*, SOR/86-304. (Table 13).
- *Agreement for the management and operation of certain properties and assets that are the responsibilities of Atomic Energy of Canada limited*, SOC Agreement (SOCA), 2015. (Table 14).
- *Agreement for the work to be undertaken on a target cost basis in order to effect the closure of the Whiteshell laboratories*, WL Agreement (WL TCA), 2015. (Table 14).
- *Agreement for the work to be undertaken on a target cost basis in order to effect the closure of the Nuclear Power Demonstration reactor*, NPD Agreement (NPD TCA), 2015. (Table 14).
- *Fitness for duty: managing worker fatigue,* REGDOC-2.2.4 Volume I, Canadian Nuclear Safety Commission, March 2017. (Table 15).
- *Fitness for duty, volume II: managing alcohol and drug use, Version 3,* REGDOC-2.2.4, Canadian Nuclear Safety Commission*,* January 2021. (Table 16).
- *Nuclear Security Regulations,* SOR/2000-209. (Table 17).

- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 1,* N299.1:19, Canadian Standards Association, 2019. (Table 18).
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 2,* N299.2:19, Canadian Standards Association, 2019. (Table 18).
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 3,* N299.3:19, Canadian Standards Association, 2019. (Table 18).
- *Quality assurance program requirements for the supply of items and services for nuclear power plants, Category 4,* N299.4:19, Canadian Standards Association, 2019. (Table 18).
- *Decommissioning quality assurance for nuclear power plants*, N286.6-98 (R2003), Canadian Standards Association, September 1998. (Table 19).
- *Class I Nuclear Facilities Regulations,* SOR/2000-204. (Table 20).
- *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207. (Table 21).
- *General Nuclear Safety and Control Regulations,* SOR/2000-202. (Table 22).

Table 1: *Management system requirements for nuclear facilities*, N286-12 (R2022), Canadian Standards Association, June 2012.

N286-12		
Section and Title	**Description**	**Implementing Document(s)**
4.5.2 Human Resources	Workers shall be competent to do the work assigned to them, based on the following: a) competence criteria shall be determined for positions based on the work to be performed and include education, experience, knowledge, ability, and performance requirements;	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-005, CNL Learning and Development
	(c) training shall be systematically developed and implemented so that the required qualification is achieved and maintained;	900-510200-PDD-001, Training and Development
	(d) expectations for trainee performance shall be established and the trainee tested against them;	900-510200-PDD-001, Training and Development
	(e) expected results and behaviour of workers shall be defined; and	900-510200-STD-001, Training Analysis

N286-12		
Section and Title	**Description**	**Implementing Document(s)**
		900-510200-STD-005, CNL Learning and Development
	(f) workers shall be provided feedback on their performance.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development

Table 2: ***General principles for the management of radioactive waste and irradiated fuel*, N292.0-19, Canadian Standards Association, March 2019.**

N292.0-19		
Section and Title	**Description**	**Implementing Document(s)**
5.13.1 Training	A training program shall be developed following an assessment of the risks associated with the hazards in the facility and the performance standard for activities.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development
5.13.2 Training	The performance standard shall be based on the nature and complexity of the tasks to be performed and the consequences of error.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development
5.13.3 Training	The waste organization shall be responsible for ensuring that a) all persons working with radioactive material/waste are qualified; and b) worker qualifications are maintained.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training

N292.0-19		
Section and Title	**Description**	**Implementing Document(s)**
5.13.4 Training	The waste organization shall verify that employees a) comply with the training provided; and b) are able to complete assigned tasks in a safe and efficient manner.	900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation

Table 3: *Quality management systems - requirements*, CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Canadian Standards Association, February 2016.

CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT)		
Section and Title	**Description**	**Implementing Document(s)**
7.1.6 Organizational Knowledge	The organization shall determine the knowledge necessary for the operation of its processes and to achieve conformity of products and services. This knowledge shall be maintained and be made available to the extent necessary. When addressing changing needs and trends, the organization shall consider its current knowledge and determine how to acquire or access any necessary additional knowledge and required updates.	900-510200-STD-001, Training Analysis 900-510200-STD-005, CNL Learning and Development
7.2 Competence	The organization shall: a) determine the necessary competence of person(s) doing work under its control that affects the performance and effectiveness of the quality management system;	900-510200-STD-001, Training Analysis 900-510200-STD-005, CNL Learning and Development

CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT)		
Section and Title	**Description**	**Implementing Document(s)**
	The organization shall: b) ensure that these persons are competent on the basis of appropriate education, training or experience;	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
7.2 Competence (cont.)	c) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken. **Note:** Applicable actions can include, for example, the provision of training to, the mentoring of, or the re- assignment of currently employed persons; or the hiring or contracting of competent persons.	900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation 900-510200-STD-005, CNL Learning and Development
	d) retain appropriate documented information as evidence of competence	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development

Table 4: *Environmental management systems - requirements with guidance for use*, CAN/CSA-ISO 14001:16 (ISO 14001:2015, IDT), Canadian Standards Association, February 2016.

CAN/CSA-ISO 14001:16 (ISO 14001:2015, IDT)		
Section and Title	**Description**	**Implementing Document(s)**
7.2 Competence	The organization shall: a) determine the necessary competence of person(s) doing work under its control that affects its environmental performance and its ability to fulfil its compliance obligations;	900-510200-STD-001, Training Analysis 900-510200-STD-005, CNL Learning and Development
7.2 Competence (cont.)	b) ensure that these persons are competent on the basis of appropriate education, training or experience;	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
	c) determine training needs associated with its environmental aspects and its environmental management system;	900-510200-STD-001, Training Analysis 900-510200-STD-005, CNL Learning and Development
	d) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken. NOTE Applicable actions can include, for example, the provision of training to, the mentoring of, or the reassignment of currently employed persons; or the hiring or contracting of competent persons.	900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation 900-510200-STD-005, CNL Learning and Development

CAN/CSA-ISO 14001:16 (ISO 14001:2015, IDT)		
Section and Title	**Description**	**Implementing Document(s)**
	The organization shall retain appropriate documented information as evidence of competence.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development

Table 5: *Fire protection for facilities that process, handle, or store nuclear substances*, N393-13 (R2018), Canadian Standards Association, December 2013.

N393-13 (R2018)		
Section and Title	**Description**	**Implementing Document(s)**
10.4 Fire safety training	10.4.1 A fire safety training needs analysis shall be performed to identify and document the staff training that is necessary for the implementation of the FPP. The needs analysis shall be based on a review of work activities, fire hazards, and required responses.	900-510200-STD-001, Training Analysis
10.4 Fire safety training (Cont.)	10.4.3 Training shall be provided within one year of hire for new staff. Staff with a term of employment of three months or less shall be exempt from this requirement .Note: This exemption does not apply to those involved in hot work or fire watch activities. 10.4.4 Fire safety training shall include, as a minimum, the following topics and procedures: a) fire protection program goals; b) basic fire prevention; c) life safety; d) the use of portable extinguishers; e) emergency procedures; f) the maintenance of egress routes; g) fire equipment availability; h) the control of transient material, hot work, and ignition sources; and i) the reporting of	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation

N393-13 (R2018)		
Section and Title	**Description**	**Implementing Document(s)**
	fires. 10.4.5 The requalification interval for those topics and procedures identified in Clause 10.4.4 shall in no case exceed three years.	

Table 6: ***Environmental monitoring programs at class I nuclear facilities and uranium mines and mills,*** **N288.4-10 (reaffirmed 2015), Canadian Standards Association, May 2010.**

N288.4-10		
Section and Title	**Description**	**Implementing Document(s)**
12.2 Training	A training and orientation program appropriate to the organization and to the activities performed should be documented and implemented in accordance with Clause 4.5.2 of CSA N286. 12.2.1 The training requirements for personnel involved in the EMP shall be described. A training and orientation program appropriate to the organization and to the activities performed should be implemented. If it has been determined that existing training documentation (such as the EMS) is appropriate to the EMP, it may be cited and applied without document duplication. 12.2.2 If training is being provided, a systematic approach to training (SAT) should be followed. The SAT should be based on the identification of the knowledge and skills required to perform the work. Note: The SAT framework generally consists of the following five phases: (a) analysis; (b) design; (c) development; (d) implementation; and (e) evaluation. 12.2.3 Training objectives for personnel should be identified prior to the	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation

N288.4-10		
Section and Title	**Description**	**Implementing Document(s)**
	commencement of the training. The training objectives should be based on the needs and competencies required. 12.2.4 Continuing training needs should be re-examined on a regular basis to determine if the training program is suitable for the work being performed and to ensure that the appropriate knowledge and skills are being maintained.	

Table 7: *Effluent monitoring programs at class I nuclear facilities and uranium mines and mills,* N288.5-11 (reaffirmed 2021), Canadian Standards Association, April 2011.

N288.5-11		
Section and Title	**Description**	**Implementing Document(s)**
12.1 Personnel Qualifications	12.1.1: All effluent monitoring program work should be performed by qualified personnel. The qualification and training requirements for each person performing an effluent monitoring program activity shall be defined. The qualification and training requirements should be appropriate to the job description. If the work is contracted out, documentation shall be available to demonstrate that the contract personnel have equivalent requisite qualifications.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training
	12.1.3: Ongoing assessment should be performed and documented to provide assurance that the personnel remain competent to perform effluent monitoring program activities.	900-510200-STD-004, Training Evaluation

<table>
<tr><th colspan="3">N288.5-11</th></tr>
<tr><th>Section and Title</th><th>Description</th><th>Implementing Document(s)</th></tr>
<tr><td rowspan="2">12.2 Training</td><td>12.2.1: The training requirements for personnel involved in the effluent monitoring program shall be described. A training and orientation program appropriate to the organization and to the activities performed should be implemented.</td><td>900-510200-STD-001, Training Analysis
900-510200-STD-002, Training Design and Development
900-510200-STD-003, Conducting Training</td></tr>
<tr><td>12.2.2: If training is being provided, a systematic approach to training (SAT) should be followed which is based on the identification of the knowledge and skills required to perform the work.</td><td>900-510200-PDD-001, Training and Development</td></tr>
<tr><td rowspan="2">12.2 (cont.)</td><td>12.2.3: Training objectives for personnel should be identified prior to the commencement of the training based on the training needs and competencies required.</td><td>900-510200-STD-001, Training Analysis
900-510200-STD-002, Training Design and Development</td></tr>
<tr><td>12.2.4: Continuing training needs should be re-examined on a regular basis to determine if the training program is suitable for the work being performed and to ensure that the appropriate knowledge and skills are being maintained.</td><td>900-510200-STD-001, Training Analysis
900-510200-STD-004, Training Evaluation</td></tr>
<tr><td>12.3 Maintenance of training records</td><td>Training records that document qualifications and training requirements should be maintained for all personnel performing effluent monitoring program activities.</td><td>900-510200-STD-003, Conducting Training</td></tr>
</table>

Table 8: ***Groundwater protection programs at Class I nuclear facilities and uranium mines and mills,*** **N288.7-15, Canadian Standards Association, June 2015.**

N288.7-15		
Section and Title	**Description**	**Implementing Document(s)**
12.2 Training	12.2.1, The training requirements for personnel involved in the GWPP or GWMP shall be described.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development
	12.2.2, A training and orientation program appropriate to the organization and to the activities performed should be implemented.	900-510200-STD-002, Training Design and Development
12.2 Training (cont.)	12.2.4, If training is provided, a systematic approach to training (SAT) should be followed.	900-510200-PDD-001, Training and Development
	12.2.5, The SAT should be based on the identification of the knowledge and skills required to perform the work.	900-510200-STD-001, Training Analysis
	12.2.6, Training objectives for personnel should be identified prior to the commencement of the training based on the training needs and competencies required.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development
	12.2.7, Continuing training needs should be re-examined on a regular basis a) to determine if the training program is suitable for the work being performed; and b) so that the appropriate knowledge and skills are being maintained.	900-510200-STD-001, Training Analysis 900-510200-STD-004, Training Evaluation
12.3 Maintenance of training records	Training records that document qualifications and training requirements	900-510200-STD-003, Conducting Training

N288.7-15		
Section and Title	**Description**	**Implementing Document(s)**
	should be maintained for all personnel performing GWPP activities.	

Table 9: *Nuclear Criticality Safety*, *Version 1.1,* REGDOC-2.4.3, Canadian Nuclear Safety Commission, September 2020.

REGDOC-2.4.3		
Section and Title	**Description**	**Implementing Document(s)**
13.4 Program Responsibilities	… Supervisors shall ensure that their staffs are suitably trained. Nuclear criticality safety staff shall participate in the development of the training program and should participate in its implementation and the evaluation of its effectiveness	900-510200-STD-003, Conducting Training 900-510200-STD-004, Training Evaluation 900-510200-STD-005, CNL Learning and Development
Section 13.5 Program Structure	Training requirements shall be determined and documented. The content of the training program shall be tailored to job responsibilities and shall support the conduct of the job. Refresher training requirements shall be determined and documented. Such training shall be provided at least every 2 years. Learning objectives of each lesson should be made available to the trainees.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
Section 13.7 Evaluation	The criticality safety training program of an organization shall be evaluated periodically… the evaluation process and the results shall be documented.	900-510200-STD-004, Training Evaluation 900-510200-STD-005, CNL Learning and Development
13.7.2 Personnel	Satisfactory completion of training shall be based upon predetermined performance criteria. Evaluation methods	900-510200-STD-003, Conducting Training

REGDOC-2.4.3		
Section and Title	**Description**	**Implementing Document(s)**
	should include written, oral, and operational examinations. Identified weaknesses shall be addressed by additional training. Acceptance of the adequacy of the individual's total training record shall be the responsibility of the immediate supervisor and of any other organizational units designated by management	900-510200-STD-005, CNL Learning and Development
13.7.3 Documentation	The employee's training record shall be documented and retained for a minimum of four years. Management may specify a longer period of time for retention.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
16.3.1 Management Responsibilities	Management shall ensure that…the level of readiness (including training) needed for response to a criticality accident is adequate.	900-510200-STD-004, Training Evaluation 900-510200-STD-005, CNL Learning and Development
16.7.1 Classroom Training	A program of training for response to a criticality accident shall be developed and provided in accordance with section 13, Nuclear Criticality Safety Training. This training shall be reviewed annually and as needed, to ensure that changes or modifications are incorporated into the training program. Other instructional formats, such as computer based training, may be used to satisfy these requirements.	900-510200-PDD-001, Training and Development

Table 10: Licence conditions handbooks and licence compliance requirements

Licence Conditions Handbooks and Licence Compliance Requirements		
Section and Title	**Description**	**Implementing Document(s)**
Licence Conditions Handbook NRTEOL-LCH-01.00/2028 Chalk River Licence Condition 2.2 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development 900-510200-LST-001, Application of Systematic Approach to Training (SAT) at CNL.
Licence Conditions Handbook NRTEOL-LCH-01.00/2028 Chalk River Laboratories Licence Condition 2.3 Staffing and Certification	Persons appointed to the following position shall be certified b) NRU Certified Health Physicist	900-510200-PDD-001, Training and Development NRU-510000-REQ-002, NRU HP Roles and Responsibilities
Port Hope Area Initiative Waste Management Project – Waste Nuclear Substance Licence Conditions Handbook LCH-WNSL-W1-2310.00/2032 Licence Condition 2.1 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development 4500-510200-PLA-001, Port Hope Area Initiative Training Plan
Licence Conditions Handbook NRTEDL-LCH-08.00/2024 Whiteshell Laboratories Licence Condition 2.2 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development 900-510200-LST-001, Application of Systematic Approach to Training (SAT) at CNL

Licence Conditions Handbooks and Licence Compliance Requirements		
Section and Title	**Description**	**Implementing Document(s)**
Licence Conditions Handbook WFDL-LCH-W4-342.00/2034 Nuclear Power Demonstration Waste Facility Licence Condition 4.2 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development
Licence Conditions Handbook WFDL-LCH-W4-331.00/2034 Gentilly-1 Waste Facility Licence Condition 4.2 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development
Licence Conditions Handbook WFDL-LCH-W4-332.03/2030 Douglas Point Waste Facility Licence Condition 2.2 Training Program	The licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development
Waste Nuclear Substance Licence Low-Level Radioactive Waste Management Office WNSL-W2-2202.0/2026 Licence Condition 2.1 Training Program	The Licensee shall implement and maintain a training program.	900-510200-PDD-001, Training and Development

Table 11: *Personnel Training, Version 2,* REGDOC-2.2.2, Canadian Nuclear Safety Commission, December 2016.

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
REGDOC-2.2.2 All (1 and 1.1)	As required by the General Nuclear Safety and Control Regulations, workers shall be trained to carry on the licensed activity. This regulatory document sets out the CNSC's requirements for licensees regarding the development and implementation of a training system. It also provides guidance on how these requirements should be met.	900-510200-PDD-001, Training and Development
2. Principles	The training system developed and implemented by each licensee shall adhere to the following two fundamental principles: 1. Performance-oriented: Training is preparation for performance on the job. All instruction that is subject to this regulatory document shall focus on essential knowledge, skills and safety-related attributes required to meet job requirements and nuclear-safety-specific needs throughout the lifecycle of the facility. 2. Systematically developed: Training shall be defined, produced and maintained through an iterative and interactive series of steps, leading from the identification of a training requirement to the confirmation that the requirement has been satisfied.	900-510200-PDD-001, Training and Development
3. Training System for Nuclear Facilities	Licensees shall ensure workers who carry on licensed activities are qualified to do the work assigned to them through the use of a training system to systematically analyze, design, develop, implement,	900-510200-PDD-001, Training and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	evaluate, document and manage new training and the revision of existing training, including continuing training. It shall be used whether the training is defined, designed, developed, implemented, evaluated, recorded and managed internally by licensees or externally through vendors or contractors. Requirements included in this section are to be applied in a manner that is commensurate with risk. All requirements shall apply but the associated training-related processes and procedures may vary depending upon the safety significance and complexity of the work being performed. In considering safety, factors to be examined include the relative importance to safeguards and security; the magnitude of any hazard involved; the lifecycle stage of the facility; the type of facility or licensed activity; the particular characteristics of the facility or licensed activity (e.g., remote location, densely populated areas with easy access to qualified workers); and any other relevant factors. Licensees shall: 1. identify all performance requirements of a job or duty area relating to licensed activities by conducting a job analysis to determine all of the tasks involved 2. define and document the necessary general worker training, initial job training and continuing training requirements for workers, based on a task analysis of the knowledge, and skills required to perform each task and the	

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	safety-related attributes required to perform their duties 3. ensure that appropriate training is designed, developed and implemented to meet the qualification requirements 4. ensure that trainers meet and maintain documented qualification requirements, particularly in the areas of subject matter expertise and instructional skills 5. ensure that formal evaluations are used to confirm and document that all trained workers are qualified to perform their duties 6. implement a training change-management process that will systematically analyze procedural and equipment changes, changes in job descriptions, and operating experience feedback (including facility and industry-wide events), in order to identify changes to the tasks and task lists and to assess potential training implications leading to training modifications 7. ensure continuing training is provided to workers as deemed necessary through the job and task analyses processes, and that it includes updates to training programs stemming from the change-management process as identified through the training needs analysis process 8. evaluate training regularly and incorporate the results of the evaluations into a training improvement process 9. ensure that workers' records in support of training and qualifications are	

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	established and maintained 10. ensure that workers have a level of training related to nuclear safety corresponding to the duties of their position and employment, including but not limited to radiation safety, fire safety, onsite emergency arrangements, and conventional health and safety	
4. Records Management for a Training System	Licensees shall develop and manage documentation related to all phases of their training including analysis, design, development, implementation and evaluation. Licensees shall maintain records on the training and qualifications of all workers. These records shall be managed and controlled, and may be requested by CNSC staff at any time. Additionally, workers' supervisors and managers shall have immediate, unencumbered and readily available access to the workers' qualification records related to work being assigned or performed. The training record for each worker, including temporary workers and contractors, shall include all qualifications and certifications granted by or relied on by the licensee to fulfill requirements of this document and that are related to the duties of the worker at that facility. Records shall include expiration dates for time-sensitive qualifications and certifications, and all requalification or recertification requirements.	900-510200-PDD-001, Training and Development
5. Guidance on the Systematic Approach to Training	The systematic approach to training (SAT) is a proven and highly successful education and training methodology,	900-510200-PDD-001, Training and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	which licensees may adopt to meet the requirements in section 3.0 of this regulatory document. SAT is also widely known as the instructional system design model (ISDM) or analysis, design, development, implementation and evaluation (ADDIE) model. A SAT-based training system provides interdependent functions consisting of analysis, design, development, implementation and evaluation. This cyclic process (see figure 1) allows training to be systematically analyzed, defined, designed, developed, implemented, evaluated, documented and managed – in order to not only meet operational and organizational requirements, but also to react quickly to changes in those requirements. Appendix A provides licensees with further guidance on using a systematic approach to training, particularly for the development of radiation safety training programs.	
5.1 Analysis Phase	The analysis phase is the foundation of any training course or training program and includes inputs from operational staff, end-users, subject-matter experts and training development experts. Its purpose is to specify the required outcome of the training in terms of essential on-the-job performance as defined by role documents, procedures or written instructions. The analysis should consider the following points: • rationale and purpose of training • scope of the training	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	• target audience • training method • location of the training • time frame for completion of the training	
5.1.1 Training Needs Analysis	A training needs analysis (TNA) is often triggered by a performance gap or deficiency that has identified training as the solution. A TNA can be used to systematically assess job performance requirements against existing performance (gap analysis) and identify specific areas that require training. A TNA may also be used to assess skills and knowledge gaps created by engineering design and equipment changes, operational changes, revised procedures, and modifications to regulatory requirements.	900-510200-STD-001, Training Analysis
5.1.2 Job and Task Analysis	To identify all performance requirements of a job or duty area, a job analysis should be conducted to determine all of the tasks involved with all states of the nuclear facility, including normal operations, accident conditions and emergencies. The end result of a job analysis is a list of tasks that should be completed to perform the job correctly. Task difficulty, importance and frequency (DIF) are considered to determine which tasks need to be part of training and to determine the initial and continuing training content. A task analysis is conducted to determine the method of task performance and associated knowledge, skills and safety-related attributes. While the knowledge and skills	900-510200-STD-001, Training Analysis

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	should be determined for each task, safety-related attributes need not be developed for each task but can be developed collectively and documented for a job or duty area.	
5.1.3 Learning Objectives	Terminal learning objectives (TLOs) are statements of the tasks that the workers must be able to demonstrate after completing the training. TLOs should be measurable and define exactly when, what and how well the trainee must be capable of performing on the job upon completion of the training. A terminal learning objective should include the following: • Performance statement: states the task to be performed • Condition statement: describes conditions under which the performance must be completed • Standards: state the measurable criteria that describe how well the performance should be completed	900-510200-STD-002, Training Design and Development
5.1.4 Target Audience Analysis	A target audience analysis determines the numbers and categories of workers to be trained and, where possible, the characteristics of the individuals who will receive the training (e.g., current job experience and prior background, experience, education and training). This information ensures that the training is designed, developed and implemented at the correct level, and assists with determining any necessary training prerequisites, including the minimum entry level education and training.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
5.2 Design Phase	The design phase should include the selection and description of the training and an environment that will enable the trainees to achieve the TLOs determined in the analysis phase. The design phase starts with the results of the analysis phase and ends with a plan for the development of the training. The design phase takes the output from the analysis phase and specifies how the information will be presented and how the knowledge, skills and safety-related attributes will be tested.	900-510200-STD-002, Training Design and Development
5.2.1 Trainee Characteristics	As a result of the analysis phase, the target audience should have been broadly defined. During this phase, the trainee characteristics should be further described in terms of their entry-level knowledge, skills and safety-related attributes, and those characteristics likely to affect their responses to particular instructional activities. Information obtained in this process will guide subsequent decisions such as those regarding appropriate instructional sequences, methods and media, and help tailor the training to trainees' needs and learning characteristics.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development
5.2.2 Instructional Program Design	The instructional program design determines the knowledge, skills and safety-related attributes required to perform a task. These knowledge, skills and safety-related attributes lead to enabling objectives (EOs), which document the knowledge, skills and safety-related attributes. These EOs are then grouped and sequenced into the	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	order most suitable for learning.	
5.2.3 Enabling Objectives	EOs are the principal units of learning and constitute a major step towards achieving the associated TLOs. As sub-components of TLOs, EOs represent manageable units of work: units that are coherent in terms of logic, learning of work, and that have a suitable scope and are appropriate for testing learning progress. Like a TLO, an EO is composed of three essential parts: • Performance statement: an observable action normally stated as one action associated with a single verb. If the action is complicated or if more than one verb is used, then the EO needs to be broken down further into other EOs with simple actions. • Conditions statement: a description of the setting or conditions under which the task is to be performed. Ideally, the conditions should mirror those in the workplace where the operation is performed. • Standard: one or more measurable criterion stating the level of acceptable performance of the task in terms of quantity, quality or time limitations. It should answer questions such as “How many?”, “How fast?” or “How well?”	900-510200-STD-002, Training Design and Development
5.2.4 Learning Assessment Plan	A learning assessment plan describes the use of formal evaluations within the qualification program. The learning assessment plan determines how	900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	progress towards, and achievement of, the required performance is checked and verified. While an assessment should be based upon the performance defined in the TLOs or EOs, limiting factors (such as time) may not permit direct observation of the full range of desired performance. The assessment plan describes how a valid and reliable sample of trainee performance will be measured and evaluated.	
5.2.5 Instructional Strategies	The instructional strategy is the combination of media, methods and environment used in the delivery of training. The advantages and disadvantages of each instructional strategy, as applied to the TLOs and EOs, should be examined to ensure that the most effective solution is selected to produce graduates capable of performing tasks as indicated in the TLOs.	900-510200-STD-002, Training Design and Development
5.2.6 On-the-job Training	On-the-job training (OJT) requirements should be considered when one or more of the TLOs may not be suitable for traditional instructional methods. If OJT is necessary, then OJT learning objectives, complete with performance statements, conditions and standards, should be produced. Subsequently, each OJT learning objective should be formally assessed using on-the-job evaluation.	900-510200-STD-002, Training Design and Development
5.2.7 Training Development Plan	The training development plan documents the decisions made during the design phase. Outcomes and decisions regarding items covered in sections 5.2.1 through 5.2.6 should be documented and used during the development phase.	900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
5.3 Development Phase	The development phase involves the procurement or production of effective instructional materials in accordance with the training development plan.	900-510200-STD-002, Training Design and Development
5.3.1 Procurement/ Production of Instructional Materials	Instructional materials should support the learning activities. Such items include instructor lesson plans, interactive courseware such as computer-based training and training aids of all types including equipment, references, job aids and testing materials. The instructional materials should include the following, where necessary: • Trainee manuals: These are reference handbooks to be used and often retained by the trainees. • Instructor guides: These are instructional specifications for use by the instructor during training preparation and delivery. They outline the specific training steps that must be used to satisfy the training development plan. • Handouts: These additional aids can supplement the trainee manuals in areas identified as difficult and/or particularly important. • Computer-based training or other media: These are to be used where they are the recommended solution based on the instructional analysis and the selection of the instructional strategy. • Question banks and some sample tests: When used during the	900-510200-STD-002, Training Design and Development

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	training, these should include guidance on where and when they should be used.	
5.3.2 Assessment Tests	Assessment tests, which address the requirement for formal evaluation, cover both progress and final testing. In general, there are two types and both should be developed. Knowledge or cognitive assessments: Usually written, these tests can include multiple choice, multiple response, dichotomous or binary (e.g., yes/no; true/false), matching, resequencing, and open-ended questions. Performance or skill-based assessments: These are practical tests based on realistic scenarios of the most important and significant skills and safety-related attributes derived from the TLOs and EOs.	900-510200-STD-002, Training Design and Development
5.3.3 Conduct of Trials (Pilot Courses)	To assess the effectiveness of the training and related materials, these materials should be reviewed by subject-matter experts, tested with individuals who are representative of the target training audience, and approved by the appropriate managers. The training and instructional materials should be revised according to the findings of the trials.	900-510200-STD-002, Training Design and Development 900-510200-STD-004, Training Evaluation
5.4 Implementation Phase	The implementation phase is to enable the trainees to successfully perform the tasks to the standards defined in the TLOs. This phase encompasses both the instructor preparation phase as well as the actual delivery of the training. It should include: • lesson plans based on the training	900-510200-STD-003, Conducting Training

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	development plan and the instructor guides prepared during the development phase • set-up of the training environment • continual monitoring to ensure that learning is taking place • arrangements for follow-on training, where necessary	
5.5 Evaluation Phase	The evaluation phase involves the assessment of the effectiveness and efficiency of the training as delivered and verification of whether the trainees have mastered the TLOs and acquired the competence needed to perform the job safely. The evaluation phase includes the following: • Formal trainee evaluation: The trainees' abilities to perform the tasks, as defined in the TLOs, should be measured through tests and assessments. This activity can be included as a process within the implementation phase. • Content and delivery: All course content and instructional strategies, methodologies and activities, including trainee evaluations, are monitored and assessed so that corrective actions can be taken if necessary. Sources of feedback include the trainees, the instructors, the support staff and the responsible managers and supervisors. • Effectiveness: This means the graduates' ability to perform, in	900-510200-STD-003, Training Conduct 900-510200-STD-004, Training Evaluation

REGDOC-2.2.2		
Section and Title	**Description**	**Implementing Document(s)**
	the workplace, the tasks for which they were trained. The primary sources of this information are the graduates and their supervisors. Additionally, information may be available through various sources ranging from needs assessments and lessons-learned reports to incident reports and rework statistics. Managers and supervisors should have continuous input to the training. • Change management: In accordance with the principles of a SAT methodology, inputs such as new or revised regulatory requirements, engineering design and equipment changes, operational changes, revised procedures, modifications and operating experience feedback (including facility and industry-wide events) should be regularly fed into the appropriate processes through the analysis phase.	

Table 12: *Canada Labour Code*, R.S.C., 1985, c. L-2.

Canada Labour Code		
Section and Title	**Description**	**Implementing Document(s)**
125.1 Duties of Employers	..Every employer shall, in respect of every work place controlled by the employer and, in respect of every work activity carried out by an employee in a work place that is not controlled by the employer, to the extent that the employer controls the activity: q) provide, in the prescribed manner, each employee with the information, instruction, training and supervision necessary to ensure their health and safety at work;	900-510200-PDD-001, Training and Development
	z) ensure that employees who have supervisory or managerial responsibilities are adequately trained in health and safety and are informed of the responsibilities they have under this Part where they act on behalf of their employer;	900-510200-PDD-001, Training and Development

Table 13: *Canada Occupational Health and Safety Regulations*, SOR/86-304.

Canadian Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
10.14 (1) Employee Education and Training	Every employer shall, in consultation with the policy committee or, if there is no policy committee, the work place committee or the health and safety representative, develop and implement an employee education and training program with respect to hazard prevention and control at the work place.	900-510200-PDD-001, Training and Development

Canadian Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
12.2 (1)	An employer must ensure that every person who is granted access to a work place and who uses protection equipment is provided with instruction by a qualified person in the use of that equipment.	900-510200-STD-003, Training Conduct 900-510200-STD-005, CNL Learning and Development
12.2 (2)	The employer must ensure that, in addition to the instruction referred to in subsection (1), every employee who uses protection equipment is provided with instruction and training by a qualified person in the operation and maintenance of the equipment and training by a qualified person in its use.	900-510200-STD-003, Training Conduct 900-510200-STD-005, CNL Learning and Development

Table 14: Site operating company agreement and target costs contracts between AECL and CNL

Site Operating Company Agreement between AECL and CNL		
Section and Title	**Description**	**Implementing Document(s)**
Site Operating Agreement between AECL and CNL		
2.3 Standard of Care	… (x) are available and are adequately experienced and trained to operate the AECL Resources and to undertake the other Work contemplated in the Statement of Work and the other provisions of this Agreement, in each case properly and efficiently, and (y) are capable of responding to emergencies and reasonably anticipated abnormal conditions; (v) preventative, routine and non-routine maintenance and repairs are performed on a basis that promotes reliable long-term and safe operation, and are	900-510200-PDD-001, Training and Development

Site Operating Company Agreement between AECL and CNL		
Section and Title	**Description**	**Implementing Document(s)**
	performed by knowledgeable, trained and experienced personnel utilizing proper equipment, tools and procedures; and (vi) appropriate monitoring and testing are done to ensure equipment is functioning as designed and to provide reasonable confidence that equipment will function properly under both normal and reasonably anticipated abnormal conditions.	
8.2 Maintenance of Skills, Minimum Work Force Requirements and Succession Planning	(b) CNL shall maintain and develop at the Sites a skilled workforce comprised of Employees, consultants, the Key Personnel and the Non-Key Personnel that are able to perform the type of services, operations, projects, work and other activities contemplated in the Statement of Work and the other provisions of this Agreement and that will promote the scientific and technical expertise of CNL nationally and internationally. CNL shall support the growth and development of the Canadian nuclear sector through the performance of the skilled workforce at CNL and the collaboration of the skilled workforce with other institutions. Without limiting the generality of the foregoing, CNL shall ensure that: (ii) all persons employed or engaged by or seconded to CNL in the performance of its obligations under this Agreement receive such training, education and supervision as is reasonably necessary to ensure the performance of the Work in accordance with the terms of this Agreement and compliance with all	900-510200-PDD-001, Training and Development

Site Operating Company Agreement between AECL and CNL		
Section and Title	**Description**	**Implementing Document(s)**
	security, health and safety rules, procedures and requirements and all Authority Requirements. (iii) CNL creates and maintains a process which allows it to assess, monitor and correct, on an ongoing basis, the competency of persons employed or engaged by or seconded to CNL in the performance of CNL's obligations consistent with the performance of the Work in accordance with the terms of this Agreement.	
Target Cost Contract for Whiteshell between AECL and CNL		
2.3 Standard of Care	…(x) are available and are adequately experienced and trained to operate the AECL Resources and to undertake the other Work contemplated in the Statement of Work and the other provisions of this Agreement, in each case properly and efficiently, and (y) are capable of responding to emergencies and reasonably anticipated abnormal conditions; (v) preventative, routine and non-routine maintenance and repairs, to the extent appropriate in the context of a Closure project, are performed on a basis that promotes reliable and safe operation, and are performed by knowledgeable, trained and experienced personnel utilizing proper equipment, tools and procedures;	900-510200-PDD-001, Training and Development
9.2 Human Resources Matters	(b) CNL shall ensure that: (ii) all persons employed or engaged by or seconded to CNL in the performance of its obligations under this Agreement receive such training, education and supervision as is reasonably necessary to	900-510200-PDD-001, Training and Development

Site Operating Company Agreement between AECL and CNL		
Section and Title	**Description**	**Implementing Document(s)**
	ensure the performance of the Work in accordance with the terms of this Agreement and compliance with all security, health and safety rules, procedures and requirements and all Authority Requirements (iii) CNL creates and maintains a process which allows it to assess, monitor and correct, on an ongoing basis, the competency of persons employed or engaged by or seconded to CNL in the performance of CNL's obligations consistent with the performance of the Work in accordance with the terms of this Agreement.	
Target Cost Contract for NPD between AECL and CNL		
2.3 Standard of Care	…(x) are available and are adequately experienced and trained to operate the AECL Resources and to undertake the other Work contemplated in the Statement of Work and the other provisions of this Agreement, in each case properly and efficiently, and (y) are capable of responding to emergencies and reasonably anticipated abnormal conditions; (v) preventative routine and non-routine maintenance and repairs, to the extent appropriate in the context of a Closure project, are performed on a basis that promotes reliable and safe operation, and are performed by knowledgeable, trained and experienced personnel utilizing proper equipment, tools and procedures;	900-510200-PDD-001, Training and Development

Site Operating Company Agreement between AECL and CNL		
Section and Title	**Description**	**Implementing Document(s)**
9.2 Human Resources Matters	(b) CNL shall ensure that: (ii) all persons employed or engaged by or seconded to CNL in the performance of its obligations under this Agreement receive such training, education and supervision as is reasonably necessary to ensure the performance of the Work in accordance with the terms of this Agreement and compliance with all security, health and safety rules, procedures and requirements and all Authority Requirements. (iii) CNL creates and maintains a process which allows it to assess, monitor and correct, on an ongoing basis, the competency of persons employed or engaged by or seconded to CNL in the performance of CNL's obligations consistent with the performance of the Work in accordance with the terms of this Agreement.	900-510200-PDD-001, Training and Development

Table 15: *Fitness for Duty: Managing Worker Fatigue,* REGDOC-2.2.4 Volume I, Canadian Nuclear Safety Commission, March 2017.

REGDOC-2.2.4 Volume I		
Section and Title	**Description**	**Implementing Document(s)**
3.4 Training and education	With respect to managing fatigue, licensees shall ensure that those with authorities, accountabilities, and responsibilities for managing worker fatigue receive initial and ongoing training commensurate with their authorities, accountabilities, and responsibilities.	900-510200-PDD-001, Training and Development

Table 16: *Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3,* REGDOC-2.2.4, Canadian Nuclear Safety Commission, January 2021.

REGDOC-2.2.4		
Section and Title	**Description**	**Implementing Document(s)**
3.6.2 Supervisory awareness program	…supervisors are trained to recognize behavioural changes in all personnel, including contractors that could pose a risk to security at a facility. Supervisory awareness training shall be delivered to supervisors and other designated personnel identified by the licensee.	900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training
3.7 Assessment and continual improvement	An assessment of... the supervisory awareness program shall be performed periodically to identify opportunities for continual improvement and to confirm the program's effectiveness.	900-510200-STD-004, Training Evaluation 900-510200-STD-005 , CNL Learning and Development
3.8 Training, education, and awareness	Licensees shall ensure that those with authorities, accountabilities, and responsibilities for monitoring alcohol and drug use and abuse, including workers, receive initial and continuing training commensurate with their authorities, accountabilities and responsibilities.	900-510200-PDD-001, Training and Development
6.1 Breath alcohol-testing process	… Licensees should refer to the Alcohol Test Committee when establishing procedures for the administration of evidential breath alcohol testing, including: • the initial and continuing training and qualification of breath alcohol technicians for the operation of approved instruments, including conversion training • the initial and continuing training and qualification of designated service personnel for the	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development

REGDOC-2.2.4		
Section and Title	**Description**	**Implementing Document(s)**
	preventative and corrective maintenance of approved instruments	
6.5 Investigative and alcohol and drug screening tools	Licensees shall establish and document the accepted use of investigative and alcohol and drug screening tools included in their respective fitness-for-duty programs. Use of these tools shall be clearly documented, and training programs shall be provided to support the designated personnel in the proper use of the tools.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training

Table 17: *Nuclear Security Regulations,* SOR/2000-209, June 2015

SOR/2000-209		
Section and Title	**Description**	**Implementing Document(s)**
34(1) Training	Every licensee shall train each of its nuclear security officers in respect of the relevant and current security duties and responsibilities.	900-510200-PDD-001, Training and Development
37(3) Records to be kept, retained and made available:	Every licensee shall keep a record of the training received by each of its nuclear security officers.	900-510200-STD-003, Conducting Training
38 Supervisory Awareness Program	Every licensee shall develop a supervisory awareness program and implement it on an ongoing basis to ensure that its supervisors are trained to recognize behavioural changes in all personnel, including contractors, that could pose a risk to security at a facility at which it carries on licensed activities	900-510200-STD-002, Training Design and Development 900-510200-STD-003, Conducting Training

Table 18: ***Quality assurance program requirements for the supply of items and services for nuclear power plants*** **(Category 1, 2, 3, 4), CSA N299.1:19, 2019**

N299.1:16/2:19/3:19/4:19		
Section and Title	**Description**	**Implementing Document(s)**
N299.1/2 5.2.6 5.2.6.2	Training shall ensure that personnel are aware of their specified responsibilities in the QA program and their job function, are competent and capable of performing their work, and that their competency is maintained. Management shall a) document, implement, and maintain the required training program and ensure effectiveness of the training program; b) document the process and the methods that will be utilized, and provide the required training commensurate with the scope, complexity, and importance of the activities; c) evaluate trainees' knowledge of the training objectives and requirements of applicable codes, standards, specifications; and d) provide on-the-job training if direct hands-on applications or experience is needed to achieve and maintain proficiency by verifying trainee performance against expectations.	900-510200-PDD-001, Training and Development
N299.3 5.2.6.2	Training shall ensure that personnel are aware of their specified responsibilities in the QA program and their job function, are competent and capable of performing their work, and that their competency is maintained. Management shall a) document, implement, and maintain training requirements;	900-510200-PDD-001, Training and Development

N299.1:16/2:19/3:19/4:19		
Section and Title	**Description**	**Implementing Document(s)**
	b) evaluate trainees' knowledge of the training objectives and requirements of applicable codes, standards, specifications and the commitments of the AHJ, when required; and c) provide on-the-job training if direct hands-on applications or experience is needed.	
N299.4 5.2.6.2	Training shall ensure that personnel are aware of their specified responsibilities in the QA program and their job function, are competent and capable of performing their work, and that their competency is maintained. Management shall a) document, implement, and maintain training requirements; b) evaluate trainees' knowledge of the training objectives, the requirements of applicable codes, standards, and specifications, and the commitments of the AHJ, when required; and c) provide on-the-job training if direct hands-on applications or experience is needed.	900-510200-PDD-001, Training and Development
N299.1/2 5.2.6.3	Management shall a) … b) qualify the personnel who are developing the training needs analysis, expectations, and programs, and qualify those delivering the training; c) define and document activities/job functions that require specialized qualifications	900-510200-PDD-001, Training and Development

N299.1:16/2:19/3:19/4:19		
Section and Title	**Description**	**Implementing Document(s)**
	and competencies (e.g., engineers, cause analysis personnel, CFSI detection personnel, Non-Destructive examination technicians, welders, software programmers, inspection and test personnel, and auditors), and their minimum qualification and requalification requirements; d) take into consideration the necessary education, experience, and proficiency (skills and abilities) of the activity/job function when determining qualification requirements; e) qualify personnel to the minimum defined qualification requirements prior to performing the activity/job function; f) ensure competencies of personnel are maintained for their roles and responsibilities, taking into account changes in technology, methods, or job responsibilities; and g) conduct reviews at predetermined intervals to verify continued competence, and document the reviews and actions initiated to correct competence deficiencies found.	
N299.1/2/3 5.2.6.4	Records shall be maintained as objective evidence of personnel competencies, indoctrination, training, and qualifications in accordance with Clause 5.5.14. ***Note:*** *The supplier is advised to keep records of indoctrination and training separate from other personnel records.*	900-510200-PDD-001, Training and Development

N299.1:16/2:19/3:19/4:19		
Section and Title	**Description**	**Implementing Document(s)**
N299.4 5.2.6.4	Records shall be maintained as objective evidence of personnel competencies, indoctrination, and training in accordance with Clause 5.5.14.	900-510200-PDD-001, Training and Development
N299.1/2/3 5.5.12.1	The supplier shall a) define the necessary qualifications of personnel (in accordance with Clause 5.2.6), process procedures, documentation, and equipment for special processes not covered by existing codes or standards, or where item or service quality requirements exceed the requirements of established codes or standards; and b) maintain qualification records for qualified personnel (in accordance with Clause 5.2.6), process procedures, documentation, and equipment in accordance with the requirements of applicable codes and standards.	900-510200-PDD-001, Training and Development
N299.1/2/3 5.5.14 5.5.14.2	The supplier shall a) retain, control, and maintain quality records consistent with applicable codes, standards or specifications, and contract requirements in order to provide objective evidence that i. ... ii. … iii. personnel, procedures, documentation, and equipment for special processes are qualified, as required by Clause 5.5.12.2 (b);	900-510200-PDD-001, Training and Development

N299.1:16/2:19/3:19/4:19		
Section and Title	**Description**	**Implementing Document(s)**
	iv. … v. …; and b) Ensure the following: i. Identification, indexing, and filing of quality records for prompt retrieval are maintained up to the time of customer acceptance of the item or service, unless the record retention period is specified by contract or by requirements of the Authority having jurisdiction (AHJ); ii. records are traceable to associated items and activities and accurately reflect the work accomplished or information required;…	

Table 19: *Decommissioning quality assurance for nuclear power plants,* N286.6-98 (R2003), Canadian Standards Association, September 1998.

N286.6-98		
Section and Title	**Description**	**Implementing Document(s)**
3. Basic Requirements - 3.4 Personnel Capability	3.4.1 Personnel responsible for decommissioning activities shall be competent to perform the tasks assigned to them.	900-510200-PDD-001, Training and Development

N286.6-98		
Section and Title	**Description**	**Implementing Document(s)**
	3.4.2 Selection and qualification criteria for personnel involved with decommissioning activities shall be established based on the required competence levels. These criteria shall include a definition of the minimum education, experience, initial training, and continuing training requirements.	900-510200-STD-001, Training Analysis 900-510200-STD-002, Training Design and Development 900-510200-STD-005, CNL Learning and Development
	3.4.3 Training programs shall be developed systematically and implemented to ensure that the required competency of personnel is achieved and maintained. Training programs shall be reviewed for effectiveness and kept up to date.	900-510200-PDD-001, Training and Development

Table 20: *Class I Nuclear Facilities Regulations,* SOR/2000-204

SOR/2000-204		
Section and Title	**Description**	**Implementing Document(s)**
14(2)	Every licensee who operates a Class I nuclear facility shall keep a record of… (e) The status of each worker's qualifications, requalification and training, including the results of all tests and examinations completed in accordance with the licence.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
14(3)	Every licensee who decommissions a Class I nuclear facility shall keep a record of… (e) The status of each worker's qualifications, requalification and training, including the results of all tests and examinations completed in accordance with the licence.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development

Table 21: *Nuclear Substances and Radiation Devices Regulations,* SOR/2000-207

SOR/2000-207		
Section and Title	**Description**	**Implementing Document(s)**
36(1)(d)	Every licensee shall keep the following records: a record of the training received by each worker; and	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development
36(2)	Every licensee shall retain a record referred to in paragraph (1)(d) for the period ending three years after the termination of employment of the worker.	900-510200-STD-003, Conducting Training 900-510200-STD-005, CNL Learning and Development

Table 22: *General Nuclear Safety and Control Regulations,* SOR/2000-202

SOR/2000-202		
Section and Title	**Description**	**Implementing Document(s)**
12(1)(b)	Every licensee shall train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence.	900-510200-PDD-001, Training and Development

4. Requirements Applicability

Table 23: Requirements Applicability across CNL Sites

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
N286-12	X	X	X	X	X	X	X	X	X
N292.0-14	X	X	X	X	X	X	X	X	X
CAN/CSA-ISO 9001:16	X	X							
CAN/CSA ISO 14001:16	X					X			
N393-13	X	X	X	X	X	X	X	X	X
N288.4-10	X		X	X		x			x
N288.5-11	X		X	X		x			x
N288.7-15	X		X	X		x			x
REGDOC-2.4.3	X	X	X	X		X		X	X
NRTEOL-01.00/2028	X								
WNSL-W1-2310.00/2032		X							

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
NRTEDL-LCH-08.00/2024						X			
WFDL-W4-342.00/2034				X					
WFDL- W4-331.00									X
WFDL-W4-332.03/2030				X					
WNSL-W2-2202.0/2026		X							
REGDOC-2.2.2	X	X	X	X	X	X	X	X	X
Canada Labour Code	X	X	X	X	X	X	X	X	X
Canadian Occupational Health and Safety Regulations	X	X	X	X	X	X	X	X	X
SOC Agreement	X	x		X	X		X	X	X
WL Agreement						X			
NPD Agreement			X						
REGDOC-2.2.4	X			X		X			
REGDOC-2.2.4 (Volume II)	X			X		X			

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
SOR/2000-209	X			X		X			X
N299.1/2/3/4	X								
N286.6-98						X			
SOR/2000-204	X		X	X		X			X
SOR/2000-207	X	X	X	X		X		X	X
SOR/2000-202	X	X	X	X	X	X	X	X	X

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment.

There are no assessment activities for requirements.

Federal Court   Cour fédérale

Date: 20230606

Docket: T-1222-21

Citation: 2023 FC 793

Toronto, Ontario, June 6, 2023

PRESENT: Mr. Justice Diner

BETWEEN:

POWER WORKERS' UNION, SOCIETY OF UNITED PROFESSIONALS, THE CHALK RIVER NUCLEAR SAFETY OFFICERS ASSOCIATION, INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS LOCAL 37, CHRIS DAMANT, PAUL CATAHNO, SCOTT LAMPMAN, GREG MACLEOD, MATTHEW STEWART AND THOMAS SHIELDS

Applicants

and

ATTORNEY GENERAL OF CANADA, ONTARIO POWER GENERATION, BRUCE POWER, NEW BRUNSWICK POWER CORPORATION AND CANADIAN NUCLEAR LABORATORIES

Respondents

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JUDGMENT AND REASONS

I. Overview

[1] A decade ago, the Canadian Nuclear Safety Commission [CNSC] began a process to implement pre-employment and random alcohol and drug testing for the most sensitive positions in Canada's nuclear power plants. The CNSC engaged in various broad-based, public stakeholder consultations to refine the policy over the years. It released a final draft in 2020, requiring Class 1 high-security nuclear sites to implement random and pre-placement drug and alcohol testing for Safety-Critical Workers.

[2] The Applicants – six individuals employed in various Safety-Critical positions at Canada's Class 1 high security nuclear plants, and their Unions – now bring this Application, a judicial review challenging the CNSC's pre-placement and random testing provisions of the policy as being unconstitutional in several facets.

[3] On January 21, 2022, the Applicants obtained an injunction from this Court staying the implementation of the impugned provisions of the policy, pending the final disposition of this Application for Judicial Review (see *Power Workers Union v Canada (Attorney General)*, 2022 FC 73 [*Power Workers 2022*]).

[4] For the reasons set out below, this judicial review will be dismissed.

II. Background

[5] Parliament established the CNSC through the *Nuclear Safety and Control Act*, SC 1997, c 9 [*Act*] to regulate the nuclear industry in the public interest. The objects of the CNSC are set out in section 9 of the *Act* (relevant sections are reproduced at Annex A to these Reasons). All nuclear facilities in Canada must be licensed by the CNSC [Licensees].

[6] The CNSC includes (i) staff working within the regulatory body; and (ii) a quasi-judicial tribunal and court of record [the “Commission”]. The Commission’s functions include rendering decisions to adopt policies on recommendation from staff, including the one challenged in this Application.

[7] The Respondents are comprised of the Attorney General of Canada [AGC] and all the licensed high-security Class 1 nuclear facilities regulated by the CNSC, namely Bruce Power L.P., Ontario Power Generation Inc., Canadian Nuclear Laboratories Ltd., and New Brunswick Power Corporation [together, the “Employers”]. The Employers operate Canada’s 19 nuclear fission technology reactors and provide most of Ontario’s energy, as well as a significant quantity of New Brunswick’s electricity. They employ the workers impacted by the RegDoc (defined below).

[8] The Applicants comprise unions representing workers at CNSC regulated nuclear facilities, namely the Power Workers’ Union, the Society of United Professionals, the Chalk River Nuclear Safety Officers Association, and the International Brotherhood of Electrical

Workers, Local 37, [together, the "Unions"] and six affected workers: Chris Damant, Paul Catahno, Thomas Shields, Matthew Stewart, Scott Lampman and Greg MacLeod. The Unions represent the workers in Safety-Critical positions [Safety-Critical Workers] affected by the pre-placement and random testing provisions of the policy in question, namely REGDOC-2.2.4, Fitness for Duty, Volume II: Managing Alcohol and Drug Use Version 3 [RegDoc] (reproduced at Annex B to these Reasons).

[9] The definition of Safety-Critical positions has evolved with the development of the RegDoc, and now consists of (i) workers certified under subsection 9(2) of the *Class 1 Nuclear Facilities Regulations*, SOR/2000-204 [*Class 1 Regulations*], excluding certified health physicists; and (ii) on-site Nuclear Response Force workers, as defined in the final version of the RegDoc, which is the subject of this Application. Workers certified under the *Class 1 Regulations* include Authorized Nuclear Officers and Unit Control Room Operators. In sum, the workers impacted by the RegDoc's pre-placement and random testing provisions are a subset of highly trained, armed, nuclear security officers, who are responsible for maintaining the security of nuclear facilities. By way of reference to other sensitive positions, the fire brigade and emergency response team members are not considered "Safety-Critical" positions, but are rather classified as "safety-sensitive" positions.

A. *The development of the RegDoc*

[10] Regulatory documents form a critical component of the CNSC's licencing and compliance framework. They typically contain two types of information for Licensees: (i) requirements; and (ii) guidance. Compliance with the regulatory document requirements is

mandatory for Licensees that use nuclear substances, operate nuclear facilities or conduct other types of licensed activities. Regulatory document guidance, on the other hand, supplements the requirements. Licensees are expected to review and consider a regulatory document's guidance, and provide an explanation to the CNSC should they choose not to follow it.

[11] In 2012, CNSC staff began public consultation to develop a regulatory document for fitness for duty, which included pre-placement and random drug and alcohol testing. This public consultation resulted in the publication of a discussion paper, including a summary of comments received from stakeholders on the draft discussion paper (What We Heard Report – DIS-12-03, published in November 2013). In November 2015, the CNSC issued and published a first draft of the RegDoc for another round of consultation from relevant stakeholders.

[12] Many stakeholders, including the Applicants, reiterated objections they had initially raised in response to the draft discussion paper, including their claims of: (i) the unclear statutory basis for imposing testing; (ii) infringement of sections 8 and 15 of the *Canadian Charter of Rights and Freedoms*, Part 1 of the *Constitution Act, 1982*, being Schedule B to the *Canada Act 1982* (UK), 1982, c 11 [*Charter*]; and (iii) inconsistencies between the arbitral case law and the proposed testing.

[13] In August 2017, CNSC staff issued a second draft of the RegDoc, restricting the scope of pre-placement and random testing to Safety-Critical Workers. This version also narrowed the definition of a Safety-Critical Worker (see paragraph [9] of these Reasons), which remains the definition in the final version of the RegDoc.

[14] In terms of the feedback received during the RegDoc's development, CNSC staff presented to the Commission the second draft of the RegDoc, at a public meeting in August 2017. The Minutes of that meeting reflect that concerns were raised about the pre-placement and random testing provisions of the RegDoc, and that the Commission directed staff to amend the RegDoc and send it back for re-consideration and approval.

[15] In an October 2017 closed meeting, CNSC staff presented a third draft of the RegDoc to the Commission, with recommended amendments. Upon consideration of the third draft, the Commission approved the current version of the RegDoc for publication and use.

[16] The impugned provisions of the RegDoc are sections 5.1 (pre-placement testing) and 5.5 (random testing). These provisions require Licensees to implement pre-placement and random drug and alcohol testing for Safety-Critical Workers. CNSC estimates that out of approximately 12,000 workers across nuclear facilities, under 10% are Safety-Critical.

[17] Section 5.1 requires Licensees to conduct pre-placement testing for all successful candidates who apply for a Safety-Critical position at a high-security nuclear facility. Pre-placement testing must be implemented for both new and incumbent workers. The RegDoc indicates that pre-placement testing is not a screening tool and should only be administered once a candidate has met all other qualifications necessary.

[18] Section 5.5 requires Licensees to have all Safety-Critical Workers submit to random drug and alcohol testing, as distinct from section 5.1 pre-placement testing. At least 25% of the Safety-Critical Worker population of all facilities must be tested randomly every year.

[19] Under section 6.1 of the RegDoc, Licensees must test for alcohol through the collection of breath samples using approved instruments defined at section 2 of the *Approved Breath Analysis Instruments Order*, SI/85-201. The testing is to be administered by qualified technicians who are independent from workgroups subject to testing.

[20] Section 6.2 of the RegDoc, indicates that for drug testing, Licensees can choose to implement laboratory urine testing, laboratory oral fluid testing, or a combination of both. Licensees must retain and utilize the services of an accredited laboratory to analyze and report the results. For urine testing, the laboratory used must be accredited by the Substance Abuse and Mental Health Services Administration [SAMHSA]. For oral fluid testing, the laboratory used must be accredited by SAMHSA or meet the *General Requirements for the Competence of Testing and Calibration Laboratories*, ISO/IEC 17025.

[21] The RegDoc establishes threshold values, or cut-off levels, for the amount of a substance that must be found in a sample to constitute a positive test result for both alcohol testing and drug testing. The positive results from laboratory tests are sent to a medical review officer who reviews, interprets and verifies the laboratory tests results for each drug class as specified in the RegDoc. When faced with a positive test result, the medical review officer must provide the

worker an opportunity to explain any alternative reasons for such result. The medical review officer will only report verified positive test results to Employers.

[22] It should be noted that the pre-placement and random testing provisions of the RegDoc have not yet been implemented. The RegDoc went into effect on January 21, 2021. The November 2020 Meeting Minutes of the CNSC reflect that the Licensees would be required to implement pre-placement testing measures within six months (by July 22, 2021), and random testing measures within twelve months (by January 22, 2022). However, in early 2022, the Applicants successfully brought a motion for an injunction before the Court. Justice Gleeson granted the injunctive relief sought, staying the implementation of sections 5.1 (pre-placement testing) and 5.5 (random testing) of the RegDoc until the final disposition of this Application (see: *Power Workers 2022* at paras 5-8).

[23] As a result, the testing mechanism contemplated under the impugned sections of the RegDoc has yet to be administered. Courts are encouraged to proceed with caution when considering the constitutionality of a provision or legislative scheme in the absence of a factual matrix (*MacKay v Manitoba*, [1989] 2 SCR 357 at 366 [*MacKay*]; *Ernst v Alberta Energy Regulator*, 2017 SCC 1 at para 22 [*Ernst*]).

III. Issues and Standard of Review

[24] Before setting out the issues before me, I note that in the Notice of Constitutional Question, the Applicants assert that the pre-placement and random testing provisions of the RegDoc are "invalid" under section 1 of the *Charter*. In the Notice of Application for Judicial

Review, the Applicants seek a declaration that sections 5.1 and 5.5 of the RegDoc are contrary to sections 7, 8, and 15 of the *Charter* and are of no force and effect. The Notice of Application also seeks an order quashing the CNSC's decision to adopt the provisions.

[25] Thus, this case is distinct from many of the administrative law cases challenging delegated legislation, in that the Applicants do not challenge the RegDoc as being *ultra vires* its enabling statute. In other words, they do not argue that the RegDoc is invalid because the CNSC exceeded the powers delegated to it by Parliament in the *Act*. Nor do the Applicants impugn the jurisdiction or *vires* of the *Act* writ large, to argue that the *Act* is contrary to the division of powers, the *Charter*, or section 35 of the *Constitution Act*.

[26] Instead, the Applicants submit that two specific elements of the RegDoc, namely the (i) pre-placement and (ii) random testing measures (sections 5.1 and 5.5), infringe several sections of the *Charter*. They contend that the CSNC's decision to adopt these measures was unreasonable. In other words, they say that while sections 5.1 and 5.5 must be struck, the remainder of the structure of the RegDoc may stand.

[27] The Applicants argue that the RegDoc's two impugned sections should fall for two reasons. First, they contend that its pre-placement and random testing requirements violate sections 7, 8, and 15 of the *Charter*, and are not justified under section 1. Second, they posit, in the alternative, that CNSC's decision to adopt the RegDoc was unreasonable on administrative law grounds.

[28] In determining the applicable standard of review in this case, it is important to understand how the issues were framed. In making their case, the Applicants pivoted between challenging the elements of the RegDoc as if they were seeking to invalidate provisions of a statute, and impugning the CNSC's decision to adopt a RegDoc that includes pre-placement and random testing requirements.

[29] On the one hand, for the purposes of their administrative law arguments, they dress the RegDoc in the garb of an administrative decision, attacking it for its unreasonableness. On the other, for the purposes of their constitutional arguments, they impugn it as a form of regulation or legislative measure that prescribes a limit on a *Charter* right.

[30] A similar blending of the classification of the RegDoc was also evident in the Applicants' written submissions. For instance, at paragraph 42 of their Factum, the Applicants state, "the RegDoc constitutes a "law" which prescribes a limit on *Charter* rights […] Non-statutory binding rules that establish obligations of general rather than specific application, and are sufficiently accessible and precise, qualify as "law" that prescribe a limit on a *Charter* right."

[31] Later, the Applicants also submit that the RegDoc purports to be a regulation and that the Commission improperly adopted it through the informal vehicle of a regulatory document, rather than having it go through the more rigorous procedure required by regulatory amendments, as further discussed in Section B (Step 2) below.

[32] However, at the outset of their Factum, at paragraph 1, the Applicants state they oppose the CNSC's decision to impose the RegDoc's requirements, and in terms of a remedy, request this Court quash the CNSC's decision to adopt the pre-placement and random testing elements of the RegDoc because those two elements are unconstitutional.

[33] In the alternative, the Applicants request that the Court remit the two "elements" of the RegDoc back to the CNSC for re-determination. During the hearing, when asked to delineate what exactly they were claiming violated *Charter* grounds, Counsel for the Applicants clarified that they were seeking a declaration of invalidity of sections 5.1 and 5.5 and for the Court to strike these impugned provisions from the RegDoc. Discussion of the remedy was mentioned at various points of the hearing. One such instance occurred at 02:43:00 to 02:45:00 of the audio recording of Day 1. Again, at no point did the Applicants request that the Court strike out the validity of the entire RegDoc.

[34] The Respondents agree with the Applicants that the constitutionality of the testing measures should be reviewed by adjudicating each *Charter* right and applying the framework in *R v Oakes*, 1986 CanLII 46 (SCC), 1 SCR 103 [*Oakes*] under section 1. The Parties are also in agreement that the Court ought not to apply the balancing framework for the review of discretionary administrative decisions set out in *Doré v Barreau du Québec*, 2012 SCC 12 at paras 37, 39 [*Doré*] (see also: *Loyola High School v Quebec (Attorney General)*, 2015 SCC 12 at paras 39-42 [*Loyola*]; *Law Society of British Columbia v Trinity Western University*, 2018 SCC 32 at para 111 [*Trinity Western*]). The Parties submitted in their written materials – and reiterated at the hearing – that the Court must not use the *Charter* values paradigm in analysing the

RegDoc, because the Applicants are not challenging the CSNC's underlying decision to adopt the entire RegDoc, rather only two sections of it.

[35] While the Parties agree on the method for *how* the Court should approach the *Charter* questions raised by the Applicants, namely under the *Oakes* approach, they split on the esoteric question of whether correctness, or no standard of review applies. They agree that reasonableness applies to the administrative law question of whether the CNSC's decision to adopt the RegDoc was reasonable.

[36] The Applicants rely on *Elementary Teachers Federation of Ontario v York Region District School Board*, 2022 ONCA 476 at paras 36-37 [*Elementary Teachers*] to argue that the correctness standard applies in their *Charter* arguments. In *Elementary Teachers,* the Ontario Court of Appeal held that an arbitrator's decision was subject to a correctness standard of review on the question of law of whether the grievor had a reasonable expectation of privacy in their workplace laptop (*Elementary Teachers* at para 37 citing to *R v Shepherd*, 2009 SCC 35 at para 20). *Elementary Teachers* has since been appealed and is now before the Supreme Court of Canada [SCC] (see: *York Region District School Board v Elementary Teachers' Federation of Ontario,* 2023 CanLII 19753 (SCC)).

[37] The Respondents, by contrast, contend that no standard of review applies to the issue of whether the testing requirements infringe the *Charter*, because the Applicants do not seek to review an administrative decision. The Respondents state in their written submissions that the application of a correctness standard is "fundamentally at odds with the *Oakes* test". They argue

that the Applicants seek to strike out provisions of the RegDoc, which in their view, is a policy "prescribed by law" that falls within the meaning of section 1 of the *Charter*. Relying on *Greater Vancouver Transportation Authority v Canadian Federation of Students British Columbia Component*, 2009 SCC 31 at paragraph 64 [*Greater Vancouver Transportation Authority*], they say the RegDoc qualifies as a "law" because it establishes a series of obligations that must be adhered to by all Licensees.

[38] I am not convinced by this distinction that the correctness standard is fundamentally at odds with the *Oakes* framework since, as recently noted by Justice Favel in *McCarthy v Whitefish Lake First Nation #128*, 2023 FC 220 at paragraph 54 [*Whitefish*], "[t]his distinction is more academic than practical, as "no standard of review" is the functional equivalent of a "correctness review"". Put simply, here the question is whether in its application, the RegDoc breaches the *Charter.*

[39] The Respondents also rely on *Reference re Marine Transportation Security Regulations*, 2009 FCA 234 [*Marine Reference*] and *Canada (Union of Correctional Officers) v Canada (Attorney General)*, 2019 FCA 212 [*Correctional Officers*]. These two Federal Court of Appeal [FCA] decisions dealt with *Charter* challenges to the validity of federal regulations.

[40] In *Marine Reference*, the AGC brought a reference to the Court under subsection 18.3(2) of the *Federal Courts Act*, RSC, 1985, c F-7 to determine their constitutional validity. As such, there was no administrative decision at play and the Court did not consider whether a standard of review was applicable.

[41] *Correctional Officers*, which was decided in 2019, involved a judicial review application to the Treasury Board's decision to adopt a standard for financial security screening procedures of correctional officers, and a directive by the Correctional Service of Canada implementing it. The applicants in *Correctional Officers* argued that the enhanced financial screening procedures infringed the section 8 *Charter* rights of employees at these correctional facilities.

[42] The FCA rejected the application judge's determination that the reasonableness standard applied in *Correctional Officers*, finding instead that the correctness standard applied. The Court went on to explain that *Doré* was not applicable because the application for judicial review "is more akin to a challenge of the constitutionality of a legislative or regulatory provision" (*Correctional Officers* at para 21):

> [21] […] the appellant is not challenging an individual administrative decision based on a provision of the 2014 Standard or the Commissioner's Directive that was interpreted by a decision maker. Instead, the appellant is challenging their adoption <u>in their entirety</u>. Thus, the Union is attacking head on the constitutionality of the 2014 Standard and the Commissioner's Directive themselves. It follows that the analytical framework described in *Doré* does not apply and that it is therefore inappropriate to apply the reasonableness standard. The appellant's application for judicial review is more akin to a challenge of the constitutionality of a legislative or regulatory provision. Such a challenge is typically subject to the correctness standard of review (*Dunsmuir*, at paragraph 58).
>
> [Emphasis in Original]

[43] In many respects, *Correctional Officers* is on point in that the Applicants here are not challenging a decision-maker's interpretation of the document in question. In both cases, they challenge the adoption of financial screening and drug testing (respectively) measures on *Charter* grounds.

[44] A few months after the release of *Correctional Officers*, the SCC released *Canada (Minister of Citizenship and Immigration) v Vavilov*, 2019 SCC 65 [*Vavilov*]. The decision in *Correctional Officers*, although decided by the FCA just before *Vavilov*, is still good law, having been cited by Chief Justice Crampton post-*Vavilov* in *Spencer v Canada (Health)*, 2021 FC 62 [*Spencer*].

[45] In *Spencer*, Chief Justice Crampton dismissed a challenge to the validity of certain federal quarantine measures affecting air travellers. The measures were part of the federal government's response to the COVID-19 global pandemic and were implemented by way of a series of Orders in Council. On appeal, the FCA held that the challenge was moot since the orders had been repealed (*Spencer v Canada (Attorney General)*, 2023 FCA 8).

[46] At paragraph 64 of *Spencer*, Chief Justice Crampton cites *Correctional Officers*, among other pre-*Vavilov* cases to find that "[t]he standard applicable to the Court's review of the issues that have been raised with respect to the *Charter*, the *Constitution Act, 1867* and the *Canadian Bill of Rights* is correctness" (see also: *Taseko Mines Limited v Canada (Environment)*, 2017 FC 1100 at paras 49 and 54, affd 2019 FCA 320 at paras 19 and 22).

[47] I will follow this approach, as suggested by the FCA at paragraph 21 of *Correctional Officers*, and followed by Chief Justice Crampton in *Spencer*. I find this approach to be consistent with my reading of *Vavilov* where the SCC confirmed at paragraphs 55-57, that the standard of correctness continues to be applied in reviewing constitutional matters.

[48] This is also consistent with subsequent binding case law issued by the FCA (*Innovative Medicines Canada v Canada (Attorney General)*, 2022 FCA 210 [*Innovative Medicines*] and *Portnov v Canada*, 2021 FCA 171 [*Portnov*]). In both decisions, the FCA found that the adoption of delegated legislation should be reviewed against the reasonableness standard unless an exception under *Vavilov* applies (see *Portnov* at para 10 and *Innovative Medicines* at para 27). These cases depart from the approach that had been set out in *Katz Group Canada Inc v Ontario (Health and Long-Term Care)*, 2013 SCC 64 [*Katz*], that the Court must find the regulation is “irrelevant,” “extraneous,” or “completely unrelated” to the statutory purpose of the enabling statute (*Katz* at para 28). *Katz* was published several years before *Vavilov*. The FCA confirmed that *Vavilov* is the most appropriate lens to consider the validity of regulations (*Innovative Medicines* at para 26, *Portnov* at paras 22-28).

[49] I note that both *Portnov* and *Innovative Medicines* are distinct from this case. They both considered the *vires* of the regulations in question in light of their enabling statute. In both decisions, the FCA determined that no exceptions to the presumption of reasonableness under the *Vavilov* framework applied (*Portnov* at para 17; *Innovative Medicines* at para 45). Here, on the other hand, the validity of the RegDoc is being challenged on the basis of certain elements violating sections 7, 8 and 15 of the *Charter*.

[50] *Vavilov* established that the standard of reasonableness is generally applicable when reviewing administrative decisions (*Vavilov* at paras 16, 23-25). However, there are two exceptions to this presumption. First, if the legislature specifies a standard of review or creates a

statutory appeal mechanism that suggests an appellate standard should be used (*Vavilov* at paras 17, 33-35).

[51] The second exception arises where the rule of law requires the application of the correctness standard for certain categories of legal questions, namely constitutional questions, general questions of law that are significant to the legal system as a whole, and questions concerning the jurisdictional boundaries between two or more administrative bodies (*Vavilov* at paras 17, 53).

[52] At paragraphs 54-56 of *Vavilov*, the SCC describes the issues that fall under the constitutional law category as including legal questions on the division of powers between Parliament and the provinces, the relationship between the legislature and other branches of the state, the extent of Aboriginal and treaty rights under section 35 of the *Constitution Act, 1982,* interpretations of the administrative decision-maker's enabling statute, and "other constitutional matters that require a final and determinate answer from the courts."

[53] The exception to the presumption of reasonableness carved out in *Vavilov* for constitutional questions follows long-standing jurisprudence confirming the certainty and rigour required in the examination of constitutional questions. As held by the FCA in *Guérin v Canada (Attorney General)*, 2019 FCA 272 at paragraph 23:

> Regarding whether the Regulations and Directives violate section 7 of the Charter, I am of the opinion that the standard of correctness must apply. <u>It is settled law that constitutional questions must be examined rigorously and without deference in the context of judicial review</u>: *Alberta (Information and Privacy Commissioner) v. Alberta Teachers' Association*, 2011 SCC 61, [2011] 3 S.C.R.

> 654, at paragraph 30*; Dunsmuir v. New Brunswick*, 2008 SCC 9, [2008] 1 S.C.R. 190, at paragraph 58 [Dunsmuir]; *Tapambwa v. Canada (Citizenship and Immigration)*, 2019 FCA 34, [2019] F.C.J. No. 186 at para. 30; *Begum v. Canada (Citizenship and Immigration)*, 2018 FCA 181, [2018] F.C.J. No. 1007, at para. 36, leave to appeal to the SCC denied, 38439 (April 18, 2019), [2018] S.C.C.A. No. 506 [*Begum*]; *Canada (Attorney General) v. Association of Justice Counsel*, 2016 FCA 92, [2016] F.C.J. No. 304, at para. 23.
>
> [Emphasis added]

[54] Similarly, in *Air Canada Pilots Association v Air Canada*, 2023 FC 138 [*Pilots Association*], this Court recently considered whether a regulatory exemption under two subsections of the *Canadian Human Rights Benefit Regulations*, SOR/80-68 infringed subsection 15(1) of the *Charter*. Justice Furlanetto held at paragraph 20, relying on paragraphs 55-57 of *Vavilov*: “The standard of review for the substantive issue is correctness. The compatibility of subsections 3(b) and 5(b) of the Regulations with the *Charter* is a constitutional question that falls within an exception to the presumption of reasonableness.”

[55] In this case, the *Charter* challenges advanced by the Applicants are characterized as “attacking head on the constitutionality” of the RegDoc (see: *Correctional Officers* at para 21). In my view, the approach used in *Correctional Officers*, and recently followed by this Court in *Spencer* and *Pilots Association*, is the more appropriate approach to adjudicate the *Charter* questions in this case; and I find it to be consistent with *Vavilov*, falling within the exception to the presumption of reasonableness of “other constitutional matters that require a final and determinate answer from the courts” (*Vavilov* at para 55).

IV. Analysis

[56] The nuclear industry is unique. All Parties concur that safety is the most important priority, and that public interest in nuclear safety is high. A nuclear incident can have devastating and long lasting impacts on the community and the environment. It is within this unique context of the highly regulated nuclear industry that I find the pre-placement and random testing provisions of the RegDoc are constitutional and do not breach sections 8, 15 or 7 of the *Charter*, as will be explained next.

A. *Applicability of the Charter*

[57] The *Charter* binds the conduct of state actors and does not limit private or non-governmental activity (*RWDSU v Dolphin Delivery Ltd*., 1986 CanLII 5 (SCC), [1986] 2 SCR 573). For instance, a search or seizure carried out by a private citizen does not trigger section 8 scrutiny unless the private citizen was acting as an agent of the state or was exercising statutory delegation of governmental powers (*R v Buhay*, 2003 SCC 30 at para 31).

[58] Subsection 32(1) of the *Charter* defines the scope of its application in the following terms:

32 (1) This Charter applies	**32 (1)** La présente charte s'applique :
(a) to the Parliament and government of Canada in respect of all matters within the authority of Parliament including all matters relating to the Yukon Territory and Northwest Territories; and	**a)** au Parlement et au gouvernement du Canada, pour tous les domaines relevant du Parlement, y compris ceux qui concernent le territoire du Yukon et les territoires du Nord-Ouest;
(b) to the legislature and government of each province in respect of all matters within the authority of the legislature of each province.	**b)** à la législature et au gouvernement de chaque province, pour tous les domaines relevant de cette législature.

[59] In *Eldridge v British Columbia (Attorney General)*, 1997 CanLII 327 (SCC), [1997] 3 SCR 624, Justice La Forest, writing for a unanimous court, summarized the applicable principles for the interpretation of section 32:

> . . . the *Charter* may be found to apply to an entity on one of two bases. First, it may be determined that the entity is itself "government" for the purposes of s. 32. This involves an inquiry into whether the entity whose actions have given rise to the alleged *Charter* breach can, either by its very nature or in virtue of the degree of governmental control exercised over it, properly be characterized as "government" within the meaning of s. 32(1). In such cases, all of the activities of the entity will be subject to the *Charter*, regardless of whether the activity in which it is engaged could, if performed by a non-governmental actor, correctly be described as "private". Second, an entity may be found to attract *Charter* scrutiny with respect to a particular activity that can be ascribed to government. This demands an investigation not into the nature of the entity whose activity is impugned but rather into the nature of the activity itself. In such cases, in other words, one must scrutinize the quality of the act at issue, rather than the quality of the actor. If the act is truly "governmental" in nature — for example, the implementation of a specific statutory scheme or a government program — the entity performing it will be subject to review under the *Charter* only in respect of that act, and not its other, private activities.

[60] In *Greater Vancouver Transportation Authority*, Justice Deschamps reiterated that the *Charter* applies not only to Parliament, the legislatures, and government, but also to "all matters within the authority of those entities" (para 14).

[61] The Parties did not cite any decisions explicitly stating that the *Charter* applies to nuclear power workplaces, nor am I aware of any such jurisprudence. However, I note that in one somewhat analogous context in the early days of the *Charter*, the Ontario Labour Relations Board found at para 35 of *Electrical Power Systems Construction Council of Ontario v Ontario Hydro*, 1984 CanLII 1050 (ON LRB): "[t]here appears to be little doubt that the *Charter* would apply to actions of government officials in issuing regulations and granting or denying licences or benefits authorized under statutes."

[62] I further note that the SCC has held that bodies created by statute (like municipalities and school boards) are government entities with legislative powers and the *Charter* applies (*Godbout v Longueuil (City)*, 1997 CanLII 335 (SCC), [1997] 3 SCR 844 at paras 50, 51 118 [*Godbout*] and *Chamberlain v Surrey School District No. 36*, 2002 SCC 86). Likewise, the CNSC is an entity that was created by Parliament, is thus a "government entity", and accordingly, the *Charter* applies.

[63] More specifically, the CNSC is a federal regulator, mandated to oversee the production and use of nuclear power in Canada, operating in the public interest. It was established as an agent of the Crown pursuant to subsection 8(2) of the *Act*. The CNSC members and president are appointed by the Governor in Council (subsections 10(1) and (3) of the *Act*). Pursuant to section

19, the Governor in Council may issue “directives” to the Commission that are legally binding. Moreover, sections 12 and 72 of the *Act* define the role of the CNSC’s President as being its chief executive reporting to the Minister of National Resources.

[64] In short, as the CNSC is governmental in nature, it is subject to *Charter* review.

B. *The pre-placement and random testing provisions of the RegDoc do not infringe section 8 of the Charter*

[65] Section 8 of the *Charter* confers the right “to be secure against unreasonable search or seizure.” At its core, the purpose of section 8 is to shield against unjustified state intrusions on personal privacy (*R v Kang-Brown*, 2008 SCC 18 at para 8; *Hunter et al v Southam Inc.*, 1984 CanLII 33 (SCC), [1984] 2 SCR 145, at p 160 [*Hunter v Southam*]). Broadly speaking, section 8 protects a claimant’s reasonable expectation of privacy against unreasonable state intrusion (*R v Tessling*, 2004 SCC 67 at paras 18-16 [*Tessling*]).

[66] I begin my analysis with a brief discussion of the applicability of the section 8 case law to the unique nature of the case at bar. In the context of criminal law, the contemplation of unreasonable search or seizure protection calls for a highly fact-specific analysis into whether an accused’s personal right to privacy was infringed by the state. As a matter of standing under section 8, an accused may only invoke his or her own personal privacy rights and not those of a third party (see for instance: *R v Edwards*, 1996 CanLII 255 (SCC), [1996] 1 SCR 128 at paras 43, 45-47 [*Edwards*]; *R v Marakah*, 2017 SCC 59 at para 12).

[67] Section 8 has certainly been found to extend beyond the protection against unreasonable search and seizure in a criminal law context (see: *R v McKinlay Transport Ltd.*, 1990 CanLII 137 (SCC), [1990] 1 SCR 627 at 640-641 [*McKinlay Transport*]; *Comité paritaire de l'industrie de la chemise v Potash*, 1994 CanLII 92 (SCC), [1994] 2 SCR 406 at 408 [*Comité paritaire*]; *Thomson Newspapers Ltd. v Canada (Director of Investigation and Research, Restrictive Trade Practices Commission) (1990)*, 1990 CanLII 135 (SCC), 54 CCC (3d) 417 at 495-496 [*Thomson Newspapers*]).

[68] However, in each of these non-criminal law decisions, the SCC contemplated the particulars of a search or seizure event that had already transpired. In *McKinlay Transport*, the Court considered the constitutionality of provisions of the *Income Tax Act*, RSC 1985, c 1, after these provisions had been applied to two corporate taxpayers.

[69] The Court in *Comité paritaire*, similarly considered the inspection powers of an agency in a regulated industrial sector (textile manufacturing), after the inspectors had attempted to investigate the premises in question in accordance with their powers under the impugned legislation. In *Thomson Newspapers*, the Court considered whether section 17 of the *Combines Investigation Act* violated sections 7 and 8 of the *Charter* after it was used to serve the corporate appellant and several of its officers with orders to appear before the Restrictive Trade Practices Commission, to be examined under oath and to produce documents.

[70] Although non-criminal, *McKinlay Transport*, *Comité paritaire* and *Thomson Newspapers* each involved a “factual foundation” to consider the constitutionality of the search or seizure incident at issue (see also *MacKay* at page 361).

[71] Evidently, in this case, the implementation of the impugned provisions is stayed pending the final determination of this Application for Judicial Review (*Power Workers 2022* at para 6). I am thus being asked to adjudicate the constitutionality of a seizure to be authorized by the RegDoc, but which has not taken place for any particular worker, given the injunction issued in *Power Workers 2022*.

[72] The FCA decisions *Correctional Officers* and *Marine Reference* (above) are instructive on how to consider an inchoate search or seizure – namely one that is authorized by a particular statutory or regulatory regime, but which has not yet taken place. *Correctional Officers*, decided after *Goodwin v British Columbia (Superintendent of Motor Vehicles)*, 2015 SCC 46 [*Goodwin*], considered the constitutionality of a prospective search in a regulatory context.

[73] In *Marine Reference*, the Court considered a regulatory scheme that would apply to screen workers employed in security-sensitive positions in Canadian ports. The regulations at issue required workers to provide biographical information about themselves and their spouses to the Minister of Transport to determine whether the workers represented a security threat to Canada’s operations. At paragraph 28 of *Marine Reference*, Justice Evans, writing for the Court, emphasized three relevant considerations to frame the *Charter* challenges brought in a particular regulatory context:

> [28] First, as the party alleging *Charter* violations, ILWU [the Applicant] has the burden of proving a prima facie breach, even when the section of the *Charter* in question requires a contextual balancing of the right against competing interests, such as sections 7 (principles of fundamental justice) and 8 (unreasonable search). Second, when the issue is whether impugned state action has the effect of infringing a *Charter* right, ILWU, as the party alleging that it does, must adduce evidence to prove it, unless it is obvious. Third, it is important to distinguish an attack on the validity of the Regulations, such as that by ILWU, from an attack on an individual decision made under them. Regulations are not invalidated merely because they may be applied in an unconstitutional manner in individual cases.

[74] In the Court's section 8 *Charter* analysis, Justice Evans first assumed for the purposes of the reference, that the regulations would constitute a search (para 48). He went on to consider the second step for the section 8 analysis, that is, whether the search as authorized by the regulations was unreasonable. The Court balanced employees' interest in their personal privacy against the public interests served by the statutory scheme (*Marine Reference* at para 49). This balancing exercise compelled the court to take into account the following considerations:

(i) contextual factors; which take into account

(ii) prior authorization and post-decision review (ie. checks and balances to prevent abuses of power); and

(iii) degree of intrusion into privacy and pressing nature of the public interest (ie. fingerprints or photographs being less intrusive).

[75] In the more recent decision of *Correctional Officers*, the FCA ruled that a directive mandating correctional officers with specific security clearance levels to submit credit reports, did not infringe section 8 of the *Charter*. Since it was not disputed that the credit check was a search within the meaning of section 8, the Court's analysis was focused on whether the directive at issue would result in an unreasonable search of the applicants. Justice Boivin, writing for the

Court in *Correctional Officers*, outlined the steps of the section 8 analysis, after having considered both the approaches taken in *Marine Reference* and in *Goodwin*:

> [24] Since the respondent did not dispute at trial that the credit check was a search within the meaning of section 8 of the *Charter*, the Federal Court limited its analysis to the issue of whether that search was abusive (Federal Court decision at paragraphs 95–98; *Hunter v. Southam Inc*., 1984 CanLII 33 (SCC), [1984] 2 S.C.R. 145).
>
> [25] For that purpose, the Federal Court methodically applied the criteria set out by the Supreme Court of Canada in and the criteria described by our Court in the *Marine Reference*. In the present case, <u>the criteria in question can be described as follows: (i) the objective of the 2014 Standard and the Commissioner's Directive; (ii) the nature of those schemes; (iii) the mechanism for conducting the search, including the degree of intrusiveness; and (iv) the subsequent review and possible redress for overseeing the search.</u>
>
> [Full citations omitted; emphasis added]

[76] In both *Marine Reference* and *Correctional Officers*, the FCA considered whether the regulations were authorized by law and whether the law itself was reasonable. However, neither address whether the manner in which the search was carried out was reasonable, for the obvious reason that no search had yet been carried out.

[77] As a similar situation is also present here, given that the scheme exists but has not yet been exercised against any Safety-Critical Workers in light of this Court's injunction, I will apply the FCA's approach as guided by the SCC in *Goodwin*, since the Court has been asked to strike regulatory provisions that empower Licensees to authorize a seizure.

Step 1: The pre-placement and random testing provisions engage section 8

[78] The first step requires the claimant to show that state conduct amounts to a search or seizure within the construct of section 8 (*R v Jones*, 2017 SCC 60 at para 13 [*Jones*]), and determine whether section 8 is engaged, based on the claimant's reasonable expectation of privacy (*Goodwin* at paras 49-51).

[79] The word 'search' has been described as "an examination, by the agents of the state, of a person's person or property": Hogg, *Constitutional Law of Canada*, vol. 2 (Toronto: Carswell, 2021) at 48:4.

[80] The term 'seizure' was defined by Justice La Forest in *Thomson Newspapers* as "the taking of a thing from a person by a public authority without that person's consent." This definition was recently applied by the FCA in *Rémillard c Canada (Revenu national)*, 2022 CAF 63 at para 71.

[81] I reiterate that not every "examination" conducted by a state actor, nor every "taking" by the government, engages the section 8 protection (*Tessling* at para 18; *Goodwin* at para 51). Rather, a search or seizure only occurs when the state has interfered with a citizen's reasonably held expectation of privacy, taking into account the "totality of the circumstances of a particular case" (*Jones* at para 13 citing *Edwards* at para 31; *R v Wong*, 1990 CanLII 56 (SCC), [1990] 3 SCR 36, at 62).

[82] In this case, the Respondents concede that requiring Licensees to collect bodily samples – whether breath, urine or saliva – necessarily involves taking personal and informational data amounting to a “seizure.” That point conceded, their position is that under the RegDoc, the state interferes in a limited manner. Based on the totality of the circumstances, the Respondents argue that Safety-Critical Workers employed at a nuclear power plant have a significantly reduced expectation of privacy.

[83] The Applicants argue that Safety-Critical Workers do not have a diminished expectation of privacy, but on the contrary, have a heightened expectation of privacy based on (a) the subject matter of the search (b) their interest in the subject matter (c) their subjective expectation of privacy in the subject matter and (d) whether this subjective expectation of privacy was objectively reasonable, having regard to the totality of the circumstances. In support of their argument that they deserve a heightened expectation of privacy, the Applicants primarily rely on the SCC decisions in *Tessling* at paragraph 32, and *R v Spencer*, 2014 SCC 43 at paragraph 18 [*R v Spencer*] and the lower court decision in *Gillies (Litigation Guardian of) v Toronto District School Board*, 2015 ONSC 1038 (Sup. Ct.) at paragraphs 79-80 [*Gillies*].

[84] In particular, the Applicants note that the urine and/or oral fluids collected in the pre-placement and random process testing are bodily samples over which the Safety-Critical Workers have both a high interest and a subjective expectation of privacy. The Applicants argue that bodily samples and what they reveal about a person’s lifestyle constitute an individual’s “biographical core”, and there can be no doubt that an individual has a significant interest in that

information both on a subjective and objective basis (*R v Plant*, 1993 CanLII 70 (SCC), [1993] 3 SCR 281 at para 20).

[85] The Applicants highlight the comments of Justice Himel, at paragraph 96 of *Gillies*:

> [96] I do not accept the respondents' submission that, in light of the Supreme Court decision in *Jarvis*, the seizure of the students' breath sample would not attract the full panoply of *Charter* rights. First, the principal deposed in his affidavit that although the breathalyzer is not intended to be a precursor to student discipline, he noted the potential for discipline for student alcohol consumption. Second, <u>the seizure of a bodily sample interferes with a person's bodily integrity regardless of the context in which it is taken</u>. I am not persuaded that the Supreme Court intended to diminish the *Charter* scrutiny to be applied to the seizure of a bodily sample. In *Jarvis*, the impugned search at issue was at a person's residence and of a person's personal documents; the subject matter of the search in the present case interferes with a person's bodily integrity. That difference is paramount.
>
> [Emphasis added]

They contend that the Superior Court's decision in *Gillies* rejects the Respondents' position that a workplace attracts a diminished expectation of privacy for workers when the object of the seizure is bodily samples. There, Justice Himel found that the practice of mandatory, blanket breathalyzer testing of students at their school prom infringed their rights under section 8.

[86] The Applicants also argue that their situation is analogous to that of the teachers in the recent Ontario Court of Appeal decision in *Elementary Teachers* at para 56. In that case, the Court of Appeal held that two teachers' section 8 rights were breached when the school's principal read and documented the teachers' personal logs of concerns about the school, which were left open on a school laptop. The Applicants rely on that case to argue that employees have

a right to keep information about their personal choices private from their employer, as well as to expect that information to remain private in the workplace.

[87] The Applicants further contend that Safety-Critical Workers have a heightened expectation of privacy because they do not consent to the pre-placement and random testing. It is compulsory and could result in significant consequences for these impacted employees, including removal from their work duties and referral to a mandatory substance abuse evaluation. The Applicants argue that Safety-Critical Workers did not – and cannot – waive their reasonable expectation of privacy or their *Charter*-protected right against unreasonable searches by choosing to work at nuclear facilities. They assert that under the RegDoc, there is no true right of refusal, but rather only a spectrum of negative employment and reputational consequences.

[88] Finally, the Applicants reject the notion that a flexible approach must be adopted in the section 8 analysis for regulatory contexts because this approach would result in a more lenient standard in assessing reasonableness of the search, and effectively diminish rights under the *Charter*. The Applicants argue (relying on *Gillies* at para 94) that even in regulatory contexts, the "full panoply" of *Charter* rights apply.

[89] The Respondents, on the other hand, primarily rely on *Goodwin* at paragraph 51 to argue that the SCC has made clear that individuals who participate in highly regulated activities have a diminished expectation of privacy, even in relation to the seizure of bodily samples to determine a measure of alcohol and drug use. In that case, Mr. Goodwin was driving on a public highway and was asked to give a breath sample to determine whether he was driving while impaired. The

Respondents emphasize that the SCC considered driving on a public highway to be a "highly regulated context," resulting in a diminished expectation of privacy (*Goodwin* at para 51). They argue that the same standard should necessarily apply to the handling of safety-critical tasks in a nuclear facility, such that the impacted positions attract a diminished expectation of privacy.

[90] The Respondents highlight that context is important in establishing the reasonable expectation of privacy because a search and seizure arising from a regulatory context cannot be reviewed under the same standard as one arising from a criminal context. The Respondents urge this Court to apply, as *McKinlay Transport* requires, a "flexible and purposive approach to s. 8 of the *Charter*" and "draw a distinction between seizures in the criminal or quasi-criminal context to which the full rigours of the *Hunter v Southam* criteria will apply, and seizures in the administrative or regulatory context to which a lesser standard may apply depending upon the legislative scheme under review" (at page 647).

[91] In my view, a flexible approach, which takes its colour from context, does not diminish *Charter* rights for individuals. As Justice Wilson wrote on behalf of the *McKinlay Transport* majority at pp 644-645:

> In my opinion, flexibility is key to interpreting any constitutional document including the *Charter*. It would be wrong, I think for the courts to apply a rigid approach to a particular section of the *Charter* since that provision must be capable of application in a vast variety of legislative schemes.
>
> […]
>
> Since individuals have different expectations of privacy in different kinds contexts and with regard to different kinds of information and documents, it follows that the standard of review of what is "reasonable" in a given context must be flexible if it is to be realistic and meaningful.

[92] *McKinlay Transport* thus established that a flexible approach is not a mechanism to be used by the courts to limit *Charter* rights. Rather, it allows the courts to interpret *Charter* rights in a wide variety of contexts in a "realistic and meaningful" way. A flexible approach reflects differing expectations of privacy for different contexts.

[93] In this case, I agree with the Respondents that the Court should use a flexible approach to the section 8 analysis due to the highly regulated nature of the nuclear power workplace. As noted above, it is undisputed that obtaining bodily samples in the workplace constitutes a seizure within the meaning of section 8.

[94] With respect to the reasonable expectation of privacy, I disagree with the Applicants that the balance of contextual factors points to a heightened expectation of privacy for Safety-Critical Workers at nuclear facilities. In particular, the Applicants argued that the compulsory nature of the pre-placement and random testing provisions and lack of consent would result in a heightened expectation of privacy. However, if Safety-Critical Workers had a right of refusal or consented to the requirement, their section 8 rights would not be engaged at all because there would be no search or seizure in the first place. As held by the Ontario Court of Appeal in *R v Wills*, 1992 CanLII 2780 (ON CA), 7 OR (3d) 337 at paragraph 86: "[a] valid consent is a waiver of one's s. 8 rights. A 'consent search or seizure' is, in fact, no search or seizure at all for the purposes of s. 8."

[95] I also take issue with the Applicants' reliance on the *Gillies* decision. It is distinguishable from the case at bar. First, the Superior Court in *Gillies* applies a very specific test for section 8

that was established by the SCC to determine whether searches conducted by teachers or a principal in the school environment is reasonable (*Gillies* at para 129). As discussed above, the framework of analysis in *Goodwin*, *Marine Reference*, and *Correctional Officers* is more appropriate for the present case, given the regulatory framework within which those three cases arise.

[96] Second, I am not convinced by the Applicants’ attempt to draw a parallel between the negative employment and reputational consequences that could befall a Safety-Critical Worker subject to a pre-placement or random test, and the “disruptive, invasive and humiliating” experience of a student subject to a breathalyzer test at their high school prom (*Gillies* at para 132).

[97] When balancing the contextual factors to determine the strength of the privacy interests at stake, I find that the section 8 rights of Safety-Critical Workers are engaged. Although these workers have a diminished expectation of privacy when working at nuclear facilities, their residual privacy interest in the collection of their bodily samples is by no means eliminated.

[98] While the seizure of bodily samples does not automatically attract a high expectation of privacy, particularly for “relatively non-intrusive samples,” such as breath (*R v Grant*, 2009 SCC 32 at para 111; *Goodwin* at paras 51 and 65), and buccal – or mouth – swabs (*R v SAB*, 2003 SCC 60 at para 44 [*R v SAB*]), the taking of one’s biographical information without their consent falls squarely within the purview of section 8. This determination is supported by the SCC’s remarks in *Goodwin*:

> [50] It is undisputed before this Court that the roadside breath demand constitutes a seizure within the meaning of s. 8 of the *Charter*.
>
> [51] It is also undisputed before this Court that drivers of vehicles have some expectation of privacy in their breath, even if a diminished one. The factors identified by this Court as "helpful markers" in *Tessling*, at paras. 43-62, support this conclusion. The seizure occurs in a vehicle (*R. v. Grant*, 2009 SCC 32, [2009] 2 S.C.R. 353, at paras. 111 and 113); in the highly regulated context of driving on a public highway (*R. v. McKinlay Transport Ltd*., 1990 CanLII 137 (SCC), [1990] 1 S.C.R. 627, at pp. 647-48); and is relatively non-intrusive (*Grant*, at para. 111). <u>While these factors support a diminished expectation of privacy, they do not eliminate any residual privacy interest in one's breath. Thus the demand to breathe into a roadside screening device constitutes a seizure that infringes on an individual's reasonable expectation of privacy. The protection of s. 8 is engaged.</u>
>
> [Emphasis added]

Step 2: The pre-placement and random testing provisions in the RegDoc are authorized by law

[99] The Applicants argue that the pre-placement and random testing provisions are not authorized by law, because there is nothing specifically in the *Act*, nor a common law rule, that authorizes the search (*R v Caslake*, [1998] 1 SCR 51 at para 12 [*Caslake*]). The Applicants rely on *R v Shoker*, 2006 SCC 44 at para 22 [*Shoker*] to argue that searches must be authorized by law through specific statutory language and not general grants of regulatory power as was used by the CNSC in passing the RegDoc, because where Parliament has chosen to authorize the collection of bodily samples, it has used both clear authorizing language, and standard safeguards surrounding the collection of bodily samples.

[100] The Applicants also rely on *expressio unius est exclusio alterius*, a maxim meaning the express mention of an item excludes others. They submit as the basis of the *expressio unius* principle that paragraph 44(1)(h) of the *Act* specifically mentions the Commission's power to make regulations prescribing medical examinations or tests to nuclear energy workers to ensure their protection, but does not contain authorizing language with respect to pre-placement or random testing, or any standards and safeguards for such methods of testing.

[101] The Applicants further argue that the *Act* does not contain any provision, other than paragraph 44(1)(h), which mentions medical examinations or tests that would include pre-placement and random testing. The Applicants contend that this absence of a specific grant of authority in the *Act* demonstrates Parliament's intent to deny the CNSC the power to impose pre-placement and random testing provisions on nuclear workers.

[102] The Respondents counter that the pre-placement and random testing provisions of the RegDoc are authorized by law, because the RegDoc is a law. As noted above, they rely on *Greater Vancouver Transportation Authority* to submit that a RegDoc can constitute a "law" where it establishes a norm or standard of general application that has been enacted by a government entity pursuant to a rule-making authority that is sufficiently precise and accessible. The Respondents contend that the RegDoc is an instrument enacted by Canada's nuclear regulator under a broad statutory grant or power, and thus satisfies the "authorized by law" requirement for section 8 of the *Charter*.

[103] The Respondents further submit that jurisprudence emanating from a regulatory context is more applicable and persuasive than that arising from the criminal context. For example, they argue that the decisions in *Caslake* and *Shoker*, which authorize the collection of bodily samples within a law enforcement regime, are not applicable in the current case because the RegDoc is not punitive in nature. Instead, the Respondents invite the Court to follow the flexible approach required in a regulatory context, as described by the SCC in *Goodwin* at para 53:

> The analysis of a search or seizure under s. 8 is a contextual inquiry: *R. v. Rodgers*, 2006 SCC 15, [2006] 1 S.C.R. 554, at para. 26. It requires regard to the purpose for which the seizure occurs, and to the statutory provisions that set out the grounds, means and consequences of the seizure. A search or seizure can be valid for one purpose and not for another.

[104] I am not persuaded by the Applicants' position because it fails to consider the regulatory context in which the seizure is authorized. It is true that neither the *Act* nor its associated *Regulations* stipulate the collection of bodily samples for drug and alcohol testing, as do certain provisions of the *Criminal Code*, RSC 1985, c C-46. However, we must adopt a more flexible approach to the "authorized by law" requirement, as suggested by the SCC, when in a regulatory and not in a criminal, context. That encapsulates the present circumstances.

[105] Indeed, here the associated *Regulations*, the *General Nuclear Safety and Control Regulations*, SOR/2000-202, and the *Class 1 Regulations* [collectively the *Regulations*], require Licensees to maintain human performance programs that include ongoing attention to reducing the likelihood of human performance-caused safety events. These regulatory provisions and CNSC's broad powers to impose licensing requirements under subsection 24(2) of the *Act* constitute a sufficient statutory basis for this Court to find that the pre-placement and random

testing provisions of the RegDoc are authorized by law. These statutory provisions also reflect Parliament's intent to empower the CNSC to regulate and set standards in the nuclear industry as it sees fit.

[106] I find the Applicants' *expressio unius* argument to be unconvincing. In particular, I do not find compelling the suggestion that this Court should look to what has been excluded from the *Act* and its associated *Regulations* to understand Parliament's intent concerning drug and alcohol testing at nuclear facilities. Indeed by reviewing subsection 24(2) and paragraph 44(1)(h) of the *Act* (see Annex A to these Reasons for both provisions), there is nothing that indicates that Parliament intended to exclude the CNSC's broad regulatory powers from applying to medical examinations and testing of workers.

[107] I note that in the context in which this judicial review application arises, Parliament has given the CNSC a wide latitude to regulate Canada's nuclear industry in the public interest. To achieve this regulatory purpose, Parliament delegates a variety of tools to the CNSC to tailor specifications and requirements to Licencees governed by the *Act* and its *Regulations*. The CNSC acted pursuant to its broad powers when it decided to implement pre-placement and random testing to bolster the fitness for duty programs and ameliorate the safety conditions in these nuclear facilities. These powers are authorized by law under subsection 24(2) of the *Act*.

Step 3: The pre-placement and random testing provisions are reasonable

[108] Before I begin my analysis of the reasonableness of the pre-placement and random testing provisions using the framework set out in *Goodwin* and applied in *Correctional Officers,* I will briefly discuss the Applicants' reliance on arbitral jurisprudence.

[109] The Applicants rely on arbitral jurisprudence, in particular *Communications, Energy and Paperworkers Union of Canada, Local 30 v Irving Pulp & Paper Ltd*, 2013 SCC 34 [*Irving*] to argue that pre-placement and random testing is unreasonable. The Applicants submit that the well-established arbitral jurisprudence about pre-placement and random testing ought to weigh heavily on the section 8 analysis because that case considered the same balancing between individual privacy rights and employer interests as does section 8. The Applicants rely on the SCC's comments in *Irving* at paras 30-31 to argue that an employer's interest in safety will not justify breaching an employee's privacy rights without reasonable cause, even in an inherently dangerous workplace:

> [30] In a workplace that is dangerous, employers are generally entitled to test individual employees who occupy safety sensitive positions without having to show that alternative measures have been exhausted if there is "reasonable cause" to believe that the employee is impaired while on duty, where the employee has been directly involved in a workplace accident or significant incident, or where the employee is returning to work after treatment for substance abuse […]
>
> [31] But the dangerousness of a workplace — whether described as dangerous, inherently dangerous, or highly safety sensitive — is, while clearly and highly relevant, only the beginning of the inquiry. It has never been found to be an automatic justification for the unilateral imposition of unfettered random testing with disciplinary consequences. What has been additionally required is evidence of enhanced safety risks, such as evidence of a general problem with substance abuse in the workplace.

[110] While the SCC's analysis of the balancing of interests between the employer and employees in *Irving*, along with the other arbitral jurisprudence, is helpful, I do not feel it is authoritative for the section 8 analysis in this case. Indeed, one must consider how Justice Abella approached *Irving*, writing at paragraph 3 of that decision:

> The legal issue at the heart of this case is the interpretation of the management rights clause of a collective agreement. This is <u>a labour law issue</u> with clear precedents and a history of respectful recognition of the ability of collective bargaining to responsibly address the safety concerns of the workplace – and the public.
>
> [Emphasis added]

[111] The reality is that *Irving* and the arbitral jurisprudence focuses on the exercise of management rights and the application of the "KVP test," a test which was contained in the labour law decision *Re Lumber & Sawmill Workers' Union, Local 2537, and KVP Co. (1965),* 16 LAC 73. The KVP test ensures "that any rule or policy unilaterally imposed by an employer and not subsequently agreed to by the union, must be consistent with the collective agreement and be reasonable" (*Irving* at para 24). While the KVP test focuses on the relationship between the employer and the employees, and the terms of the collective agreement between them, a section 8 analysis is more contextual and requires the examination of the totality of circumstances.

[112] In any event, the circumstances in the present case are distinguishable from those in *Irving* in two significant ways. First, the subject matter under review is a measure enacted by a federal regulator, and not workplace requirements introduced by an employer. Second, the RegDoc does not mention disciplinary consequences, whereas the employer policy in *Irving* did.

Also notable is the fact that *Irving* does not preclude the implementation of pre-placement and random testing in workplaces (*Irving* at para 52):

> [52] This is not to say that an employer can never impose random testing in a dangerous workplace. If it represents a proportionate response in light of both legitimate safety concerns and privacy interests, it may well be justified.

[113] In keeping with the analysis set out by *Goodwin* as applied in *Correctional Officers*, my assessment of whether the seizure authorized by sections 5.1 and 5.5 of the RegDoc is reasonable, will be subject to the following criteria: (a) the purpose of the RegDoc and the provisions at issue; (b) the nature of the regulatory scheme; (c) the mechanism for obtaining the bodily samples, including the degree of intrusiveness; and (d) the subsequent review and possible redress for seizure, i.e. the availability of judicial oversight (see *Correctional Officers* at para 25). Each of these four criteria is discussed next.

(a) *The purpose of the RegDoc and the provisions at issue*

[114] I am satisfied that the purpose of the RegDoc and of its pre-placement and testing provisions, is to standardize and improve Licensees' fitness for duty programs relating to drug and alcohol testing.

[115] The Respondents submit that the pre-placement and random testing provisions of the RegDoc arose from a need for better fitness for duty provisions in light of lessons from nuclear disasters such as the one in Fukushima, Japan in 2011. This required looking abroad to align with international standards, including the recommendations and expectations of the International

Atomic Energy Agency [IAEA], as well as addressing domestic developments such as measures needed to respond to the introduction of the *Cannabis Act*, SC 2018, c 16.

[116] As mentioned by the 2021 Arbitral Decision in this matter, "[t]he RegDoc is the product of almost 10 years of study and consultation by the CNSC, in which the parties to this litigation have participated, and over the course of which this litigation has been anticipated": *Ontario Power Generation, Bruce Power, Power Workers' Union, Society of United Professionals, The Chalk River Nuclear Safety Officers Association and International Brotherhood of Electrical Workers, Local 37 v Canadian Nuclear Laboratories and New Brunswick Power*, 2021 CanLII 65284 (ON LA) at para 2 [Arbitral Decision].

[117] In the course of its research, the CNSC commissioned a number of key reports, which it relied on when developing the RegDoc. These reports include: (i) "*Review, Analysis and Synthesis of CNSC's Licensees' Fitness for Duty Programs*" by AIM Health Group in 2011 [AIM Report]; (ii) "*The Forensic Toxicology of Alcohol and Best Practices for Alcohol Testing in the Workplace*" by James Wigmore in 2014 [Wigmore Report]; (iii) "*State of Policies and Practices on Substance Use in Safety-sensitive Industries in Canada*" by the Canadian Centre on Substance Use and Addiction in 2017 [CC Report]; (iv) "*Urine Drug Testing Practices*" by Dr. Albert Fraser in 2014 [Fraser Report]; and (v) "*Recent Alcohol and Drug Workplace Policies in Canada: Considerations for the Nuclear Industry*" by Barbara Butler and Associates Inc. in 2012 [Butler Report].

[118] The findings in these five reports [Reports] point to an identified need for better methods of detection of drug and alcohol impairment at nuclear facilities, as well as to the efficacy of the testing methods proposed by the RegDoc.

[119] In particular, the AIM Report looked into deficiencies in the CNSC's existing fitness for duty programs and compared them with standards from the IAEA, the world's central intergovernmental forum for scientific and technical co-operation in the peaceful use of nuclear energy. Canada is a member of the IAEA, as one of its 175 member states. While the AIM Report found that CNSC's existing fitness for duty programs were compliant with IAEA standards, it also found the programs across the different nuclear facilities in Canada were inconsistent with each other. Page 24 of the AIM Report recommended the following specific areas of improvement within the domain of "substance use and abuse":

- Improve the policy of Licensees to include clear expectations on the number of hours of alcohol abstinence necessary prior to reporting to work or on-call;
- Define additional policy statements for off-duty expectations regarding use, possession or distribution of illegal substances;
- Drug and/or alcohol testing protocols need to be defined.

[120] The Wigmore Report noted that there were concerns with supervisory awareness programs for detecting impairment in the workplace, including a lack of scientific evidence to show that supervisors were able to detect impairment since some workers may not show outward signs of impairment but still exhibit symptoms of functional impairment.

[121] For its part, the CC Report indicated that the impact of legalization and regulation of cannabis in Canada could result in increased use in populations that typically did not use cannabis, particularly adults in the workforce.

[122] The Fraser Report discussed the efficacy of urine drug testing practices and how it could be used to detect impairment.

[123] The Butler Report addressed the deterring effects of random testing and recommended it as a more objective method of testing than reasonable cause testing (testing after referral based on judgment calls made by supervisors).

[124] According to the Respondents, these five Reports informed the development of the RegDoc to improve methods of detection of drug and alcohol impairment at nuclear facilities.

[125] The record, including the Reports, produced over the course of the decade leading up to the planned 2021 implementation of the RegDoc, shows that the pre-placement and random testing provisions were reasonably included in the RegDoc after years of research identified specific gaps in the existing fitness for duty programs, particularly with respect to reliable, consistent, and accurate methods to detect drug and/or alcohol impairment among workers at nuclear facilities. CNSC staff testified that the Commission had, as early as 2007, identified gaps and inconsistencies in the existing fitness for duty programs, particularly for drug use. As a result, CNSC staff researched drug and alcohol use, the risks posed to the nuclear industry, and what steps would reduce those risks.

[126] The bolstering of Licensees' fitness for duty programs relating to drug and alcohol testing is a compelling purpose in light of those gaps in protecting against the identified risks. This compelling purpose weighs in favour of the reasonableness of the seizure required by the pre-placement and random testing measures.

[127] I note that the purpose of the pre-placement and random testing provisions is also aligned with the defence-in-depth principle. As underscored by the Respondents, in the nuclear industry, one cannot "wait and see" given the severe consequences that often result from nuclear incidents. Thus fitness for duty programs must be built on a foundation that layers various measures to minimize risk and implement best practices to both prevent failure, and ensure safety. Contrary to the Applicants' submissions, pre-placement and random testing procedures neither undermine nor diminishes that principle. Rather, they represent additional measures to the other uncontested methods of detecting drug and alcohol impairment in the RegDoc. The additional measures contribute to the purpose of the scheme, namely to improve the fitness for duty programs relating to drug and alcohol testing.

[128] Under the defence-in-depth principle, the existence of multiple methods and layers of detection of drug and alcohol impairment is not a redundancy, but rather an intended outcome. In this unique case, the defence-in-depth principle helps to justify multiple methods of detection by pre-placement and random testing under the regime of the RegDoc; it does not controvert that principle or undermine the purpose of the scheme.

(b) *The nature of the regulatory scheme*

[129] In the context of a regulatory scheme, the SCC departed from the rigid framework of analysis in *Hunter v Southam* to assess the reasonableness of a search and/or seizure. As Justice La Forest held for the Court in *Comité paritaire*, "[i]n a context in which their occupations are extensively regulated by the state, the reasonable expectations of privacy employers may have…are considerably lower" (at page 420). He added at page 421:

> It is thus impossible, without further qualification, to apply the strict guarantees set out in *Hunter v. Southam Inc.*, *supra*, which were developed in a very different context. The underlying purpose of inspection is to ensure that a regulatory statute is being complied with. It is often accompanied by an information aspect designed to promote the interests of those on whose behalf the statute was enacted. The exercise of powers of inspection does not carry with it the stigmas normally associated with criminal investigations and their consequences are less draconian. While regulatory statutes incidentally provide for offences, they are enacted primarily to encourage compliance. It may be that in the course of inspections those responsible for enforcing a statute will uncover facts that point to a violation, but this possibility does not alter the underlying purpose behind the exercise of the powers of inspection.

[130] Furthermore, as held by Justice Karakatsanis writing for the majority at paragraph 60 of *Goodwin*, "[the SCC] has recognized in its s. 8 jurisprudence that the characterization of a search or seizure as either criminal or regulatory is relevant in assessing its reasonableness. Where an impugned law's purpose is regulatory and not criminal, it may be subject to less stringent standards." Likewise, in this case, the highly regulated nature of nuclear facilities is relevant for assessing the reasonableness of the seizure (see also *Comité paritaire* at page 418 and *Marine Reference* at para 50).

[131] The RegDoc's administrative law context differs from the criminal domain (*McKinlay Transport* at para 647; *Thomson Newspapers* at paras 495-496). The focus here is rather the broad public interest served by the RegDoc, namely nuclear safety (see *Marine Reference* at para 53). As the FCA held in *Correctional Officers* at para 29, where the impugned directive was administrative and not criminal in nature: "[t]he case law is uniformly clear: the resulting searches are thus considered less intrusive than those performed in a criminal investigation."

[132] In sum, considering the nature of this regulatory scheme, I find that the RegDoc's context supports the reasonableness of the searches under its pre-placement and random testing provisions.

(c) *The mechanism for obtaining the bodily samples, including the degree of intrusiveness*

[133] The SCC held in *Goodwin* at paras 64-67 that the two relevant factors to assess the reasonableness of the manner of a search are (i) the degree of intrusiveness on an individual's bodily integrity, and (ii) the reliability of the results. The Applicants argue that the manner in which the testing is carried out as proposed in the RegDoc is unreasonable, because the collection of bodily samples is highly intrusive, and the RegDoc's testing methodology is unreliable because it may show only past drug use rather than present impairment.

[134] The two testing methods (breath samples and buccal swabs) are prescribed by sections 6.1 and 6.2 of the RegDoc. Under the third – and arguably the most contentious – bodily sample method contained in the RegDoc, Licensees will be required to conduct urine testing in a

secure and private testing location, a measure intended to protect bodily integrity and reduce, as the Respondents assert, any affront to privacy and dignity of Safety-Critical Workers (*R v SAB* at para 44).

[135] The Respondents counter that the manner in which the testing is carried out is reasonable for two primary reasons. First, as mentioned above, while the collection of bodily samples can be intrusive, they urge this Court to use a flexible approach, one that considers other contextual factors, such as the narrow scope of the RegDoc, and the absence of disciplinary consequences that flow from a positive test result. Second, they emphasize that the testing methods contained in the RegDoc are highly reliable.

[136] As I have already addressed the intrusiveness of the collection of bodily samples as well as the need for a flexible approach and the consideration of contextual factors due to the regulatory context, I will focus on the reliability of the testing methodology of the RegDoc in my analysis of the reasonableness in the testing methodology.

[137] The Applicants argue that the alcohol and drug testing methods outlined in the RegDoc actually detect the amount of alcohol and/or drug that an individual has taken, which can only be used to determine whether an individual is intoxicated, but cannot be used to accurately measure the level of impairment of an intoxicated individual. They point to the Butler Report, which suggests that no alcohol and/or drug testing method can actually and directly measure an individual’s level of impairment from alcohol and/or drug use.

[138] A CNSC staff member testified that the testing methods outlined in the RegDoc were actually designed to measure recency of use, and recency is the most accurate indicator of impairment. Specifically, the Butler Report suggests that while alcohol and drug testing cannot measure impairment, it can accurately measure the concentration of a substance in a person's body and/or the recency of use of a substance, which are both strong indicators of impairment when examined in conjunction with studies available on the impact and duration of the effects of drugs on performance.

[139] The Butler Report also examines how different cut-off levels set out for testing affect the accuracy of measuring recent use. CNSC staff used this research to set the cut-off levels in the RegDoc to represent narrow windows on recent use to ensure the accuracy of test results. In other words, the cut-off levels in the RegDoc are set so that a positive test result would indicate very recent use and be a better signal for possible impairment. Therefore, there is a research-established link between the RegDoc's testing methods, including the proposed cut-off levels for a positive test result, and the detection of alcohol and drug impairment.

[140] Finally, turning back to the fundamental safety assurance objective of the impugned provisions, the testing methodology outlined in the RegDoc also embodies the nuclear safety principle of defence-in-depth and its multiple layers. First, it sets out a combination of testing methods for higher accuracy. For example, Licensees can opt for a combination of urine drug testing and oral fluid drug testing. Second, the RegDoc requires multiple steps of analysis before a positive result is reported, namely a laboratory screening, followed by examination, as well as confirmation from a medical review officer.

(d) *The subsequent review and possible redress for seizure (i.e. availability of judicial oversight)*

[141] The consequences arising from a regulatory scheme that enables a search or seizure generally (i.e., without prior authorization for each incident) are lessened if an individual subject to the regulatory scheme can challenge both the basis for, and the accuracy of, their test results (*Goodwin* at para 69). As such, the availability and adequacy of judicial oversight, or "procedural safeguards", are relevant measures in assessing the reasonableness of a search or seizure under section 8 (*Goodwin* at paras 71-72).

[142] The Applicants, through their argument of an absence of reasonable and probable grounds for the pre-placement and random testing measures, are effectively challenging the availability of judicial oversight. They argue that in the absence of prior judicial authorization, a search is presumptively unreasonable and the state bears the onus of rebutting that presumption, relying on *R v Spencer* at paragraph 68. The Applicants submit, given the absence of reasonable and probable grounds, that the presumption has not been rebutted and therefore the proposed pre-placement and random testing is unreasonable.

[143] The Applicants contend that random testing is, by definition, without grounds. They also assert that pre-placement testing arises from an individual's application for a Safety-Critical position, not because of reasonable and probable grounds to suspect that an individual might be impaired at work. The Applicants rely on pages 167 and 168 of *Hunter v Southam* to submit the SCC affirmed that the state's interest only prevails over the individual's right to privacy "at the point where credibly-based probability replaces suspicion".

[144] The applicants in *Marine Reference* also argued that the regulatory scheme in that case was "fatally flawed" because there was no prior authorization for the searches (i.e., security screenings). However, the FCA rejected those arguments at paras 57-59 of its decision:

> [55] ILWU argues that the scheme is fatally flawed because it lacks any adequate checks to prevent the abuse of the power to obtain and use information about an employee. In particular, prior independent authorization is not required, and an employee who has been refused a security clearance has no right of review by an independent decision-maker. Hence, any "search" under the Regulations is unreasonable.
>
> [56] Counsel relies on *Canada (Combines Investigation Acts, Director of Investigation and Research) v. Southam Inc.*, 1984 CanLII 33 (SCC), [1984] 2 S.C.R. 145 ("*Hunter*"), for the proposition that, even when undertaken as part of a regulatory scheme, a search will normally not be reasonable for the purpose of section 8 without prior authorization by an independent person capable of acting in a judicial manner.
>
> [57] I disagree. In my opinion, *Hunter* cannot be applied to the scheme under consideration here. For one thing, to require prior authorization before an employee completes a security clearance application would serve no purpose because all employees complete the same form. The complaint in this case is not to abuses in the way that forms are administered to different employees, but to the form itself.
>
> [58] Further, cases in which prior authorization has been required have invariably arisen in contexts where criminal and *quasi*-criminal offences are being investigated and where the expectation of privacy is highest. Here, in contrast, existing and future employees who wish to work in security-sensitive positions in marine transportation, a highly regulated activity giving rise to a much lower expectation of privacy, may be refused a security clearance, which may adversely affect their employment opportunities. See *Comité paritaire* at 419-20.
>
> [59] To the extent that ILWU argues that authorization is required before the information provided by an employee is checked a8nd verified by law enforcement and intelligence agencies, its argument is equally flawed. It would be impracticable to require prior authorization before the information provided by thousands of port employees across the country could be processed. Nor is it clear to me what purpose would be served by

> such an exercise, since it will often not be possible to identify potential security risks until background checks have been conducted.
>
> [Emphasis added]

[145] I agree with the FCA's approach in *Marine Reference* that the Court cannot take a rigid approach of requiring prior authorization in its assessment of the availability of judicial oversight. In *Correctional Officers*, the FCA found that correctional officers who were obligated to consent to credit checks, which constituted a search under section 8, were afforded judicial oversight because the scheme allowed them to explain any adverse information in their credit report and contest any decision to revoke their reliability status as a result of an adverse search result (*Correctional Officers* at para 32). The correctional officers also had recourse to the Federal Courts and the Human Rights Commission, which the FCA found to be "undeniably relevant in assessing the reasonableness of the search" (*Correctional Officers* at para 32).

[146] In *Goodwin* at para 71, the Court found "[t]he nature of the review required will of course vary with the circumstances, including the nature of the scheme. On the other hand, the availability of oversight is particularly important where, as here, a search or seizure occurs without prior authorization: *R v Tse*, 2012 SCC 16, [2012] 1 SCR 531, at para 84. While less exacting review may be sufficient in a regulatory context, the availability and adequacy of review is nonetheless relevant to reasonableness under s. 8."

[147] Here, under the "Drug-testing process" (section 6.2 of the RegDoc), Safety-Critical Workers are provided with the opportunity to explain any alternative reasons for the positive test result, and if a medical review officer finds a legitimate medical explanation for the positive test

result, it will not be considered “verified” or reported to the Employers. Thus, similar to the regulatory scheme in *Correctional Officers*, the RegDoc provides a procedure to contest the results of the search.

[148] I agree with the Respondents that the RegDoc does not result in any adverse disciplinary consequences if a Safety-Critical Worker receives a positive test. Under section 6.3 of the RegDoc, Safety-Critical Workers who receive a verified positive test result shall be removed from Safety-Critical duties and referred for a mandatory substance abuse evaluation. The removal from Safety-Critical duties does not result in the individual’s dismissal. Instead, the individual is referred to a substance abuse evaluation, which is a medical process designed for rehabilitation.

[149] Neither the removal from Safety-Critical duties, nor the referral to a substance abuse evaluation, are detrimental to Safety-Critical Workers. At least, that is all that I am prepared to conclude at this early stage, which is before the RegDoc has been applied to any particular case. Based on the record,the purported detrimental effects of a positive test to employment reside in the realm of the hypothetical, rather than on any tangible basis.

[150] Although the RegDoc does not outline an appeal mechanism for adverse consequences resulting from a positive test result once the administrative process is complete, such as a possibility of judicial review or of filing a complaint to a third-party, any administrative decision made by the Employers under the regulatory scheme of the RegDoc can eventually be subject to judicial review before the Federal Court.

[151] In conclusion, the pre-placement and random testing provisions of the RegDoc engage, but do not infringe, section 8 of the *Charter*. The Safety-Critical Workers have a diminished expectation of privacy due to the highly regulated nature of their workplace, and the testing provisions are reasonable when considering all the contextual factors at hand, including the regulatory context, the public interest in nuclear safety, the identified need to bolster fitness for duty programs, the reliability of the testing methodology, and the availability of judicial oversight.

C. *The pre-placement and random testing provisions of the RegDoc do not infringe section 7 of the Charter*

[152] Section 7 of the *Charter* guarantees the right to life, liberty and security of the person and the right not to be deprived thereof except in accordance with the principles of fundamental justice.

[153] There is a two-step test for applying section 7. The Court must first determine whether the impugned provisions deprive the claimant of life, liberty, or security of the person. If affirmed, the Court must then determine whether the deprivation is contrary to the principles of fundamental justice (*R v Beare*, [1988] 2 SCR 387 at 401).

[154] These steps are sequential. As noted by the SCC in *Blencoe v BC (Human Rights Commission)*, 2000 SCC 44 [*Blencoe*] at para 47, “if no interest in the respondent’s life, liberty or security of the person is implicated, the s. 7 analysis stops there” (see also: *R v Pontes*, [1995] 3 SCR 44 at para 47).

[155] The Applicants claim that the provisions deprive them of their security of the person interest. They argue that the absence of reasonable and probable cause to authorize each seizure renders the pre-placement and random testing provisions of the RegDoc in contravention of the principles of natural justice. Specifically, the Applicants submit that the impugned provisions are: arbitrary because the testing is without reasonable and probable grounds; overbroad because it captures employees who are not suspected of being impaired; and disproportionate given all the existing measures in place in nuclear facilities, as well as the non-contested measures already contained in the RegDoc that sufficiently monitor impairment.

[156] The Respondents dispute these assertions. They rely on *Wakeling v United States of America*, 2014 SCC 72 at paras 49-50 [*Wakeling*] to submit that the arguments raised by the Applicants under their section 7 challenge can and should be dealt with under the section 8 analysis. In any event, the Respondents argue that the pre-placement and random testing provisions of the RegDoc are not arbitrary, overbroad or grossly disproportionate, and that any interference with the bodily integrity of Safety-Critical Workers resulting from the testing, is in accordance with the principles of fundamental justice.

[157] At the outset, I am of the view that the Applicants' concerns are more appropriately framed for consideration under the section 8 *Charter* analysis and not section 7. I agree with the Respondents' submission that a section 7 analysis in this case is redundant since the taking of bodily samples ought only be considered under section 8 (*Wakeling* at paras 49-50; *R v Rodgers*, 2006 SCC 15 at paras 23-24; *Ontario (Attorney General) v Bogaerts*, 2019 ONCA 876 at para 54

[*Bogaerts*]). Nonetheless, I will respond to the Applicants' section 7 claim for the sake of completeness.

[158] The Applicants argue the impugned provisions engage the "security of the person" interest. In particular, they argue that pre-placement and random testing provisions lead to a measure of psychological harm by compromising Safety-Critical Workers' bodily integrity. In support of their argument that security of the person is engaged, the Applicants rely on two decisions, *Jackson v Joyceville Penitentiary (TD)*, [1990] 3 FC 55 [*Jackson*], and *Cruikshanks v Stephen*, 1992 CanLII 1929 (BC CA) [*Cruikshanks*]. Both decisions involved a prison inmate contesting the requirement to submit to a urinalysis test.

[159] However, the facts and issues in both *Jackson* and *Cruikshanks* are highly distinguishable from the RegDoc's testing for several reasons.

[160] In *Jackson*, Justice MacKay found that the design of the impugned regulation was at risk of improper use by prison staff. The primary concern was that inmates could be subjected to a demand for a urine sample, or punished for refusing to provide a sample, at the whim of prison staff, and that the test could conceivably be used as a tool to coerce inmates to do certain acts or as a form of punishment outside of the disciplinary system mandated by statute. At para 49 of *Jackson*, the Court characterized the section 7 *Charter* issue before it as follows:

> Section 41.1 in so far as it permits a member to require an inmate, who is considered to have ingested an intoxicant, to provide a specimen of the inmate's urine for analysis to detect the presence of an intoxicant in the body of the inmate, when coupled with disciplinary proceedings for failure to obey a lawful order if the requirement not be met, contravenes section 7 of the Charter by

> depriving the inmate of the right to liberty and security of the person in a manner that does not accord with the principles of fundamental justice.
>
> (see also para 91)

[161] It was in this context that the Court found the deprivation of the inmate's security of the person and liberty interests (*Jackson* at para 96):

> To require an inmate to provide a specimen of urine for purposes of testing for trace elements of intoxicants, as section 41.1 provides, is in my view, an interference with bodily integrity. Urinalysis may reveal health or other conditions beyond the indications sought for traces of unauthorized intoxicants. In many cases requiring a specimen for testing aside from health reasons might lead to a measure of psychological stress, particularly where, as here, the procedure for collecting the sample involves direct observation by another. The requirement deprives the inmate concerned of security of his or her person. To require this or risk punishment for failure to comply with an order, as practice under standing orders for disciplinary proceedings here provides, is also an interference with the liberty of the person.

[162] The Applicants' reliance on *Cruikshanks* is also misplaced due to different circumstances. In *Cruikshank*, the Court of Appeal for British Columbia did not consider the section 7 *Charter* rights of the inmate:

> [123] We are agreed as we assume was the learned judge in the court below, that <u>in the particular circumstance of this case</u> the requirement as a condition of mandatory supervision to furnish urinalysis samples on demand by a supervisor or peace officer without reasons or probable grounds, was not authorized by any law or regulation <u>and constituted a breach of *Charter* s.8.</u>
>
> [Emphasis added]

[163] There is well-established case law setting out the test for demonstrating an interference with the security of the person interest. It was recently summarized by the Ontario Court of Appeal in *Bogaerts* as follows:

> [52] To demonstrate an interference with security of the person, an applicant must show either (1) interference with bodily integrity and autonomy, including deprivation of control over one's body: *Carter v. Canada (Attorney General)*, 2015 SCC 5, [2015] 1 S.C.R. 331, at paras. 66-67, or (2) serious state-imposed psychological stress: *Blencoe v. British Columbia (Human Rights Commission)*, 2000 SCC 44, [2000] 2 S.C.R. 307, at paras. 81-86; Hamish Stewart, *Fundamental Justice:* Section 7 *of the* Canadian Charter of Rights and Freedoms, 2nd ed. (Toronto: Irwin Law, 2019), at pp. 95-106.

[164] The Applicants here have not demonstrated either prong of the security of the person interest test. The choice to work in a Safety-Critical position at a nuclear power plant is not one of the "basic choices going to the core of what it means to enjoy individual dignity and independence protected by s. 7" (*Blencoe* at para 49). Section 7 does not protect property or other predominantly economic interests, including the right to practice a particular profession. The adverse effect of not working one's preferred position at a nuclear power plant is not protected under the scope of section 7 (*Marine Reference* at para 47, citing *Mussani v College of Physicians and Surgeons of Ontario* (2004), 74 OR (3d) 1, at paras 41-43).

[165] I note that the Applicants provided no authority to support the notion that section 7 guarantees the right to have one's choice of employment. The closest analogy occurred only on one occasion, when a minority of the SCC judges (Justice La Forest writing, supported by two other) held that the right to choose to establish one's home vis-à-vis a job fell within section 7 liberty interests. The other six *Godbout* judges struck down the municipal resolution requiring its

employees to reside within its boundaries, as invalid, because it violated section 5 of the *Quebec Charter of Rights and Freedoms*, RSQC, C-12.

[166] The facts and context in *Godbout* are thus also very different from those under review. In the 25 years since the SCC decided *Godbout*, suffice it to say that the threshold to demonstrate a section 7 breach on the basis of employment is significant and requires more than the non-invasive taking of saliva, urine or breath samples to check for evidence of drugs or alcohol as a measure to protect the broader public.

[167] Ultimately, if the Safety-Critical Workers fundamentally object to being tested on the basis of security of their person, they can apply for the other 90% of positions in nuclear facilities not classified as "safety-critical" or work in a less safety sensitive industry.

[168] Since the Applicants have not demonstrated that their section 7 interests are implicated, "the s. 7 analysis stops there" (*Blencoe* at para 47).

D. *The pre-placement and random testing provisions of the RegDoc do not infringe section 15 of the Charter*

[169] Subsection 15(1) of the *Charter* safeguards every individual's right to the equal protection and benefit of the law, without discrimination based on, among other grounds, race, national or ethnic origin, colour, religion, sex, age or mental or physical disability.

[170] Subsection 15(1) of the *Charter* requires the claimant to show (i) that the impugned law draws a distinction or has a disproportionate impact on the basis of an enumerated or analogous ground; and (ii) that the law has the effect of reinforcing, perpetuating, or exacerbating disadvantage (*R v Sharma*, 2022 SCC 39 at para 28 [*Sharma*]).

[171] The first step of the subsection 15(1) test requires the claimant to demonstrate either that the law draws a distinction on the basis of an enumerated or analogous ground, or that the law has a disproportionate impact on a group identified by an enumerated or analogous ground. This is a question of "whether the impugned law created or contributed to a *disproportionate impact* on the claimant group based on a protected ground" (*Sharma* at para 31; Emphasis in original).

[172] The Applicants' claim fails on the first step of the section 15 test for two reasons. First, the RegDoc applies to a job category of workers at nuclear power facilities. This is not a "protected group" for the purposes of section 15. Moreover, the Applicants do not properly establish individuals experiencing 'drug dependency' as an enumerated or analogous ground of persons living with a disability. The RegDoc does not draw a distinction, either on its face or through an adverse impact on that ground. The Applicants have not adduced any evidence to show that the RegDoc may result in a situation wherein certain workers affected by it are members of a disadvantaged group, or may experience disadvantage.

[173] The Applicants rely on human rights case law to argue that "drug dependency" should be recognized as an analogous ground worthy of protection under section 15 of the *Charter*. They

rely on *British Columbia (Public Service Employee Relations Commission) v BCGSEU*, [1999] 3 SCR 3 [*BCGSEU*] to argue that this Court should use a human rights analysis to establish discrimination under subsection 15(1). The SCC found there to be "little reason for adopting a different approach when the claim is brought under human rights legislation which, while it may have a different legal orientation, is aimed at the same general wrong as s. 15(1) of the *Charter*" (*BCGSEU* at para 48).

[174] Under a human rights analysis, the Applicants submit that drug dependency is recognized as a protected ground and can give rise to *prima facie* discrimination if three factors are present: (i) the worker has a drug dependency, (ii) they have experienced an adverse impact, and (iii) the drug dependency was a factor in that adverse impact (*Entrop v Imperial Oil Limited*, 2000 CanLII 16800 (Ont CA) at para 92 [*Entrop*] and *Canada (Human Rights Commission) v Toronto-Dominion Bank*, [1998] 4 FC 205 (CA) at para 28 [*TD Bank*]).

[175] It would not be appropriate to apply a human rights analysis instead of a *Charter* section 15 analysis to determine whether the RegDoc provisions draw a distinction on an analogous ground, especially given that the Applicants have not brought any evidence to support that there are drug dependencies amongst Safety-Critical Workers.

[176] The clear and authoritative criteria established by the SCC to recognize an analogous ground under section 15, holds that an analogous ground cannot be found without compelling reasons. Analogous grounds are similar to the enumerated grounds insofar as they identify a

basis for stereotypical decision-making or a group that has historically suffered discrimination. They describe personal characteristics that are either immutable or constructively immutable.

[177] The analysis for determining an analogous ground involves "considering whether differential treatment of those defined by that characteristic or combination of traits has the potential to violate human dignity in the sense underlying s. 15(1)" *(Corbiere v Canada (Minister of Indian and Northern Affairs)*, [1999] 2 SCR 203 at paras 59-60 [*Corbiere*]). Once a ground has been found to be analogous, it will always be considered a ground in the future (*Corbiere* at para 13):

> [13] What then are the criteria by which we identify a ground of distinction as analogous? The obvious answer is that we look for grounds of distinction that are analogous or like the grounds enumerated in s. 15 — race, national or ethnic origin, colour, religion, sex, age, or mental or physical disability. It seems to us that what these grounds have in common is the fact that they often serve as the basis for stereotypical decisions made not on the basis of merit but on the basis of a personal characteristic that is immutable or changeable only at unacceptable cost to personal identity. This suggests that the thrust of identification of analogous grounds at the second stage of the *Law* analysis is to reveal grounds based on characteristics that we cannot change or that the government has no legitimate interest in expecting us to change to receive equal treatment under the law. To put it another way, s. 15 targets the denial of equal treatment on grounds that are actually immutable, like race, or constructively immutable, like religion. Other factors identified in the cases as associated with the enumerated and analogous grounds, like the fact that the decision adversely impacts on a discrete and insular minority or a group that has been historically discriminated against, may be seen to flow from the central concept of immutable or constructively immutable personal characteristics, which too often have served as illegitimate and demeaning proxies for merit-based decision making.

[178] As noted above, while I find that the RegDoc makes a distinction between the job categories of workers at nuclear power facilities, it does not do so on an enumerated ground. The SCC has rejected claimants' attempts to recognize occupational status as an analogous ground (see: *Delisle v Canada (Deputy Attorney General)*, [1999] 2 SCR 989 at para 44; *Baier v Alberta*, 2007 SCC 31 at para 65).

[179] The SCC has also rejected the analogous ground of "substance orientation." In *R v Malmo-Levine; R v Caine*, 2003 SCC 74 at para 185, the Court held:

> [185] A taste for marihuana is not a "personal characteristic" in the sense required to trigger s. 15 protection: *Andrews v. Law Society of British Columbia*, [1989] 1 S.C.R. 143. As Malmo-Levine argues elsewhere, it is a lifestyle choice. It bears no analogy with the personal characteristics listed in s. 15, namely race, national or ethnic origin, colour, religion, sex, age, or mental or physical disability. It would trivialize this list to say that "pot" smoking is analogous to gender or religion as a "deeply personal characteristic that is either unchangeable or changeable only at unacceptable personal costs": *Egan v. Canada*, [1995] 2 S.C.R. 513, at para. 5; *Vriend*, *supra*, at para. 90. Malmo-Levine's equality claim therefore fails at the first hurdle of the requirements set out in *Law v. Canada (Minister of Employment and Immigration)*, [1999] 1 S.C.R. 497. The true focus of s. 15 is "to remedy or prevent discrimination against groups subject to stereotyping, historical disadvantage and political and social prejudice in Canadian society": *Swain*, *supra*, at p. 992, *per* Lamer C.J.; and *Rodriguez*, *supra*, at p. 616. To uphold Malmo-Levine's argument for recreational choice (or lifestyle protection) on the basis of s. 15 of the Charter would simply be to create a parody of a noble purpose.

[180] An identified protected ground is a threshold question for the section 15 analysis. If there is no enumerated or analogous ground identified, there is no need to consider whether the law creates or contributes to a distinction. The section 15 challenge fails on the first step of the section 15 test.

[181] For the edification of the Safety-Critical Workers challenging the pre-placement and random testing provisions of the RegDoc, I will note a few deficiencies in their section 15 had a full analysis been merited. In particular, the Applicants did not advance any evidence, statistical or otherwise, as was done in *Fraser*, about the demographic make-up of Safety-Critical Workers, to support their claim that a disproportionate number of these Workers have drug dependencies and would be affected by the impugned provisions of the RegDoc. At the hearing, Counsel to the Applicants, relying on paragraph 57 of *Fraser v Canada (Attorney General)*, 2020 SCC 28, suggested that I take judicial notice of the existence of drug dependencies among Safety-Critical Workers. I am not prepared to do so.

[182] The Applicants also failed to explain how the impugned provisions would result in an arbitrary disadvantage for Safety-Critical Workers with drug dependencies, lacking evidence beyond a mere "web of instinct" (*Kahkewistahaw First Nation v Taypotat*, 2015 SCC 30 at para 34). Lastly, the Applicants did not demonstrate that the provisions are arbitrary, prejudicial or stereotyping (*Sharma* at para 53).

[183] Another deficiency of the section 15 arguments (beyond what I have found to be a neutral policy on both its face and in its effects) is that since the RegDoc has not been implemented, there are no concrete situations that can be addressed. No worker has yet been impacted by the implementation of the RegDoc, due to the injunction that was issued before its intended implementation date. Thus, any actual impact or potential discrimination is purely hypothetical.

[184] Indeed, this observation is applicable to the entire *Charter* analysis. The harm alleged by the Applicants as a result of potential section 8, 7 or 15 breaches is hypothetical at this point in time. It could be that the ensuing Employers' policies, implementing pre-placement and random testing at nuclear facilities in accordance with the licensing requirements of the RegDoc, could infringe workers' *Charter* rights under sections 8, 7 and 15. However, these policies have not been enacted and this Court cannot work in the realm of the hypothetical when the RegDoc and its effects are neutral on their face (*Ernst* at para 22; *Ozcevik v Canada (Revenue Agency)*, 2021 FC 13 at para 30).

[185] In light of my findings with respect to sections 8, 15 and 7 of the *Charter*, I decline to address the Parties' arguments with respect to section 1 of the *Charter*.

[186] Finally, before moving on to the Applicant's administrative law arguments, I turn back to the earlier discussion on standard of review, and the *Doré*/*Loyola* approach that I found to be inapplicable to this Application. However, even if I had applied the *Doré*/*Loyola* framework and its proportionality analysis to determine whether the CNSC's decision to adopt specific provisions in the RegDoc has an adverse effect on the rights of employees and candidates in the nuclear industry, I would have arrived at the same outcome as I did under the correctness standard. This is because the measures contained in sections 5.1 and 5.5 of the RegDoc pass *Doré* muster, because they support a proportionate balancing between, on the one hand, their objective of bolstering fitness for duty standards in order to protect the public, and on the other hand, the *Charter* rights and values of Safety-Critical Workers under sections 7, 8 and 15.

[187] After all, as argued by Professor Richard Stacey in his recent article on *Doré*, the *Oakes* framework and *Doré* approach are “merely different heuristics, or modes of reasoning” to determine whether the limit to a *Charter* right is justified, and thus both have a common underlying culture of justification (Richard Stacey, “Public Law’s Cerberus: A Three-Headed Approach to Charter Rights-Limiting Administrative Decisions” (2023) 1-36 Can J Law Jurisprud).

E. *The impugned RegDoc provisions are reasonable under administrative law*

[188] Having disposed of the constitutional arguments, I now turn to my analysis of the second issue. The administrative law issues raised by the Applicants with respect to the two RegDoc provisions are separate from the *Charter* challenges, and were raised in the alternative, in the event that the Court were to find no *Charter* breaches. That has occurred, such that I will now address these alternate arguments.

[189] Specifically, the Applicants argue from an administrative law perspective that if this Court should find the pre-placement and random testing provisions of the RegDoc constitutional, these aspects are nonetheless unreasonable because (i) there was no statutory basis for the Commission to adopt the two impugned testing provisions; and (ii) the Commission did not provide adequate reasons to justify the inclusion of the provisions in the RegDoc, particularly when addressing stakeholder concerns about the *Charter* raised during the consultation phase.

[190] I agree with the Parties that the administrative law questions at issue are reviewable on a standard of reasonableness, meaning the rationale for the RegDoc’s inclusion of pre-placement

and random testing provisions must be rational, logical and justified under the relevant law and facts (*Vavilov* at paras 102, 105).

[191] To ensure nuclear safety, Parliament created and empowered the CNSC, a highly specialized administrative body. Its expertise commands a high level of deference from reviewing courts with respect to the decisions of the Commission, as emphasized in *Citizens Against Radioactive Neighbourhoods v BWXT Nuclear Energy Inc,* 2022 FC 849 at para 42:

> [60] Where, as here, the issues at play involve detailed factual findings and discretionary decisions within the heartland of the tribunal's expertise, the reasonableness standard requires that considerable deference be given to the tribunal's determinations. This is particularly so when the issues under review concern nuclear safety and the tribunal is the nuclear safety regulator. In short, the CNSC is much better placed than a reviewing court to factually assess and determine what types of possible accidents are likely to occur at a nuclear power plant and how to conduct the assessment of the environmental impacts of potential accidents. It is therefore inappropriate for a reviewing court to second-guess these determinations through a detailed re-examination of the evidence as the appellants would have us do in the instant case.
>
> See also: *Greenpeace Canada v Canada (Attorney General),* 2016 FCA 114 at para 60

[192] It is within the unique context of the highly specialized CNSC, that I find the Commission's decision to adopt the pre-placement and random testing provisions of the RegDoc was reasonable, intelligible and justified.

(1) There is a statutory basis for the random testing provisions to be in the RegDoc

[193] The Applicants argue that the RegDoc does not have a statutory basis. First, they rely on their submissions with respect to section 8 of the *Charter* to submit that the pre-placement and

random testing provisions of the RegDoc are *ultra vires*, because they were not authorized by law, and thus were unlawful and unreasonable. Second, the Applicants argue that the Commission fettered its discretion by adopting the contested provisions using its broad licencing authority. Third, the Applicants contend that the mechanism used by the Commission to adopt the RegDoc unreasonably denied them participatory rights.

[194] The Respondents maintain that the RegDoc was authorized by law, and lawfully adopted using the Commission's broad licensing authority. The Respondents argue that the Commission had multiple tools at its disposal to implement the pre-placement and random testing provisions of the RegDoc, and that it was reasonable for the Commission to choose regulatory documents for flexibility and adaptability. The Respondents submit that this decision attracts a high level of deference, because of the unique context of, and CNSC's expertise in, the nuclear industry. The Respondents contend that the Applicants were not denied participatory rights since they were consulted during the development process of the RegDoc, and had the opportunity to submit comments and share concerns.

[195] As discussed earlier under the section 8 *Charter* analysis for the "authorized by law" requirement, the RegDoc indeed has a statutory basis: under the *Act*, the CNSC had the authority and the discretion to choose the instrument under which to implement pre-placement and random testing provisions. It chose the regulatory document as the instrument due to its flexibility and adaptability. This was a reasonable decision, informed by changing circumstances such as guidance coming from the IAEA after the nuclear accident in Fukushima, evolving international

practices, the legalization of cannabis in Canada, evolving research on the accuracy and efficacy of drug and alcohol testing, and divergent stakeholder demands.

[196] The purpose of the RegDoc further justifies the instrument chosen. CNSC staff testified that the purpose of the RegDoc is to bolster fitness for duty programs by adding more reliable methods to detect impairment, including pre-placement and random testing. This purpose does not fall directly within the scope of subparagraph 44(1)(h)(iii) of the *Act* (the regulation-making power), which is geared towards the "protection of nuclear energy workers".

[197] For example, as explained by the Respondents at the hearing, dosimetry tests, which measure the level of radiation a person is exposed to, would fall under the regulation-making power of subparagraph 44(1)(h)(iii) since dosimetry tests are a type of medical test prescribed for the protection of nuclear energy workers by ensuring they are not exposed to radiation levels that would threaten their health. By contrast, the purpose of the pre-placement and random testing measures of the RegDoc aims to protect the broader community interests and public safety.

[198] Considering these competing demands, CNSC was justified in using the broader powers under subsection 24(5) of the *Act* to add mandatory requirements to the licence. The RegDoc was always intended to be a licensing requirement, and never purported to be a non-binding policy or a guideline. Therefore, the CNSC did not fetter its discretion in passing mandatory pre-placement and random testing requirements through a regulatory document.

[199] With respect to participatory rights, the CNSC conducted broad outreach over the course of the decade during which the RegDoc was developed. The Commission provided multiple opportunities for the public – including the Applicants – to comment at various stages of the development of the RegDoc.

[200] The other mechanisms under the *Act*, which the Applicants argue the CNSC should have proceeded under – namely, the formal licence amendment process under section 25 and the regulation-making authority under section 44 – would not likely have provided the Applicants with any significant additional participatory rights beyond opportunities they received to participate in the RegDoc's development process. Pursuant to the formal licence amendment process and the regulation-making authority under subsections 39(1) and 40(1) of the *Act*, the Applicants would have been given the opportunity to appear before the Commission in a hearing, as occurred with the RegDoc.

[201] Although regulatory documents are not specifically discussed in the *Act*, they do form part of the legislative framework. They are a lawful mechanism under which to implement licence requirements, and provide for considerable stakeholder input, as occurred in the case under review.

[202] For all the reasons outlined above, the CNSC reasonably chose to use the RegDoc as the mechanism by which to include pre-placement and random testing provisions as a condition of the Employers' licences. The RegDoc and the decade-long process that led to its publication, in

which the Parties had opportunities to be heard during that lengthy consultation and development phase, all properly formed part of the CNSC's licensing basis.

(2) The Commission provided adequate reasons for the RegDoc

[203] The Applicants argue that the rationale provided by the CNSC for the inclusion of the pre-placement and random testing provisions in the RegDoc, does not meet the *Vavilov* standards of "an internally coherent and rational chain of analysis" (*Vavilov* at para 85). The Applicants submit that the RegDoc does not provide an adequate basis to explain the rationale for what amounts to such a significant new requirement for impacted Safety-Critical Workers. The Applicants further submit there is no concise set of documents to show that adequate reasons were provided, and that the thousands of pages of documents that form the Certified Tribunal Record [CTR] constitute a "data dump". They point out that this term was in fact used by a Commission member at the August 2017 public meeting.

[204] The Applicants argue that even if this Court gives deference to the institutional setting in which the RegDoc was adopted, there are fundamental gaps in the development of the pre-placement and random testing provisions that make the inclusion of these provisions in the RegDoc unjustifiable, unintelligible and unreasonable. In particular, the Applicants raise the Commission's lack of responsiveness to stakeholder concerns with *Charter* breaches.

[205] The Applicants submit that the Commission undertook no analysis of the Unions' concerns flowing from the *Charter* and from arbitral jurisprudence, despite their awareness and recognition of the impact of the impugned provisions on *Charter* rights as voiced during the

public meeting in August 2017. They also argue that the record shows that CNSC staff dealt with the core constitutional and legal concerns only in a cursory fashion. The Applicants point out that they are not making a procedural fairness argument based on the lack of reasons provided by the CNSC, but rather submit that the inadequacy of the reasons provided gives rise to the fatal flaw of the decision to include the impugned provisions in the RegDoc (*Vavilov* at para 133).

[206] The Respondents counter that the extensive CTR reveals an internally coherent and rational chain of analysis in accordance with *Vavilov*, and that the CNSC adequately addressed stakeholder concerns with respect to *Charter* rights. They rely on *Sketchley v Canada (Attorney General)*, 2005 FCA 404 at para 37 and *Gupta v Canada (Attorney General)*, 2016 FC 1089 at para 17, to submit that when a decision-maker can adopt recommendations from a body which assists it in its duties, those recommendations form a part of the decision and thus formal reasons are not required.

[207] In addition, the Respondents argue that the Commission is not a quasi-judicial tribunal, but can have a quasi-judicial role, and carry out functions such as providing punishments when it acts as a court of record under sections 20 and 48 of the *Act*. However, the creation of regulatory documents, such as the RegDoc, which serve to create new licensee requirements relating to pre-placement and random testing, falls squarely within the Commission's regulatory and administrative role, which does not require it to issue formal reasons.

[208] The SCC addressed the sufficiency of reasons at para 103 of *Vavilov*:

> [103] While, as we indicated earlier (at paras. 89-96), formal reasons should be read in light of the record and with due

> sensitivity to the administrative regime in which they were given, a decision will be unreasonable if the reasons for it, read holistically, fail to reveal a rational chain of analysis or if they reveal that the decision was based on an irrational chain of analysis: see *Wright v. Nova Scotia (Human Rights Commission)*, 2017 NSSC 11, 23 Admin. L.R. (6th) 110; *Southam*, at para. 56. A decision will also be unreasonable where the conclusion reached cannot follow from the analysis undertaken (see *Sangmo v. Canada (Minister of Citizenship and Immigration)*, 2016 FC 17, at para. 21 (CanLII)) or if the reasons read in conjunction with the record do not make it possible to understand the decision maker's reasoning on a critical point.

[209] I find that the documents in the CTR provide a rational chain of analysis to justify the inclusion of the pre-placement and random testing provisions in the RegDoc. As discussed above, the inclusion of these provisions was in response to an identified need to bolster fitness for duty programs, particularly with respect to the detection of drug and alcohol impairment.

[210] While the Applicants argue that "the reasons in conjunction with the record do not make it possible to understand the decision maker's reasons on a critical point" – that point being responsiveness to concerns about the *Charter* – I find that both the record before me and the regulatory scheme of the RegDoc show that the CNSC not only considered stakeholder concerns about *Charter* rights, but also addressed these concerns by modifying the RegDoc after considering the stakeholder feedback.

[211] Specifically, CNSC staff created "Comments Tables" to collect all the comments provided in the public feedback process from stakeholders, which included feedback from many of the Applicants and Employers, in addition to the responses to the feedback in the form of comments from CNSC staff. The Comments Tables were published on the CNSC's website for

public consultation during the development phase of the RegDoc. They form part of the reasons for the Commission's decision and show that CNSC staff reasonably considered and addressed *Charter* rights.

[212] In their responses to stakeholder comments, CNSC staff explained how the RegDoc balanced privacy interests with the CNSC's mandate to prevent unreasonable risk in various ways, including the environment, to public health and safety, and to national security, arising from the development production and use of nuclear energy.

[213] Furthermore, the statutory scheme of the final version of the RegDoc shows changes from earlier versions as being directly responsive to stakeholder concerns. The modifications made in response to public feedback include the narrowing of the categories of workers affected by the pre-placement and random testing provisions, the inclusion of the duty to accommodate, and the consideration of the *Canadian Human Rights Act*, RSC, 1985, c H-6.

[214] The flaws that the Applicants point to in the CNSC's reasons are "merely superficial or peripheral to the merits of the decision" (*Vavilov* at para 100). They have pointed to missing documents in the CTR, even though CNSC staff testified in cross-examination that these documents were sent to the Commission by staff. They also point to contradictory statements made by the Employers about the efficacy of testing methods and the sufficiency of existing impairment detection methods at the time – statements which were made over the course of the decade-long development of the RegDoc. None of these alleged flaws, in my opinion, are enough to show that the CNSC's decision to implement the RegDoc was based on an irrational

chain of analysis given the totality of the evidence before the Court, including the Reports discussed above.

V. Costs

[215] The Parties have jointly submitted that costs be awarded in a lump sum of $20,000 to either the collective group of Applicants or Respondents who prevail in this judicial review. Accordingly, the Applicants shall pay an inclusive lump sum of $20,000 to the Respondents.

VI. Conclusion

[216] For the reasons outlined above, I find the pre-placement and random testing provisions, sections 5.1 and 5.5 respectively, of the RegDoc pass constitutional muster, in that they do not breach sections 8, 15 or 7 of the *Charter*. I also find that the CNSC's decision to adopt the pre-placement and random testing provisions was reasonable from an administrative law perspective. The Application for Judicial Review is accordingly dismissed. Costs are issued to the Respondents in the amount of $20,000.

JUDGMENT in T-1222-21

THIS COURT'S JUDGMENT is that:

1. The pre-placement and random testing provisions of the RegDoc (sections 5.1 and 5.5 respectively) do not infringe sections 8, 15 or 7 of the *Charter*.
2. The CNSC's decision to adopt sections 5.1 and 5.5 of the RegDoc was reasonable.
3. The Application for Judicial Review is dismissed.
4. The Applicants shall pay an inclusive lump sum of $20,000 in costs to the Respondents.

"Alan S. Diner"

Judge

ANNEX A
***Nuclear Safety and Control Act*, SC 1997, c 9**
***Loi sur la sûreté et la réglementation nucléaires*, LC 1997, ch 9**

Objects	**Mission**
9 The objects of the Commission are	**9** La Commission a pour mission :
(a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to	**a)** de réglementer le développement, la production et l'utilisation de l'énergie nucléaire ainsi que la production, la possession et l'utilisation des substances nucléaires, de l'équipement réglementé et des renseignements réglementés afin que :
(i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,	**(i)** le niveau de risque inhérent à ces activités tant pour la santé et la sécurité des personnes que pour l'environnement, demeure acceptable,
(ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and	**(ii)** le niveau de risque inhérent à ces activités pour la sécurité nationale demeure acceptable,
(iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and	**(iii)** ces activités soient exercées en conformité avec les mesures de contrôle et les obligations internationales que le Canada a assumées;
(b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the	**b)** d'informer objectivement le public — sur les plans scientifique ou technique ou en ce qui concerne la réglementation du domaine de l'énergie nucléaire — sur ses activités et sur les conséquences, pour la santé et

development, production, possession and use referred to in paragraph (a).

la sécurité des personnes et pour l’environnement, des activités mentionnées à l’alinéa a).

[…]

[…]

Licences

Licences et permis

Licenses

Catégories

24 (1) The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26(a) to (f) that is specified in the licence for the period that is specified in the licence.

24 (1) La Commission peut établir plusieurs catégories de licences et de permis; chaque licence ou permis autorise le titulaire à exercer celles des activités décrites aux alinéas 26a) à f) que la licence ou le permis mentionne, pendant la durée qui y est également mentionnée.

Application

Demande

(2) The Commission may issue, renew, suspend in whole or in part, amend, revoke or replace a licence, or authorize its transfer, on receipt of an application

(2) La Commission peut délivrer, renouveler, suspendre en tout ou en partie, modifier, révoquer ou remplacer une licence ou un permis ou en autoriser le transfert lorsqu’elle en reçoit la demande en la forme réglementaire, comportant les renseignements et engagements réglementaires et accompagnée des pièces et des droits réglementaires.

(a) in the prescribed form;

(b) containing the prescribed information and undertakings and accompanied by the prescribed documents; and

(c) accompanied by the prescribed fee.

[…]

[…]

Conditions for issuance, etc.

(4) No licence shall be issued, renewed, amended or replaced — and no authorization to transfer one given — unless, in the opinion of the Commission, the applicant or, in the case of an application for an authorization to transfer the licence, the transferee

(a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and

(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Terms and conditions of licences

(5) A licence may contain any term or condition that the Commission considers necessary for the purposes of this Act, including a condition that the applicant provide a financial guarantee in a form that is acceptable to the Commission.

[…]

Conditions préalables à la délivrance

(4) La Commission ne délivre, ne renouvelle, ne modifie ou ne remplace une licence ou un permis ou n’en autorise le transfert que si elle est d’avis que l’auteur de la demande ou, s’il s’agit d’une demande d’autorisation de transfert, le cessionnaire, à la fois :

a) est compétent pour exercer les activités visées par la licence ou le permis;

b) prendra, dans le cadre de ces activités, les mesures voulues pour préserver la santé et la sécurité des personnes, pour protéger l’environnement, pour maintenir la sécurité nationale et pour respecter les obligations internationales que le Canada a assumées.

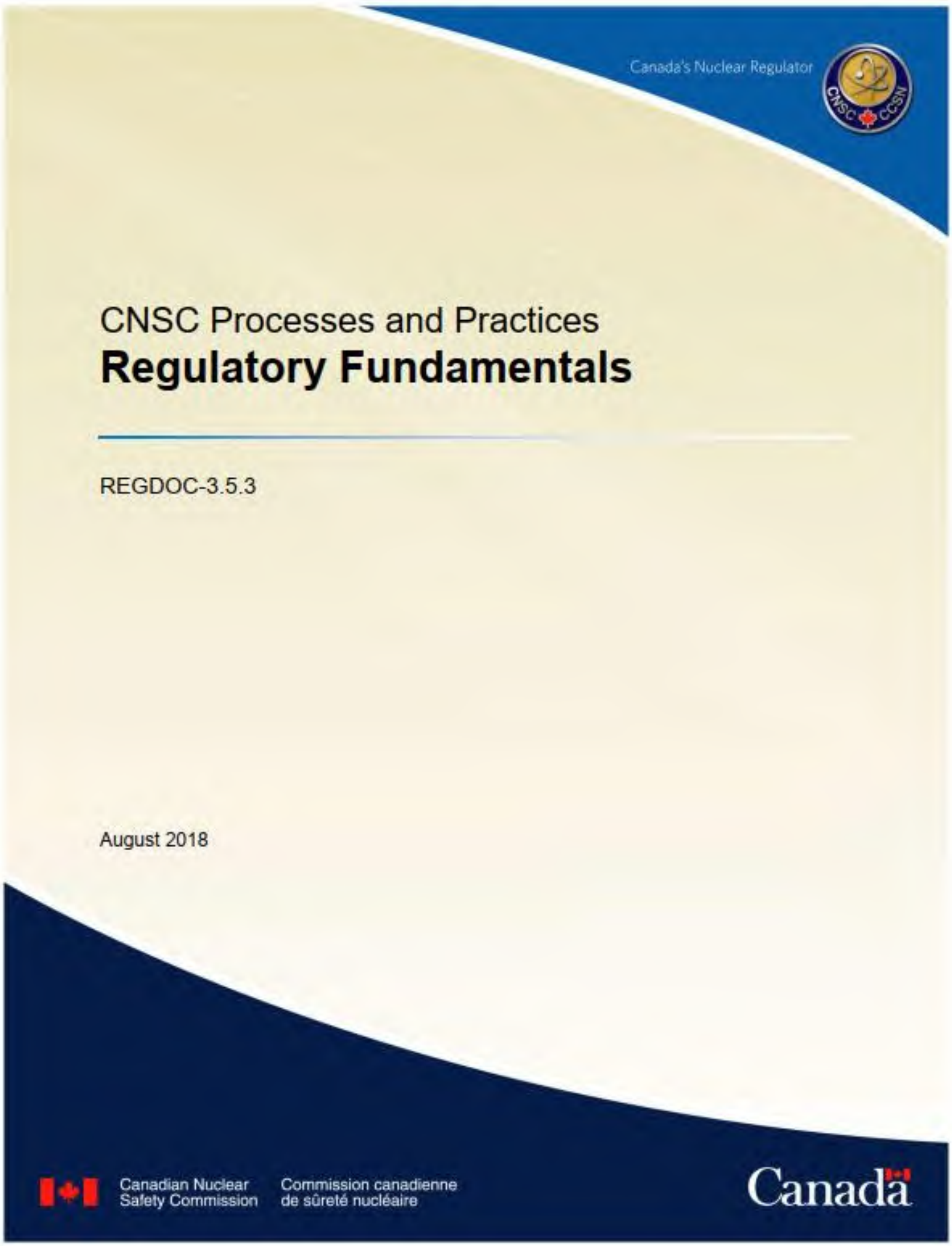
Conditions des licences et des permis

(5) Les licences et les permis peuvent être assortis des conditions que la Commission estime nécessaires à l’application de la présente loi, notamment le versement d’une garantie financière sous une forme que la Commission juge acceptable.

[…]

Renewal, etc.	**Renouvellement, suspension et révocation**
25 The Commission may, on its own motion, renew, suspend in whole or in part, amend, revoke or replace a licence under the prescribed conditions.	**25** La Commission peut, de sa propre initiative, renouveler, suspendre en tout ou en partie, modifier, révoquer ou remplacer une licence ou un permis dans les cas prévus par règlement.
Regulations	**Règlements**
44 (1) The Commission may, with the approval of the Governor in Council, make regulations	**44 (1)** Avec l’agrément du gouverneur en conseil, la Commission peut, par règlement :
[…]	[…]
(h) respecting the protection of nuclear energy workers, including prescribing	**h)** régir la protection des travailleurs du secteur nucléaire, notamment :
[…]	[…]
(iii) medical examinations or tests and the circumstances under which they are to be conducted on persons so employed, and	**(iii)** déterminer les examens médicaux et les tests qu’une telle personne doit subir et les circonstances dans lesquelles elle doit les subir,

ANNEX B
REGDOC-2.2.4, Fitness for Duty, Volume II: Managing Alcohol and Drug Use Version 3



Canada's Nuclear Regulator

CNSC CCSN

CNSC Processes and Practices

Regulatory Fundamentals

REGDOC-3.5.3

August 2018

Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Canada

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Preface

The Canadian Nuclear Safety Commission (CNSC) is the federal organization responsible for regulating the use of nuclear energy and materials in Canada. It regulates to protect health, safety, security and the environment, and to implement Canada's international commitments on the peaceful use of nuclear energy. The CNSC also disseminates objective scientific, technical, and regulatory information to the public.

Regulatory document REGDOC-3.5.3, *Regulatory Fundamentals*, outlines the CNSC's regulatory philosophy and approach to applying the Nuclear Safety and Control Act. It provides information for licensees, applicants and the public, and contains neither guidance nor requirements. It replaces P-299, *Regulatory Fundamentals* (2005) and INFO-0795, *Licensing Basis - Objective and Definitions* (2010).

This regulatory document is part of the CNSC's processes and practices series of regulatory documents, which also covers information on licensing processes, compliance, and enforcement. The full list of regulatory documents is included at the end of this document, and can also be found on the CNSC's website.

Table of Contents

Regulatory Fundamentals

1. Introduction

1.1 Purpose

This regulatory document is intended for information only and does not contain any requirements for CNSC licensees. It describes the CNSC's regulatory approach and philosophy, and outlines how the CNSC applies the *Nuclear Safety and Control Act* (NSCA) and regulations made under the authority of the NSCA in its regulatory oversight. The information in this regulatory document will be of interest to anyone seeking to learn more about the CNSC and how it regulates nuclear activity in Canada.

1.2 Scope

This document describes the CNSC's regulatory activities.

2. About the CNSC

Regulation is a key instrument used by government to enable economic activity and to protect health, safety, security and the environment in Canada. The Government of Canada has determined that the use of nuclear substances and nuclear energy offers benefits, and that the associated risks must not be at an unreasonable level. These two facts drive the need for Canadian legislation and a regulatory body to oversee nuclear activities in Canada.

The NSCA came into force on May 31, 2000. It establishes the Canadian Nuclear Safety Commission (CNSC), its objects, and the framework under which it can effectively and independently meet those objects. The CNSC was established in 2000 under the NSCA and reports to Parliament through the Minister of Natural Resources. The CNSC replaced the former Atomic Energy Control Board, which was founded in 1946.

The CNSC is the sole authority in Canada to regulate the development, production and use of nuclear energy, and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to prevent unreasonable risk. The CNSC's mandate also requires it to disseminate objective scientific, technical and regulatory information to the public.

Parliament has also given the CNSC the authority to conduct environmental assessments under the *Canadian Environmental Assessment Act, 2012*.

The CNSC has also been delegated authority to implement Canada's agreement with the International Atomic Energy Agency on nuclear safeguards verification. For more information, see the *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* [1] and the *Protocol Additional to the Agreement between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*[2].

2.1 The Commission

The Commission[1] is an independent, quasi-judicial tribunal and a court of record, with the powers, rights, and privileges necessary to carry out its duties and enforce its orders. It has a central role in CNSC operations, and operates at arm's length from the government with no ties to the nuclear industry.

The Commission has up to seven permanent members, who are appointed by the Governor in Council for terms of up to five years. One member is designated as President of the Commission and Chief Executive Officer of the CNSC.

Subject to the approval of the Governor in Council[2], the Commission may make and amend regulations as it deems necessary for attaining the objects of the NSCA. The Commission is also empowered to grant licences to conduct nuclear activities. Commission decisions are science- and safety-based; they may not be overturned by the Government of Canada, and they are reviewable only by the Federal Court of Canada. These measures help ensure the independence of the Commission.

The Governor in Council may issue directives to the CNSC. Any such directive may only be of general application on broad policy matters with respect to the objects of the Commission, and not in respect of a particular case before the Commission.

To maintain its adjudicative distance from CNSC staff, the Commission communicates with staff only through the Commission Secretariat and through formal proceedings. This separation serves to maintain the Commission's independence.

2.2 CNSC staff

The Commission employs the staff it considers necessary for the purposes of the NSCA.

The CNSC has highly skilled scientific, technical, professional and administrative personnel who carry out the work necessary to fulfill the Commission's mandate. CNSC staff perform several functions such as:

- conducting expert research and analysis
- verifying licensee compliance with regulatory requirements
- conducting activities to enforce licensee compliance, when necessary
- preparing material, known as Commission member documents (CMDs), for the Commission and appearing before the Commission at proceedings to answer questions
- carrying out a wide range of internal activities that enable the success of the CNSC's core operational work

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[1] In this document, the term "Commission" refers to the appointed members forming the Commission.
[2] In Canada, the Governor in Council is the Governor General acting on the advice of Cabinet.

The Commission may also enter into contracts for services to receive advice and assistance in the exercise or performance of any of its powers, duties or functions under the NSCA.

2.3 What the CNSC regulates

The CNSC regulates the conduct of activities related to the use, production and distribution of nuclear energy and substances as defined by section 26 of the NSCA. This includes activities related to:

- uranium mines and mills
- uranium fuel fabrication and processing
- nuclear power plants
- nuclear substance processing
- industrial and medical applications
- nuclear research and educational activities
- transportation of nuclear substances
- nuclear security and safeguards
- import and export activities
- waste management facilities

3. The CNSC's Regulatory Framework

The CNSC's regulatory framework (see figure 1) consists of the *Nuclear Safety and Control Act* (NSCA) and other laws passed by Parliament that govern the regulation of Canada's nuclear industry, as well as regulations, licences and documents that the CNSC uses to regulate the industry.

Figure 1: Key elements of the CNSC's regulatory framework

The regulatory framework also includes guidance, which is used to inform the applicant or licensees on how to meet requirements, elaborate further on requirements, or provide best practices. While the CNSC sets requirements and provides guidance on how to meet requirements, an applicant or licensee may put forward a case to demonstrate that the intent of a requirement is addressed by other means. Such a case must be demonstrated with supportable evidence. CNSC staff consider guidance when evaluating the adequacy of any case submitted. This does not mean that the requirement is waived; rather, it is an indication that the regulatory framework provides flexibility for licensees to propose alternative means of achieving the intent of the requirement. The Commission is always the final authority as to whether the requirement has been met.

CNSC requirements and guidance take into account international regulatory best practices and modern codes and standards, and align with the International Atomic Energy Agency's Safety Fundamentals and Safety Requirements. The CNSC cooperates with other organizations and jurisdictions to foster the development and application of a consistent, effective regulatory framework in Canada and for international nuclear regulators. The CNSC welcomes stakeholder feedback on its regulatory framework at any time.

Further information on the CNSC's regulatory framework can be found on the CNSC's Regulatory framework overview Web page.

3.1 The *Nuclear Safety and Control Act*

The NSCA establishes the CNSC's mandate to regulate the development, production, and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in Canada.

The mandate of the CNSC is informed by the objects of the Commission, set out in section 9 of the NSCA, which are:

> (a) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information in order to
>
> (i) prevent unreasonable risk, to the environment and to the health and safety of persons, associated with that development, production, possession or use,
> (ii) prevent unreasonable risk to national security associated with that development, production, possession or use, and
> (iii) achieve conformity with measures of control and international obligations to which Canada has agreed; and
>
> (b) to disseminate objective scientific, technical and regulatory information to the public concerning the activities of the Commission and the effects, on the environment and on the health and safety of persons, of the development, production, possession and use referred to in paragraph (a).

When making licensing decisions, the Commission is guided by section 24, paragraph 4 of the NSCA, which states:

> No licence shall be issued, renewed, amended or replaced — and no authorization to transfer one given — unless, in the opinion of the Commission, the applicant or, in the case of an application for an authorization to transfer the licence, the transferee

(a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and
(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

3.2 Regulations made under the *Nuclear Safety and Control Act*

The regulations made under the NSCA provide further legislative authority with respect to topic-specific considerations, using a combination of prescriptive and performance-based approaches. Prescriptive approaches tell licensees exactly what they need to do to meet requirements, whereas performance-based approaches set specific performance measures that licensees must meet with respect to particular aspects of their licensed activities.

There are 13 regulations under the NSCA, including the *General Nuclear Safety and Control Regulations* and the *Radiation Protection Regulations*. Regulations under the NSCA describe the general application of requirements for nuclear activity in Canada, and also provide requirements for Class I and Class II nuclear facilities, uranium mines and mills, and the use of nuclear substances. The Canadian Nuclear Safety Commission By-laws and the *Canadian Nuclear Safety Commission Rules of Procedure* define the management and conduct of the Commission's affairs.

More information about all regulations under the NSCA can be found on the List of regulations on the CNSC website.

3.3 Licences and certificates

3.3.1 Licences

Section 26 of the NSCA describes activities that no person shall conduct except in accordance with a licence. The NSCA gives the Commission the power to grant licences for these activities.

All applicable licence conditions are reflected in the respective licence, including those that require the licensee to ensure that qualified personnel carry out the licensed activities, and that adequate provision is made for the protection of the environment, the health and safety of persons, and the maintenance of Canada's domestic and international obligations.

For more information on licensing, see section 6.1 of this document.

3.3.2 Certificates

The CNSC also issues certificates for people to carry out prescribed duties and for the use of prescribed equipment, and for the packaging and transport of nuclear substances. In each case, the certificate sets out applicable regulatory requirements. See section 5.4 for more information on certification.

3.4 CNSC regulatory documents and industry standards

In addition to the NSCA and the regulations made under it, the CNSC has developed regulatory documents, which are a key part of its regulatory framework for nuclear activities in Canada. They provide additional clarity to licensees and applicants by explaining how to meet the requirements set out in the NSCA and the regulations made under it. Regulatory documents are organized into three key categories: regulated facilities and activities, safety and control areas, and other areas of regulatory engagement.

The CNSC maintains an efficient and streamlined regulatory framework by making appropriate use of industry standards. These include, but are not limited to, standards created by independent, third-party standard-setting organizations such as the CSA Group, the American Society of Mechanical Engineers, the International Commission on Radiological Protection and the Institute of Electrical and Electronics Engineers. Industry or international standards may be referenced in CNSC regulatory documents.

More information about the CNSC's regulatory documents and CSA Group nuclear standards can be found on the CNSC's Regulatory documents Web page.

3.5 Safety and control areas

Safety and control areas (SCAs) are the technical topics that CNSC staff use to assess, review, verify and report on regulatory requirements and performance across all regulated facilities and activities. By providing a common language and architecture, SCAs improve understanding and communication within the CNSC, as well as between the CNSC and licensees, the Commission and other stakeholders. The CNSC's 14 SCAs are organized in three functional areas: management, facility and equipment, and core control processes.

SCAs do not constrain the CNSC in its conduct of regulatory oversight activities. Additional topics may be added as needed to provide satisfactory assurance of compliance.

Appendix B provides a table that lists the SCAs and their respective specific areas.

3.6 Role of consultation in the regulatory framework

Consultation with the public, licensees and other stakeholders is an integral component of developing the CNSC's regulatory framework. Regulations and regulatory documents published by the CNSC are generally subject to a formal public consultation process. Meetings and workshops may be organized to engage stakeholders and solicit feedback on the development of regulatory policies, requirements and guidance, and on what regulatory instruments are appropriate.

When proposing changes to the regulatory framework, the CNSC uses a variety of means to actively seek input from licensees, the public, non-governmental organizations, all levels of government, and international stakeholders. All input gained from these activities is considered when the CNSC develops and maintains its regulatory instruments. The CNSC uses discussion papers to solicit early feedback from stakeholders about the development of new or amended regulations, and when it is considering new areas of oversight or exercising its existing regulatory authority in a new manner.

The CNSC communicates openly and transparently with stakeholders, while respecting Canada's access to information and privacy laws. It consults stakeholders when establishing priorities, developing policies and planning programs and services. The CNSC also cooperates with other jurisdictions to increase efficiency and effectiveness; for example, entering into formal arrangements where appropriate.

4. Public and Aboriginal engagement

4.1 Commission proceedings

Commission proceedings include public hearings and public meetings. At public hearings, the Commission hears information pertaining to the making of licensing and certification decisions. Public meetings are used to brief the Commission about significant developments that affect the nuclear regulatory process, or to ask the Commission to make administrative decisions or deal with administrative issues.

Interested parties can be heard in the public hearing process. With respect to public meetings, interested parties are invited to observe, but do not usually participate. Hearings and meetings can also be viewed online as webcasts.

4.2 Dissemination of objective scientific, technical and regulatory information

As part of its mandate to disseminate objective scientific, technical, and regulatory information, the CNSC informs the public about the development, production, possession, transport and use of nuclear substances on an ongoing basis. This is accomplished through various means, including:

- regulatory documents, decisions, reports, and plans posted to the CNSC website
- public Commission hearings and meetings
- live webcasts during Commission hearings and meetings
- social media platforms (YouTube, Facebook, Twitter and LinkedIn) and online resources (available on the CNSC website) that provide technical and scientific information in plain language
- public information sessions
- public consultation on, and publication of, regulations and regulatory documents
- sessions across Canada, to familiarize people with the CNSC and its role, and how they can participate in CNSC regulatory processes

In addition, the CNSC encourages its experts to share their knowledge, and it publishes scientific and technical paper abstracts, as well as journal articles authored by CNSC staff on its website. Staff also attend national fairs and conferences that specifically target youth, municipalities, and the medical community. This ongoing dialogue is important for increasing public understanding and trust in the CNSC.s role of protecting Canadians, their health, and the environment.

4.3 Aboriginal consultation and engagement

The CNSC seeks opportunities to work with Indigenous Peoples to understand any concerns they may have about the nuclear sector, and to ensure the safe and effective regulation of nuclear energy and materials.

As an agent of the Crown, the CNSC is responsible for fulfilling its legal duty to consult, and where appropriate, accommodate Indigenous Peoples when its decisions may have an adverse impact on potential or established Aboriginal and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*.

The CNSC's approach to Aboriginal consultation includes commitments to uphold the honour of the Crown through information sharing, relationship building and promoting reconciliation, as well as to meeting its common-law duty to consult. The CNSC supports a coordinated, whole-of-government approach to improve the efficiency and effectiveness of the consultation process.

The CNSC cannot delegate its obligation, but can assign procedural aspects of the consultation process to licensees. In many cases, licensees are best positioned to collect information and propose any appropriate additional measures. The information collected and measures proposed by licensees to avoid, mitigate or offset adverse impacts is used by the CNSC in meeting its obligations and in its efforts toward reconciliation.

For further information on the CNSC's approach to Indigenous consultation and engagement, see REGDOC-3.2.2, *Aboriginal Engagement* [3].

5. The CNSC's Regulatory Approach

As discussed earlier in this document, the CNSC regulates to prevent unreasonable risk to the environment, the health and safety of persons, and national security. To this end, the CNSC has established a licensing and compliance system to ensure that all persons who use or possess nuclear substances and radiation devices do so in accordance with a licence, and that regulated parties have safety and security provisions in place that ensure compliance with regulatory requirements.

This section addresses the major elements that comprise the CNSC's regulatory approach.

5.1 Regulatory philosophy

The CNSC's regulatory philosophy is based on the following:

- Licensees are directly responsible for managing regulated activities in a manner that protects health, safety, security and the environment, and that conforms with Canada's domestic and international obligations on the peaceful use of nuclear energy.
- The CNSC is accountable to Parliament and to Canadians for assuring that these responsibilities are properly discharged.

The CNSC therefore ensures that regulated parties are informed about requirements and provided with guidance on how to meet them, and then verifies that all regulatory requirements are and continue to be met.

5.2 Continuous improvement

The CNSC is committed to continuous improvement of both its internal operations and its regulation of the Canadian nuclear industry. The CNSC therefore requires licensees to strive to further reduce the risks associated with their licensed activities on an ongoing basis. It assesses how licensees manage risk during both normal operations and in response to potential accident conditions applying concepts such as the ALARA[3] principle and defence in depth (see section 4.3,). In its assessments, the CNSC considers how licensees continuously evaluate, manage, and further reduce uncertainties with respect to hazards and safety issues. This also includes assessing how licensees consider additional safety and mitigation options as techniques and technologies evolve.

5.3 Defence in depth

CNSC requirements necessitate the implementation of defence in depth (DiD) in the design, construction and operation of nuclear facilities or the undertaking of nuclear activities. With DiD, more than one level of defence (i.e., protective measure) is in place for a given safety objective, so that the objective will still be achieved even if one of the protective measures fails.

To achieve this, multiple independent level of defence must be put into place to the extent practicable, taking organizational, behavioural, and engineered safety and security elements into account, such that no potential human or mechanical failure relies exclusively on a single level of defence.

DiD applies to a wide range of facilities and activities. Appendix A illustrates how the different levels are defined for nuclear power plants.

5.3.1 Emergency preparedness

With regard to emergency preparedness and response, the CNSC has multiple emergency-related roles that translate to reducing risk in the event of an emergency. The CNSC regulates licensees' onsite emergency plans at nuclear facilities, ensures that applicants provide support to and have arrangements in place with offsite authorities (such as municipal and provincial governments), and is also part of the whole-of-government approach to federal nuclear emergency planning.

In the unlikely event of a nuclear emergency, the CNSC's role is to monitor and evaluate the actions of any nuclear operators involved, provide technical advice and regulatory directives when required, and inform the government and the public of its assessment of the situation. The CNSC's emergency preparedness program ensures well-coordinated, suitable responses to emergencies by integrating with nuclear operators; municipal, provincial and federal government agencies; first responders; and international organizations. The program is regularly tested through exercises that involve simulated incidents in coordination with licensees and government agencies.

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[3]A principle of radiation protection that holds that exposures to radiation are kept as low as reasonably achievable (ALARA) , social and economic factors taken into account. Section 4 of the *Radiation rotection Regulations* stipulates licensee requirements with respect to ALARA. A similar principle, best available technology and techniques economically achievable (BATEA), may also be applied to releases of hazardous substances.

5.4 Graded approach

The graded approach is a systematic method or process by which elements such as the level of analysis, the depth of documentation and the scope of actions necessary to comply with requirements are commensurate with:

- the relative risks to health, safety, security, the environment and the implementation of international obligations to which Canada has agreed
- the particular characteristics of a nuclear facility or licensed activity

The CNSC applies the graded approach to licensing and compliance activities.

This approach is driven primarily by assessment of the risk associated with the activities being regulated, and the performance history of the licensee.

The degree of oversight is also informed by:

- the complexity and potential harm posed by the licensed activity
- technical assessments of submissions
- relevant research
- information supplied by parties to Commission proceedings
- international activities that advance knowledge in nuclear and environmental safety
- cooperation with other regulatory bodies

When applying the risk-informed approach, the following principles are adhered to:

- the meeting of regulatory requirements
- the maintenance of sufficient safety margins
- the maintenance of defence in depth

If a licensee cannot achieve the required level of safety, it will not be permitted in any case to continue conducting its licensed activities.

5.5 Protection of the environment

Environmental protection is a shared federal–provincial responsibility. The CNSC cooperates with other jurisdictions and departments and, where appropriate, enters into formal arrangements to protect the environment more effectively and to coordinate regulatory oversight.

The CNSC's environmental protection mandate includes design objectives and best practices to minimize or eliminate the release of nuclear or hazardous substances to the environment. Environmental protection measures are commensurate with the level of risk associated with the activity. The CNSC determines whether a licensee or applicant will make adequate provision to protect the environment against unreasonable risk, and verifies compliance with associated regulatory requirements.

For further information on environmental protection, see REGDOC-2.9.1, *Environmental Principles, Assessments and Protection Measures* [4].

5.6 Protection of the health and safety of persons

The CNSC sets dose limits that are within the protective health limits and establishes regulations that set requirements to prevent unreasonable risk to the health and safety of persons. These limits are described in the *Radiation Protection Regulations* and are consistent with the recommendations of the International Commission on Radiological Protection (ICRP).

The *Radiation Protection Regulations* also require every licensee to implement a radiation protection program that takes into consideration the ALARA principle.

In addition to radiological hazards, regulating to prevent unreasonable risk to the health and safety of persons addresses conventional health and safety hazards.

5.7 Protection of national security

To prevent risk to national security, the CNSC works closely with nuclear facility operators, law enforcement and intelligence agencies, international organizations, and other governmental departments to ensure that nuclear substances and facilities are adequately protected. Nuclear security in Canada is aided by the *Nuclear Security Regulations* under the *Nuclear Safety and Control Act*. These regulations set out detailed security requirements for licensed nuclear facilities and other regulated activities.

5.8 International obligations

The CNSC participates in international fora to provide global nuclear leadership and to benefit from international experience and best practices. It also participates in undertakings implemented by the International Atomic Energy Agency (IAEA) (for example, IAEA peer reviews), the ICRP and other international organizations, as well as in activities under certain treaties such as the *Convention on Nuclear Safety* [5].

These international activities help inform the CNSC's decision-making processes to:

- understand and compare various ways of evaluating and mitigating risks
- share research and operational experience

5.9 Nuclear non-proliferation

The CNSC is responsible for implementing Canada's nuclear non-proliferation commitments and government policy:

- to assure Canadians and the international community that Canada's nuclear exports do not contribute to the development of nuclear weapons or other nuclear explosive devices
- to promote a more effective and comprehensive international nuclear non-proliferation regime

The international *Treaty on the Non-Proliferation of Nuclear Weapons* [6] (NPT) is the cornerstone of Canada's efforts to promote its objectives of international disarmament, non-proliferation, and the peaceful use of nuclear energy. NPT commitments to which Canada has agreed include:

- to not receive, manufacture, or acquire nuclear weapons or other nuclear explosive devices

- to accept IAEA safeguards on all nuclear material for peaceful use in Canada
- to ensure that Canada's nuclear material exports are subject to IAEA oversight

The CNSC implements these commitments through the NSCA and corresponding regulations, including the *Nuclear Non-proliferation Import and Export Control Regulations*.

5.10 Safeguards

The term "safeguards" refers to the measures taken by the IAEA, in accordance with the NPT, to verify that nuclear material is not diverted from peaceful uses to the development of nuclear weapons. The safeguards agreements between the Government of Canada and the IAEA give the IAEA the right and obligation to monitor Canada's nuclear-related activities, and to verify nuclear material inventories and flows in Canada.

Through its regulatory oversight, the CNSC ensures that all applicable licensees have safeguards programs in place to allow for:

- monitoring and reporting on nuclear material and activities
- providing IAEA safeguards inspectors with access to areas where nuclear material is stored, and to certain specified nuclear-related manufacturing and research activities
- providing operational and design information for nuclear facilities to the IAEA

Where required by the safeguards agreements, the CNSC compiles licensee information and submits it to the IAEA on behalf of the Government of Canada. The CNSC also cooperates with the IAEA in developing new safeguards approaches for Canadian facilities, and contributes to efforts to strengthen IAEA safeguards internationally.

6. Licensing and Certification

The Commission makes independent, objective and risk-informed decisions, taking into consideration all of the information provided by applicants, stakeholders, Indigenous peoples, and staff. CNSC staff make recommendations to the Commission based on thorough assessment of factual evidence. The Commission recognizes the role of professional judgment, particularly in areas where no objective standards exist.

6.1 Licensing

The licensing process consists of submission of a licence application, an assessment of the application by CNSC staff, and a decision by the Commission. The CNSC considers both the complexity of the nuclear activity and the regulatory approach determined to be the most appropriate, given the relative risks.

6.1.1 Licensing basis

The licensing basis sets the boundary conditions for a regulated activity, and establishes the basis for the CNSC's compliance program for that regulated activity.

All licensees are required to conduct their activities in accordance with the licensing basis, which is defined as a set of requirements and documents for a regulated activity comprising the following:

1. The regulatory requirements set out in the applicable laws and regulations
2. The conditions and safety and control measures described in the licence, and the documents directly referenced in that licence
3. The safety and control measures described in the licence application and the documents needed to support that licence application

Documents needed to support the licence application are those documents that demonstrate that the applicant is qualified to carry out the licensed activity, and that appropriate provisions are in place to protect worker and public health and safety, to protect the environment, and to maintain national security and measures required to implement international obligations to which Canada has agreed. Examples are detailed documents supporting the design, safety analyses and all aspects of operation to which the licensee makes reference, documents describing conduct of operations, and documents describing conduct of maintenance.

6.1.2 Licence conditions handbook

The CNSC's licensing regime includes the licence conditions handbook (LCH), which is a companion piece to interpret a licence. The general purpose of the LCH is, for each licence condition, to clarify the regulatory requirements and other relevant parts of the licensing basis.

The LCH, which should be read in conjunction with the licence, provides compliance verification criteria that the licensee must follow to comply with licence conditions, operational limits and information on delegation of authority and applicable versions of documents referenced in the licence. The LCH also provides non-mandatory recommendations and guidance on how to comply with licence conditions and criteria.

6.2 Certification

Certification applies to persons carrying out prescribed duties and the use of prescribed equipment, and to the packaging and transport of nuclear substances.

6.2.1 Certification of persons

Positions identified in regulations or a licence must hold a CNSC certification. The purpose of personnel certification is to regulate personnel who are assigned to positions that have a direct impact on the safe operation of a facility, or on the health and safety of workers, the public or the environment.

The CNSC's regulatory framework defines CNSC requirements and expectations for certification processes, including the qualifications, training, and examinations necessary to become certified, and the work experience, training and testing necessary to maintain a certification.

6.2.2 Certification of prescribed equipment

Certification of equipment is an attestation from the CNSC that prescribed equipment[4] is safe for use by qualified personnel. No prescribed equipment – barring exemptions such as smoke detectors and other equipment with a very small amount of a nuclear substance – can be used in Canada unless it is certified model or used in accordance with a CNSC licence.

6.2.3 Certification of transport packaging

The CNSC issues licences and certificates for packaging and transport of nuclear substances, as stipulated in the *Packaging and Transport of Nuclear Substances Regulations, 2015* (PTNSR 2015). These regulations are based on the IAEA's *Regulations for the Safe Transport of Radioactive Material* (2012 Edition) (IAEA Regulations).

The CNSC's REGDOC-2.14.1, *Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015*,[7] helps the regulated community comply with the PTNSR 2015. REGDOC-2.14.1 links provisions in the regulations to relevant content in the IAEA Regulations, the *Nuclear Safety and Control Act* (NSCA), other CNSC regulations, and other related information.

The CNSC regulates all aspects of the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages. In addition, the PTNSR 2015 require certain types of package design to be certified by the CNSC before being used in Canada. The PTNSR 2015 also provide for the certification of special form radioactive material confirming that the sealed source containing the radioactive material is designed to be strong enough to maintain leak tightness under the conditions of use and wear for which the sealed source was designed.

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[4]Prescribed equipment is defined as the equipment prescribed by section 20 of the *General Nuclear Safety and Control Regulations*.

Note 1: Section 20 of the *General Nuclear Safety and Control Regulations* states that each of the following items is prescribed equipment for the purposes of the *Nuclear Safety and Control Act* (NSCA):

(a) a package, special form radioactive material, low dispersible radioactive material, fissile-excepted radioactive material, radioactive material that has a basic radionuclide value that is not listed in the IAEA Regulations and an instrument or article that has an alternative activity limit for an exempt consignment, as those terms are defined in subsection 1(1) of the *Packaging and Transport of Nuclear Substances Regulations, 2015*;
(b) a radiation device and a sealed source, as defined in section 1 of the *Nuclear Substances and Radiation Devices Regulations*;
(c) Class II prescribed equipment, as defined in section 1 of the *Class II Nuclear Facilities and Prescribed Equipment Regulations*; and
(d) equipment that is capable of being used in the design, production, operation or maintenance of a nuclear weapon or nuclear explosive device.

Note 2: All controlled nuclear equipment is prescribed equipment for the purposes of the NSCA, with respect to the import and export of that equipment.

6.3 Pre-licensing and pre-certification engagement

The CNSC provides applicants with the option to engage in pre-licensing or pre-certification activities to facilitate discussion between stakeholders, the CNSC and any other relevant government bodies prior to submitting a licence or certificate application. These interactions may facilitate understanding of regulatory processes and requirements, while also allowing for early identification and resolution of potential regulatory or technical issues. Pre-licensing and pre-certification activities can only inform a licensing or certification process; they do not result in issuance of a licence or certificate under the NSCA, and in no way fetter the Commission's decision-making authority.

Pre-licensing engagement can vary in complexity from process-related questions to technical assessments that provide feedback to a potential applicant. An example of a pre-licensing technical assessment is a CNSC review of a proposed facility design to identify problems and means for their resolution.

Pre-licensing and pre-certification activities may also allow potential regulatory or technical issues to be identified early on, and improve an applicant's understanding of the CNSC's regulatory processes and requirements.

6.4 Application assessment by CNSC staff

When the CNSC receives a licence application, staff evaluate it to determine if the proposed safety and control measures described in the application, and the documents needed to support the application, are adequate meet applicable requirements.

Documents needed to support the licence application are those documents that demonstrate that the applicant is qualified to carry out the licensed activity, and that appropriate provisions will be made to protect worker and public health and safety, to protect the environment, and to maintain national security and measures required to implement international obligations to which Canada has agreed. Examples include detailed documents supporting the design, safety analyses and all aspects of operation to which the applicant makes reference; documents describing conduct of operations; and documents describing conduct of maintenance.

Regulatory documents and industry standards may be referenced in the information supplied by an applicant in support of its licence application, and are used by CNSC staff to evaluate the application. These regulatory documents and standards become part of the licensing basis when referenced in the licence application or its supporting documentation, or when directly referenced in a licence.

Information submitted in support of an application must demonstrate that proposed safety and control measures will meet or exceed CNSC expectations. All submissions are expected to be supported by appropriate analytical, experimental or other suitable evidence. When deciding whether to renew an existing licence, the Commission also considers past performance by verifying compliance history.

Technical assessments are conducted to support licensing, compliance, regulatory decision making and development of regulatory positions. CNSC staff perform these assessments based on the best available science (such as technical knowledge and analytical methods), taking operating experience into consideration. Technical assessments determine whether submitted documents and supporting evidence presented to the CNSC by any stakeholder have a sound technical basis, measured against the CNSC regulatory framework. These assessments address the completeness (coverage and adequacy), comprehensiveness (depth), and the validity of the rationale and technical justification provided in submissions, and are also used to verify licensee compliance with regulatory requirements.

If CNSC staff conclude that an application is not complete or satisfactory, the applicant will be asked to submit additional information. Normally, applications do not proceed to a decision until staff are satisfied with the application.

6.5 Licensing and certification decisions

Licensing decisions include the issuance, refusal, amendment, renewal, suspension, revocation, replacement or transfer of a licence. Certification and decertification are determined by way of certification decisions. The CNSC's independence and transparency in decision making are supported by fair, open, transparent and predictable regulatory processes. Commission hearings provide stakeholders with the opportunity to be heard, and the Commission takes stakeholder input into consideration in its decision-making processes, In addition, the Commission recognizes the role of professional judgment, particularly in areas where no objective standards exist.

The Commission is the overall decision-making authority for all licensing matters. For decisions related to some low-risk facilities or activities, the Commission delegates its decision-making authority to certain CNSC staff members called designated officers (DOs). For more risk-significant facilities and activities, decisions are made by the Commission.

CNSC staff make recommendations to the Commission, and the Commission considers those recommendations along with input from external stakeholders (including the applicant or licensee) in its decision making. The Commission or the DO issues the licence or certificate, adding conditions as appropriate.

If the Commission deems it to be in the public interest to do so, then licensing decisions involve public hearings before the Commission. Commission proceedings are open to the public and are webcast live on the CNSC website.

7. Compliance

Once a license is issued, CNSC staff continue oversight through a compliance program. Compliance is defined as conformity by regulated persons or organizations with the requirements of the *Nuclear Safety and Control Act* (NSCA), the regulations made under the NSCA, licences, certificates, decisions, and orders made by the CNSC.

The licensee bears the primary responsibility for safety at all times, including compliance with regulatory requirements. The CNSC undertakes necessary and reasonable measures to ensure compliance. These measures include influencing compliance awareness, verification and enforcement (see sections 7.2 to 7.4 for more information on compliance verification and enforcement).

The CNSC holds information sessions and communicates with licensees regularly, in order to increase licensees' awareness of their responsibilities and to promote compliance.

7.1 Planning of compliance verification activities

The CNSC's compliance planning process ensures that compliance activities are carried out in a systematic and risk-informed manner. Annual compliance work plans outline the scope, scheduling, resourcing and timeframe for the activities to be undertaken for the next compliance cycle for a particular licence or class of licence.

The CNSC has developed a set of compliance verification activities that are based on the ongoing review of previous compliance findings and operational information. Once approved by the CNSC, any changes proposed by the licensee during the course of the given year are evaluated and documented using a risk-informed approach. Progress reviews are conducted periodically to monitor execution of the plan.

7.2 Compliance verification

The CNSC inspects and reviews operational activities and documentation to verify licensee compliance with requirements. The frequency, scope, type and depth of these inspections and reviews are risk-informed. Where there may be overlap in regulatory oversight with other regulatory bodies, the CNSC coordinates its verification activities to optimize efficiency and reduce administrative burden on licensees.

To evaluate licensee compliance, the CNSC conducts both field verification activities and desktop reviews.

Field verification activities include inspections and other surveillance and monitoring activities. Inspection is the process by which the CNSC inspectors gather data from the site of a licensed activity and analyze the data, for the purpose of confirming that workers, activities, facilities, and equipment are in compliance with the given licensing basis.

CNSC inspections are led by designated inspectors and are planned, controlled, coordinated, consistent and transparent (open to formal scrutiny). Conducted in alignment with the SCAs, the objectives of inspections are defined and communicated to licensees. Licensees are also made aware of inspection criteria, and of the standards of performance and methodologies being used.

Desktop reviews generally entail consideration of documents and reports, such as quarterly technical reports, annual compliance reports, special reports, and documentation related to design, safety analysis, programs and procedures. Licensees are required to provide information to the CNSC through baseline reporting (scheduled) and event reporting. They are also expected to notify the CNSC of changes to operating processes, procedures or programs, or to submit written requests of such changes. In all cases, the CNSC assesses this information to ensure that operations remain within the licensing basis.

Where a deficiency or deviation is either self-identified by the licensee or detected by CNSC staff, the regulated party is expected to address or correct the situation promptly. If necessary, the CNSC may also take enforcement action to compel compliance with regulatory requirements.

7.3 Enforcement

The purpose of enforcement is to compel licensees or regulated persons back into compliance where non-compliance is detected. The CNSC does not take enforcement action to punish, but rather to encourage compliance, to maintain continued safety, and to deter further non-compliance.

The CNSC uses a graded approach to enforcement. Regulated parties typically identify and self-correct non-compliances on an ongoing basis; however, where enforcement is indicated, the appropriate enforcement action for the given situation is determined, taking into account such considerations as:

- the risk significance of the non-compliance with respect to health, safety, security, the environment and international obligations
- the circumstances that lead to the non-compliance (including acts of willfulness)
- the compliance history of the regulated party
- operational and legal constraints (for example, the *Directive to the Canadian Nuclear Safety Commission Regarding the Health of Canadians*)
- industry-specific considerations

Enforcement actions include informal discussion, orders, administrative monetary penalties and legal prosecution. Any enforcement action can be used independently or in combination with others, resulting in a wide range of options for the CNSC.

7.4 Compliance reporting

CNSC staff report to the Commission, the public, licensees, the Government of Canada, the International Atomic Energy Agency, and other interested parties on the results of compliance verification and enforcement activities. Compliance reports document the safety performance of regulated activities, and are based on the CNSC's independent evaluation of compliance and licensee performance.

Appendix A: Levels of Defence in Depth for Nuclear Power Plants

Defence in depth is a principle implemented primarily through a combination of multiple consecutive and independent levels of protection. For nuclear power plants, defence in depth consists of different levels of equipment and procedures to maintain the effectiveness of physical barriers placed between radioactive materials and workers, the public, or the environment. Table A shows an example of the objectives and implementation of each level in a defence-in-depth regime for a nuclear power plant.

Table A: Objectives and implementation of defence in depth for nuclear power plants

Level	Objective	Implementation
1	Normal operation: To prevent deviations from normal operation, and to prevent failures of structures, systems and components (SSCs) important to safety.	• Conservative design • High-quality materials, manufacturing and construction (e.g. appropriate design codes and materials, design procedures, equipment qualification, control of component fabrication and plant construction, operational experience) • A suitable site was chosen for the plant with consideration of all external hazards (e.g. earthquakes, aircraft crashes, blast waves, fire, flooding) in the design • Qualification of personnel and training to increase competence • Strong safety culture • Operation and maintenance of SSC in accordance with the safety case
2	Operational occurrences: To detect and intercept deviations from normal operation, to prevent AOOs from escalating to accident conditions and to return the plant to a state of normal operation.	• Inherent and engineered design features to minimize or exclude uncontrolled transients to the extent possible • Monitoring systems to identify deviations from normal operation • Operator training to respond to reactor transients
3	Design basis accidents: To minimize the consequences of accidents and prevent escalation to beyond design basis accidents.	• Inherent safety features • Fail-safe design • Engineered design features, procedures that minimize design basis accident (DBA) consequences • Redundancy, diversity, segregation, physical separation, safety system train/channel independence, single-point failure protection • Instrumentation suitable for accident conditions • Operator training for postulated accident response

4	Beyond design basis accidents: To ensure that radioactive releases caused by beyond design basis accidents, including severe accidents, are kept as low as practicable.	• Beyond design basis accidents guidance to manage accidents and mitigate their consequences as far as practicable • Robust containment design with features to address containment challenges (e.g. hydrogen combustion, overpressure protection, core concrete interactions, molten core spreading and cooling) • Complementary design features to prevent accident progression and to mitigate the consequences • Features to mitigate radiological releases (e.g. filtered vents)
5	Mitigation of radiological consequences: To mitigate the radiological consequences of potential releases of radioactive materials that may result from accident conditions.	• Emergency support facilities • Onsite and offsite emergency response plans and provisions • Plant staff training on emergency preparedness and response

Source: *Implementation of Defence in Depth at Nuclear Power Plants: Lessons Learnt from the Fukushima Daiichi Accident*, NEA No. 7248, 2016 [8].

Appendix B: Safety and Control Area Framework

The CNSC's regulatory requirements and expectations for the safety performance of programs are organized into a framework made up of 3 functional areas and 14 safety and control areas (SCAs), which are subdivided into specific areas. Table B outlines each functional area and their respective SCAs and specific areas.

Table B: Key elements of the CNSC's Safety and Control Area Framework

Functional area	Safety and control area	Specific area
Management	1. Management system	Management system
		Organization
		Performance assessment, improvement and management review
		Operating experience (OPEX)
		Change management
		Safety culture
		Configuration management
		Records management
		Management of contractors
		Business continuity
	2. Human performance management	Human performance program
		Personnel training
		Personnel certification
		Initial certification examinations and requalification tests
		Work organization and job design
		Fitness for duty
	3. Operating performance	Conduct of licensed activities
		Procedures
		Reporting and trending
		Outage management performance
		Safe operating envelope
		Severe accident management and recovery
		Accident management and recovery

Functional area	Safety and control area	Specific area
Facility and equipment	4. Safety analysis	Deterministic safety analysis
		Hazard analysis
		Probabilistic safety assessment
		Criticality safety
		Severe accident analysis
		Management of safety issues (including R&D programs)
	5. Physical design	Design governance
		Site characterization
		Facility design
		Structure design
		System design
		Component design
	6. Fitness for service	Equipment fitness for service / equipment performance
		Maintenance
		Structural integrity
		Aging management
		Chemistry control
		Periodic inspection and testing
Core control processes	7. Radiation protection	Application of ALARA
		Worker dose control
		Radiation protection program performance
		Radiological hazard control
		Estimated dose to public
	8. Conventional health and safety	Performance
		Practices
		Awareness
	9. Environmental protection	Effluent and emissions control (releases)
		Environmental management system (EMS)

Functional area	Safety and control area	Specific area
		Assessment and monitoring
		Protection of the public
		Environmental risk assessment
	10. Emergency management and fire protection	Conventional emergency preparedness and response
		Nuclear emergency preparedness and response
		Fire emergency preparedness and response
	11. Waste management	Waste characterization
		Waste minimization
		Waste management practices
		Decommissioning plans
	12. Security	Facilities and equipment
		Response arrangements
		Security practices
		Drills and exercises
	13. Safeguards and non-proliferation	Nuclear material accountancy and control
		Access and assistance to the IAEA
		Operational and design information
		Safeguards equipment, containment and surveillance
		Import and export
	14. Packaging and transport	Package design and maintenance
		Packaging and transport
		Registration for use

Glossary

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology*.

REGDOC-3.6 includes terms and definitions used in the *Nuclear Safety and Control Act* and the regulations made under it, as well as in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

References

1. International Atomic Energy Agency (IAEA), IAEA Information Circular 164 *Agreement Between the Government of Canada and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, Vienna, 1972

2. IAEA, IAEA Information Circular 164 Add.1 Protocol Additional to the Agreement between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, Vienna, 2000

3. Canadian Nuclear Safety Commission (CNSC), REGDOC-3.2.2, *Aboriginal Engagement*, Ottawa, Canada, 2016

4. CNSC, REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures,* version 1.1, Ottawa, Canada, 2017

5. *Convention of Nuclear Safety & Security* (http://www-ns.iaea.org/conventions/nuclear-safety.asp)

6. *Treaty on the Non-Proliferation of Nuclear Weapons* (http://www.un.org/en/conf/npt/2005/npttreaty.html)

7. CNSC, REGDOC-2.14.1, *Information Incoporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations,* Ottawa, Canada, 2015

8. Nuclear Energy Agency (NEA), *Implementation of Defence in Depth at Nuclear Power Plants: Lessons Learnt from the Fukushima Daiichi Accident*, NEA No. 7248, 2016

Additional Information

1. International Atomic Energy Agency, IAEA Safety Standards Series No. SF-1, *Fundamental Safety Principles: Safety Fundamentals*, 2006.

2. For a list of all legislation relevant to the CNSC, visit the CNSC's List of regulations Web page.

CNSC Regulatory Document Series

Facilities and activities within the nuclear sector in Canada are regulated by the Canadian Nuclear Safety Commission (CNSC). In addition to the *Nuclear Safety and Control Act* and associated regulations, these facilities and activities may also be required to comply with other regulatory instruments such as regulatory documents or standards.

Effective April 2013, the CNSC's catalogue of existing and planned regulatory documents has been organized under three key categories and twenty-six series, as set out below. Regulatory documents produced by the CNSC fall under one of the following series:

1.0 Regulated facilities and activities

Series 1.1 Reactor facilities
1.2 Class IB facilities
1.3 Uranium mines and mills
1.4 Class II facilities
1.5 Certification of prescribed equipment
1.6 Nuclear substances and radiation devices

2.0 Safety and control areas

Series 2.1 Management system
2.2 Human performance management
2.3 Operating performance
2.4 Safety analysis
2.5 Physical design
2.6 Fitness for service
2.7 Radiation protection
2.8 Conventional health and safety
2.9 Environmental protection
2.10 Emergency management and fire protection
2.11 Waste management
2.12 Security
2.13 Safeguards and non-proliferation
2.14 Packaging and transport

3.0 Other regulatory areas

Series 3.1 Reporting requirements
3.2 Public and Aboriginal engagement
3.3 Financial guarantees
3.4 Commission proceedings
3.5 CNSC processes and practices
3.6 Glossary of CNSC terminology

Note: The regulatory document series may be adjusted periodically by the CNSC. Each regulatory document series listed above may contain multiple regulatory documents. For the latest list of regulatory documents, visit the CNSC's website.

FEDERAL COURT

SOLICITORS OF RECORD

DOCKET:	T-1222-21
STYLE OF CAUSE:	POWER WORKERS' UNION, SOCIETY OF UNITED PROFESSIONALS, THE CHALK RIVER NUCLEAR SAFETY OFFICERS ASSOCIATION, INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS LOCAL, 37, CHRIS DAMANT, PAUL CATAHNO, SCOTT LAMPMAN, GREG MACLEOD, MATTHEW STEWART AND THOMAS SHIELDS v ATTORNEY GENERAL OF CANADA, ONTARIO POWER GENERATION, BRUCE POWER, NEW BRUNSWICK POWER CORPORATION AND, CANADIAN NUCLEAR LABORATORIES
PLACE OF HEARING:	TORONTO, ONTARIO (HYBRID HEARING)
DATE OF HEARING:	DECEMBER 6-8, 2022
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DATED:	JUNE 6, 2023

APPEARANCES:

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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CNL Reporting to Regulatory Agencies REV 0.3

900-514300-MCP-006

Information Use

Approved by	Title	Date
Sandra Faught	Manager, ERM Licensing Support	2023/07/17

Effective Date: 2023/07/18
Expiry Date: 2026/07/18

Refer to ATOM for current version. Printed copies should not be considered current without first consulting ATOM.

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
0.3	2023/07/17	Issued as “Approved for Use”	B. Scott	S. Brewer S. Faught A. Coulas	S. Faught on behalf of S. Brewer
0.3D1	2023/07/13	Issued for “Review and Comment” The following minor changes were made: · 7.1.2.2 - added item 4) to advise the CNSC Event Reporting and Response Lead (or Licensing Lead) of the intent to submit a combined report when providing verbal report. · Updated List of Regulatory Agencies in Appendix A to include Emergency Measure Organization – MB and MB Dept of Labour and Immigration	B. Scott	S. Brewer S. Faught A. Coulas	
0.2	2023/03/10	Issued as “Approved for Use”	B. Scott	S. Brewer	S. Brewer
0.2D0.1	2023/02/20	Issued for “Review and Comment” The following minor changes were made to address comments from CNSC staff’s review: · 3.1.1 - updated to clarify that the more stringent reporting requirement will apply when requirements in the licence/LCH differ from those in the NSCA or Regulations · 3.1.2.1 - added ‘REGDOC-3.1.2 or REGDOC 3.1.3, as applicable’ · 3.1.3 - added ‘secret and top secret’ to confidential reports · 7.1.3.2 - corrected reference email	B. Scott	C. Gallagher A. Dash B. Scott	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		· 7.2.2 - added 2nd method for upgrading proactive notification · 9 - corrected reference to REGDOC-3.1.3 · Fixed minor grammatical errors The following minor changes were made as part of IM quality check: · 3 - renamed to ‘Pre-requisites’ · 5 - renamed to ‘Roles and Responsibilities’ · Corrections to several references in section 9			
0.1	2022/12/19	Issued as “Approved for Use.	B. Scott	S. Brewer	S. Brewer
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		· Updated revision numbering from Revision 1 to 0.1 as per new approval workflow			
0.1D0.2	2022/05/17	Reviewed for CNSC comments and Additions due to actions from a root cause analysis ***Approval not complete as additional items were identified to be added.**	B. Scott	S. Cotnam	
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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		requirements for upgrading a proactive notification to a reportable event · 5.1.3 – Replaced MST with DST, and removed reference to FLM · 5.1.4 - Added responsibility to notify CNL Legal, CNO, and CRO for specific events · (*) 6.1 – Flowchart updated to better reflect process and to include ‘Events that could trigger Stakeholder interest’ · 3.1.9.3 & 7 .4 - New sections dealing with ensuring involvement of CNL Legal for certain events. · 7.1.1 - Added a statement to select either “Notification” or “Yes for Reportable” when processing an ImpAct, but not both. · Added 7.2.2 Process for Upgrading a Proactive Notification to a Reportable Event · Updated “Project Officer (or Designated Point of Contact) to Event Reporting and Response Lead (or Licensing Lead) · Updated generic use of ‘Notification’ to ‘Communication’ or other similar term to differentiate from ‘Proactive Notifications’ · Strengthened Appendix A · Added Appendix C, Proactive Notification Template			
0	2018/11/28	Issued as “Approved for Use”. Cancels and supersedes: Procedure CW-508760-PRO-001	V.Mihaylov	S. Karivelil	S. Cotnam

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		"Canadian Nuclear Laboratories Reporting of Unplanned Events and Situations to the Canadian Nuclear Safety Commission"			
D1	2018/08/28	Issued for "Review and Comment".	V.Mihaylov	J. Chilton J. deRuiter S. Faught C.Gallagher D. Garrick G.Hamilton S. Karivelil K. Leroux S. Mistry B. Scott R. Swartz M. Vickerd	

Table of Contents

1. Scope and Applicability

The requirements of this procedure constitute a standard for consistent reporting to regulatory agencies and are applicable to all sites operated by CNL.

This procedure describes the requirements, the process, and the responsibilities for reporting by Canadian Nuclear Laboratories (CNL) to the Canadian Nuclear Safety Commission (CNSC) as required by the *Nuclear Safety and Control Act* (NSCA) [1] and the associated regulations, and to other regulatory agencies, as per the applicable legislation.

The document applies to the CNL employees who are Designated Representatives of the Licensee (DROL) and are responsible for reporting to the CNSC, and in general to the CNL staff responsible for reporting to regulatory agencies.

Appendix A includes an alphabetic list of regulatory agencies, other than the CNSC, to which CNL reports, the type of arrangement, and the Functional Support Area or department responsible.

Any questions regarding the content or the application of this document can be directed to CNL Regulatory Affairs via email: RegAff@cnl.ca (>>RegAff).

2. Purpose

The purpose of this procedure is to ensure a consistent manner of reporting to regulators for all licensed CNL sites.

The information provided in the reports is used by the regulatory agencies in responding to emergencies, monitoring ongoing events, confirming licensing basis, studying potential safety problems, assessing trends and patterns, monitoring performance, and identifying precursors of more significant events.

3. Pre-requisites

To ensure compliance and coherence of this document with the relevant legislation and CNSC regulatory documents, the procedure follows the same convention in formulation of requirements, i.e., the word "shall" is used to express a mandatory requirement to be satisfied by the licensee, "should" is used to express guidance or that which is advised, "may" is used to express an option or that which is advised or permissible within the limits of this document, and "can" is used to express possibility or capability.

3.1 Requirements for Reporting to the CNSC

3.1.1 Determination of Reportability and Reporting Timelines

The reporting requirements applicable to CNL are specified in the NSCA [1] and the pertinent regulations. The CNSC's regulatory documents' series "3.1 Reporting Requirements" sets out the framework for event and compliance monitoring reporting by the licensees. As identified in their associated Licence Conditions Handbook (LCH), either REGDOC-3.1.2, *Reporting Requirements - Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [2] or REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees,* *Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices* [3] will be applicable to the various CNL sites. Appendix A of these regulatory documents provides a list of situations and events that require a report or a notification to CNSC staff, the applicable reporting provisions, and the required reporting timelines.

The criteria for determination of the reportability of situations/events and the relevant reporting timelines for submission of verbal and written reports can be found in the licenses, LCHs, the NSCA [1] and the pertinent regulations, and the applicable regulatory documents from the series "3.1 Reporting Requirements". With respect to reporting requirements, should the requirements found in the pertinent applicable licence/LCH differ from the standard terms stated in legislative documents (NSCA and regulations), those with the more stringent reporting requirements shall be considered as most applicable.

When documented in ActionWay, non-compliances with regulatory requirements identified as a result of CNSC inspections shall not be flagged as reportable (see *Improvement Action (ImpAct) Corrective Action Program* [4] for further information).

3.1.2 Requirements for Preliminary Reporting to CNSC Staff

The purpose of the preliminary reporting is to provide CNSC staff with timely initial information on reportable occurrences or situations/events of regulatory interest, thus allowing them to respond to emergencies, monitor ongoing events, and identify precursors of more significant events.

After determining or becoming aware that an event is reportable, the responsible CNL DROL shall immediately report verbally, and file a preliminary written report to the CNSC, as applicable; that is, after steps to mitigate the consequences (as applicable) have been taken.

Preliminary reports should contain enough information so that CNSC staff have an understanding of the effects of the event on the health, safety and security of Canadians and the environment.

All reasonable efforts to obtain timely information that has been reviewed for accuracy should be made, when filing a report to the CNSC. For reports of situations or events that have not attained stability and predictability, timeliness of informing CNSC staff of the situation or event should be prioritized over the availability of data or information. Under the *Packaging and Transport of Nuclear Substances Regulations (PTNSR 2015)* [5], dangerous occurrences, as defined in section 35, are reported after the obligations listed in subsection 36(1) have been met.

3.1.2.1 Immediate Verbal Report to CNSC Duty Officer

As described in CNSC REGDOC-3.1.2 Section 2 item #8 [2], the DROL shall immediately report any of the following events to the CNSC Duty Officer:

- situations or events that trigger actions under emergency response programs, this includes but is not limited to:
  - activation of the Emergency Operations Centre (EOC) in error, or due to false alarms,

- when ambulance or police services have been called to site.[1]

- events that could trigger stakeholder interest such as a spill, a release, or an injury, or
- events that fall under the reporting requirements of the *General Nuclear Safety and Control Regulations* (GNSCR) [6], subsection 29(1).

Note: A direct verbal communication with the CNSC Duty Officer has to be ensured, i.e, the DROL has to speak to a person and make sure that the message has been acknowledged; leaving only a voicemail is not sufficient.

REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response* [7] establishes the requirements for reporting to CNSC of activation of the emergency response organization.

Important:

- All alarms resulting in activation of CNL's EOC, including false alarms, are to be reported to the CNSC Duty Officer;
- As per the agreement with CNSC [8], rapidly identifiable false or spurious alarms that occur at CNLs four high security sites (Chalk River Laboratories, Whiteshell Laboratories, Douglas Point and Gentilly-1) whereby they would not require substantive or further mitigation measures and which do not result in activation of CNL's EOC are not immediately reportable to the CNSC Duty Officer. This includes spurious fire alarms and the response to such;
- Fire alarms at all other CNL sites are reported as per the requirements applicable to that site (i.e., REGDOC-3.1.2 [2] or REGDOC-3.1.3 [3]).

See section 7.1.2.1 for details on the Duty Officer reporting process.

3.1.2.2 Immediate Verbal Report to CNSC Event Reporting and Response Lead (or Licensing Lead)

Initial information for reportable occurrences, which do not fall under the criteria for reporting directly to the CNSC Duty Officer (see 3.1.2.1 above), shall be verbally communicated by a DROL to the CNSC Event Reporting and Response Lead (for CRL) or relevant CNSC Licensing Lead (for other sites) via a phone line or in person, as practical.

Note: Leaving only a voicemail is not sufficient. The DROL has to make sure that the message has been acknowledged and understood by the CNSC representative, either via direct verbal communication or from a received email response confirming the details.

See section 7.1.2.2 for details on the reporting process.

[1] If an ambulance or police service (off-site response) was called to site for a non-occupational event and not in the conduct of a licensed activity, the Duty Officer is to be called to report the off-site response, however, this is not considered a reportable event. The DROL will follow-up with the CNSC Event Reporting and Licensing Lead (for CRL) or Licensing Lead (for other sites) with a proactive notification.

3.1.3 Requirements for Follow-up Written Reports

All written reports (preliminary, combined, and full) shall be submitted using the form *Unplanned Event Report* [9], and filed electronically with CNSC staff. Any additional or supporting information shall be also submitted electronically (e.g., air/water monitoring data).

Note: Although REGDOC-3.1.2 [2] and REGDOC-3.1.3 [3] permit written reports to be filed by fax or regular mail, the current arrangement between CNL and CNSC [10] is that all written submissions are to be filed electronically, no hard copy submissions required (with the exception of confidential information). Confidential reports (including secret and top secret) are submitted as a hardcopy via courier service.

3.1.3.1 Preliminary Report

Written preliminary reports (form *Unplanned Event Report* [9]) shall be submitted to CNSC staff within the required timeframes stated in Appendix A of REGDOC-3.1.2 [2], or per the guidance from REGDOC-3.1.3 [3], or in the applicable regulations after the immediate verbal report to a duty officer or CNSC Event Reporting and Response Lead (or Licensing Lead). The report shall capture the information reported during the initial verbal communication.

Note: If an emergency is reported to the CNSC duty officer, a written preliminary report is not required. For all other reports to the duty officer, a preliminary written and full report (or combined report) is still required.

A cover letter is not required for a preliminary report. The form [9] shall be filed with CNSC staff as a pdf email attachment.

See section 7.1.3.1 for details on the Preliminary Report process.

3.1.3.2 Combined Report

A combined report, i.e., a report that serves as preliminary and full at the same time, can be submitted instead of a preliminary report, where no additional information or investigation beyond the preliminary report can reasonably be expected. It is recommended that a combined report be issued within five days of reporting the event. If there is an ongoing investigations (i.e., a fact finding investigation is not complete) or the exact cause is still unknown, a combined report cannot be issued.

Where a combined report is going to be submitted, it must be communicated to the CNSC Event Reporting & Response Lead (or Licensing Lead) at the time of the verbal report so as not to miss the deadline for submitting preliminary reports.

A cover letter for regulatory close-out is required for combined reports, as they serve as preliminary and full at the same time, and the form [9] shall be enclosed with this letter. The letter shall include:

- the reason(s) why the preliminary report is submitted as combined; and
- a statement that CNL considers that the correspondence with the enclosed reporting form completes the reporting requirements for the event.

The cover letter and the form shall be submitted to CNSC staff as separate pdf email attachments.

See section 7.1.3.2 for details on the Combined Report process.

3.1.3.3 Full Report

Written full report (form *Unplanned Event Report* [9]) shall be submitted to CNSC staff within the timeframe required by the licence, LCH, or applicable regulations, after the preliminary report.

For full reports the form shall be enclosed with a cover letter for regulatory close-out, which shall include:

- a statement that CNL considers that the correspondence with the enclosed reporting form completes the reporting requirement for the event.

The cover letter and the form shall be submitted to CNSC staff as separate pdf email attachments.

Note: Failure to submit a full report within the required timeframe constitutes a separate reportable event.

See section 7.1.3.3 for details on the Full Report process.

In the event that complete detailed information cannot be obtained within the specified reporting timeframe (due to an increase in the significance level of the event, or when an investigation will extend beyond the specified reporting timeframe), the final report shall be submitted as per the identified timeframe. It shall be noted in the report the reason for the incomplete detailed information (e.g., the investigation is ongoing), and a date included for when an updated (revised) report will be issued. This shall be captured in a REG-action (REG-C) within the event ImpAct, and details provided in a Regulatory Commitments Summary table (see Appendix A of [14]).

It is recommended that CNL should notify CNSC staff prior to the full report due date, to advise that the full report is incomplete, and a revised report will be forthcoming.

See section 3.1.4.1 on requirements for Revised Reports section 7.1.3.4 for details on the Revised Report process.

3.1.4 Requirements for Other Written Submissions

3.1.4.1 Revised Report

A revised report shall be submitted during the following circumstances:

- complete detailed information cannot be obtained within the specified reporting timeframe for the Full Report,
- additional information on the event becomes subsequently available, or

- when the original report has been found to contain a considerable amount of incorrect technical information.

The revised report shall contain all the information needed to replace/supersede the original report (i.e. it should not consist of only the amendments to the original report).

See section 7.1.3.4 for details on the Revised Report process.

3.1.4.2 Request for Retraction of Unplanned Event Report

In general, requests for retraction are submitted for events that were reported in error and were subsequently determined not to be reportable. When the retraction of a preliminary, combined, or full report is required, written justification shall be provided to CNSC staff along with a request for retraction.

See section 7.1.4.1 for details on the process.

3.1.5 Requirements for Notifications & Communications

3.1.5.1 Proactive Notification for Unplanned Occurrences

Occurrences that may not initially appear to fall under any reporting provision, but are relevant to the safety of operation, significant as an operating experience, or that may have an impact on the reputation of CNL or the nuclear industry, should be considered as potentially reportable or of regulatory interest. Such items require a proactive notification (verbal, followed by email) to the CNSC Event Reporting and Response Lead (or Licensing Lead), prior to determining their actual reportability.

Proactive notifications of eligible items must be provided in timely fashion. The proactive notification shall be submitted as soon as the ImpAct documenting the occurrence has been raised in the ActionWay system.

Additional guidance:

- It is strongly recommended that occurrences that fall into ‘grey area’ are considered for proactive notification. Subsequently these occurrences may or may not be determined as items reportable to the CNSC.
- If an event has been determined to fall under a reporting provision within REGDOC-3.1.2 [2], or REGDOC-3.1.3 [3], then it cannot be sent as a proactive notification.
- The decision for proactive notification has to be made independently of possible consideration for ‘public disclosure’.
- For Duty Officer calls when a request for an ambulance or police service to attend a site for a non-occupation injury that occurred during the conduct of non-licensed activities (i.e., personal medical issue, while not conducting a licensed activity), a written proactive notification will be provided to the CNSC Event Reporting and Response Lead (or Licensing Lead) as this is not considered a reportable event.

3.1.5.2 Upgrade of Proactive Notification to a Reportable Event

Should additional information related to a proactive notification result in the event being deemed reportable, or a request received from the regulator requesting the event be deemed reportable, then the requirements (see section 3.1.1) and process for a Reportable Event must be followed (see section 7.1). For instance, if the event originally should have been a call to the CNSC Duty Officer, then a call must be placed to the Duty Officer to identify the proactive notification is now being considered as a reportable event.

Note: The timeline for reportable events begins as soon as the event has been ungraded from proactive notification to a reportable event.

3.1.5.3 Communications to CNSC Staff on Planned Events

In accordance with the NSCA [1] and the regulations, CNL is required to provide formal notice to CNSC of specific planned events, such as: removal or reinstatement of certified personnel, planned disposal of records, or intent to conduct security exercise.

When documented in ActionWay, such occurrences shall not be flagged as reportable or for notification (see *Improvement Action (ImpAct) Corrective Action Program* [4] for further information).

These formal notices shall be electronically submitted as formal email or as a pdf email attachment; no specific CNL forms are to be used.

3.1.5.4 Public Disclosure

CNL public communications are governed by public information programs, which address the activities of public interest at the different CNL sites. The public information programs are prepared in accordance with the CNSC REGDOC-3.2.1.*, Public Information and Disclosure* [11]. The programs outline the commitment to provide open and transparent access to information on unplanned situations and events.

The public information programs, pertinent to the different CNL sites are described in the following documents:

- *Public Information Program for Canadian Nuclear Laboratories* (CNL) [12] for Chalk River Laboratories, Whiteshell Laboratories, Prototype Reactor sites and Heavy Water Plant sites, and
- *PHAI Phase 2 Public Information Program* [13], for the Historic Waste Program (HWP).

Information on unplanned occurrences from all CNL sites, shall be forwarded to CNL Corporate Communications for further consideration.

Examples of occurrences which may qualify for public disclosure include: events with off-site effects, impact of natural events (e.g., earthquake, flood), significant industrial accidents, protest group actions, etc.

CNSC staff shall be formally notified by CNL Corporate Communications when announcements under the public disclosure protocol are made.

3.1.5.5 Communications to Atomic Energy of Canada Limited

Atomic Energy of Canada Limited (AECL) is the federal Crown Corporation responsible for the long-term contractual arrangement for the management and operation of CNL under a government-owned, contractor-operated model.

AECL shall receive formal notice by email of the following:

- unplanned situations or events of ImpAct significance levels 1 and 2;
- Event Initial Reports (EIR);
- announcements made under a public disclosure protocol;
- security events; and
- any other situation or event at the discretion of the CNL Chief Regulatory Officer (CRO).

The information shall be communicated to the AECL Chief Security Officer (CSO) by the CNL CRO, CSO, or designate(s) thereof.

3.1.6 Requirements for Integrated/Harmonised Reporting

CNSC staff shall be copied on correspondence regarding events that are reportable to other regulatory agencies (e.g., Environment and Climate Change Canada, Employment and Social Development Canada, etc).

3.1.7 Requirements under the CNL ImpAct Process

The *Improvement Action (ImpAct) Corrective Action Program* [4] shall be used to document all unplanned situations and events.

Note: Timely reporting is a responsibility of the DROLs (section 5.3). The reporting timeline depends solely on the applicable regulatory provisions (section 3.1.1) and shall not be affected by the schedule of the ImpAct process.

3.1.8 Requirements for Formal Correspondence to CNSC

The requirements of the CNL procedure *Managing Regulatory Communications and Commitments* [14] shall be followed for correspondence and other aspects of the reporting process as applicable.

Prior to sending out, any correspondence materials (e.g., letters, enclosures, supporting materials) shall be submitted for review to Regulatory Affairs, licensing managers or designates. For complex technical matters, the correspondence shall be submitted to the relevant SME for review as well. Correspondence that contains information of potential public interest shall be submitted for review to Corporate Communications.

3.1.9 Other Requirements for Reporting to the CNSC

3.1.9.1 Requirements for Annual Compliance Monitoring Report

An Annual Compliance Monitoring Report (ACMR) for the previous calendar year shall be filed with the CNSC every year, as scheduled in the applicable licences/LCHs for the different CNL sites, and shall include:

- Information that can be made available to the public without restrictions; any classified, protected, proprietary, or personal information shall be submitted to the CNSC separately in accordance with the CNSC's *Guidance Document on Confidential Filings* [15] and CNL's *Protection of Information* procedure [16];
- Sufficient details to provide CNSC staff with information to verify that the regulatory requirements are met and that operations have been conducted safely;
- Information on each of the 14 areas in the CNSC's Safety and Control Area (SCA) framework and other matters of regulatory interest; if a particular SCA is not relevant or does not apply to a particular CNL site, a statement to that effect shall be included in the report.

Each ACMR is intended to exist as a stand-alone document to provide the site-specific information. Information related to company-wide functional support areas and their associated SCAs are identified in the CNL ACMR. If information from any previous ACMRs is needed for completeness, this information shall be repeated to the appropriate level of detail.

Appendix B of REGDOC-3.1.2 [2] or REGDOC-3.1.3 [3] provides a sample structure as guidance for the preparation of an ACMR, based on the CNSC's SCA framework. This sample structure has been included in the ACMR templates: *Site Annual Compliance Monitoring Report Template* [17] for use at each site, and the *CNL Annual Compliance Monitoring Report Template* [18] for details on CNL site-wide SCAs. For additional information on completing the ACMRs, see *Preparation and Content of CNL Annual Compliance Monitoring Reports* [19].

Additional compliance monitoring reports shall be submitted (e.g., quarterly, monthly, or according to a licensee-specific schedule) if required by the site specific licence/LCH.

3.1.9.2 Annual Report of Radiation Detections in Packaging and Transport

Any nuclear substance referred to in paragraph 2(2)(o) of the PTNSR 2015 [5], must be characterized at the earliest possible time to determine the extent to which it is subject to the PTNSR 2015 and the Nuclear Substances and Radiation Devices Regulations [20].

Where such characterizations have been performed, an annual report containing a summary of radiation detections for the calendar year before the date of the report shall be filed with the CNSC by April 30.

3.1.9.3 Guidelines for Involving CNL Legal Department

There are times when events may require that CNL's Legal Department be advised in order to provide assistance. Should the DROL become aware of any of the following events, they shall immediately reach out to the CRO, CNO, and the Legal Department for further assistance and guidance:

- Any unplanned event with a Significance Level 1 or 2;
- An unplanned event with a high probability of triggering an Administrative Monetary Penalty by either the CNSC (as outlined in the *Administrative Monetary Penalties Regulations* [21]) or another Regulator;

Note: these events include, but are not limited to repeat, CNL-wide events that resulted in significant releases to the environment (i.e., multiple action level & regulatory limit exceedance); repeat events that caused significant injuries and near misses; exposure of persons to radiation in excess of the applicable radiation dose limits; or repeat events that fall within GNSCR 29(1) [6] that wasn't in itself a Significance Level 1 Event.

- A request by CNSC for an EIR to be tabled and/or discussed before the Commission;
- A request from CNSC at the Director-General level identifying dissatisfaction and/or concern regarding an event that occurred at CNL;
- Any Order or GNSCR 12(2) [6] request issued by CNSC as a result of an event or CNL reporting.

See section 7.4.1 and 7.4.2 for details on the process to involve CNL Legal Department.

3.2 Requirements for Reporting to Regulatory Agencies other than the CNSC

Formal notifications or reports to regulatory agencies other than the CNSC shall be submitted electronically. No specialized CNL forms shall be used; the information shall be laid out and formatted on a case-by-case basis.

Where applicable, any specific requirements from regulatory agencies for formatting and/or submission method shall be followed (e.g., Environment and Climate Change Canada requirements for reporting through their on-line reporting system). The Functional Support Manager should confirm with the regulatory agency (via direct contact or website) the requirements for submission.

Under the direction of the signing authority, before the communication is sent out it shall be submitted for review to CNL Regulatory Affairs staff, along with all pertinent materials, i.e., attachments and enclosures.

The list shown in Appendix A includes regulatory agencies and responsible authorities at provincial, federal, and international level, to which CNL has obligations to report.

4. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [22] contains specific meanings for those words that require further clarification.

4.1 Definitions

Can	*Can* is used to express possibility or capability.
Certified	Certified by the CNSC under paragraph 21(l)(i) of the NSCA [1] or by a designated officer authorized under paragraph 37(2)(b) of the NSCA.
Dangerous Occurrence	List of situations that can be considered as 'dangerous occurrence' is provided in section 35 of PTNSR 2015 [5].
Designated Representative of the Licensee	A DROL is a CNL staff member who is designated and authorized to communicate with, and make commitments to, CNSC staff on behalf of CNL for their organizational unit, facility, project, or program within their financial authority to do so. DROL is also a CNL staff member who is designated and authorized to make and submit unplanned situation or event reports to CNSC staff. The members of this group are identified in *Site Licences, Certificates, Permits, Building/Facility Contacts, & Licence Representatives* [23].
Event/Occurrence/ Situation	Any unwanted, unintentional sequence of occurrences that result in or could potentially result in consequences to operation and safety. These terms are used interchangeably to avoid duplication in sentences. They are given the same meaning.
Licensing Manager	Manager in charge of ensuring compliance with Licence, LCH, NSCA [1], and all other applicable regulations for a particular CNL site, business line, facility, project, or program.
May	*May* is used to express an option or that which is advised or permissible within the limits of this document.
Prescribed	Prescribed by regulation of the CNSC.
Proactive Notification	A notification refers to the obligation to inform the CNSC (or other regulatory agency) of events or situations where no further reporting is required. If further reporting is necessary, the licensee should submit a preliminary report instead.

Report	1) Initial or follow-up, verbal or written communication with the CNSC (or other regulatory agency) with regards to reportable situations, events, or dangerous occurrences. 2) Scheduled written submission to CNSC (or other regulatory agency) in response to the applicable regulatory requirements.
Shall	*Shall* is used to express a requirement to be satisfied by the licensee.
Should	*Should* is used to express guidance or that which is advised.

4.2 Acronyms

ACMR	Annual Compliance Monitoring Report
CNO	Chief Nuclear Officer
CNLRPD	Canadian Nuclear Laboratories Regulatory Program Division (Division within CNSC Directorate of Nuclear Cycle and Facilities Regulation)
CNSC	Canadian Nuclear Safety Commission
CRO	Chief Regulatory Officer
DROL	Designated Representative of the Licensee
DST	Dedicated Screening Team
EIR	Event Initial Report
EOC	Emergency Operations Centre
GNSCR	General Nuclear Safety and Control Regulations
HWP	Historic Waste Program (Port Hope, Port Granby)
LCH	Licence Conditions Handbook
MRM	Management Review Meeting
NSCA	Nuclear Safety and Control Act
PTNSR	Packaging and Transport Nuclear Safety Regulations
SCA	Safety and Control Area
SME	Subject Matter Expert

5. Roles and Responsibilities

5.1 Employees

Responsibilities of all CNL employees include:

- Verbally notifying their line management (and DROL if applicable) on discovery of any unplanned situation or event;
- Initiating an ImpAct (as per *Improvement Action (ImpAct) Corrective Action Program* [4]) for the situation or event, and follow the ImpAct process.

5.2 Dedicated Screening Team and Management Review Meeting

The Dedicated Screening Team (DST) responsibilities, under the ImpAct process, are to review ImpAct submissions daily for all CNL ImpActs

The Management Review Meeting (MRM) members are responsible for reviewing and confirming the reportability of the ImpAct submissions. The MRM chair will inform the appropriate DROL of any MRM recommendations, including on the reportability of a situation or event.

5.3 Designated Representatives of the Licensee or CNLs Representative for the Regulatory Body

Note: for the purposes of this document, CNLs Representative for other Regulatory Bodies shall be referred to as DROLs.

The responsibilities of the DROLs include:

- Maintaining expertise on reportability of situations/events particular to their organizational unit;
- Proactively providing an early notification to the relevant CNSC Event Reporting and Response Lead (or Licensing Lead) of potentially reportable situations or events;
- Determining the reportability[2] of the occurrence, and when applicable identify it as reportable in the ImpAct system;
- Ensuring that the CRO, CNO and CNL's Legal Department are advised for any Significance Level 1 or 2 event, any event with a high probability of triggering an Administrative Monetary Penalty, or on receipt of a GNSCR 12(2) [6] letter (see 3.1.9.3)
- Ensuring that the Managers, Supervisors and the Subject Matter Experts (SME) within their organization are capable of recognizing reportable occurrences;
- Consulting with SMEs (including Functional Support Area/SCA DROL and Facility DROL), manager of Regulatory Affairs, or Licensing Managers, as necessary, to determine the reportability of a situation or event;

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[2] DROLs shall not consult with CNSC staff to determine the reportability of a situation or event.

- Reporting to, or notifying CNSC staff or other regulatory bodies of situations or events as per the applicable requirements;
- Ensuring the appropriate context, the quality, and the technical correctness of the unplanned event reports;
- Reviewing attachments and enclosures to ensure that they are complete, are of the highest quality, are technically correct, and that they sufficiently address the issues, requests, regulatory requirements etc., and/or that they satisfactorily state and explain the proposed actions to be undertaken by CNL;
- Ensuring that all written materials have been reviewed by staff of the Regulatory Affairs branch, and the relevant Licensing Managers, prior to submission to the CNSC;
- Ensuring that staff within their organizations to whom this procedure applies know and comply with the requirements it sets for the reporting process;
- Initiating and authorizing cause analysis for situations or events, as appropriate; and
- Participating and contributing to the development of ACMRs, and any other scheduled reporting submissions as required by the applicable licence/LCH.

5.4 Chief Regulatory Officer

The CRO has the authority as described in the Management System Manual [24] and:

- Acts as an authorized representative of CNL in dealings with the CNSC (Commission).
- Appoints DROLs for specific SCAs.
- Acts as an authorized representative of CNL in dealings with AECL.

5.5 Regulatory Affairs Manager

Regulatory Affairs Manager and designates are responsibilities for:

- Maintaining and updating this procedure;
- Ensuring all DROLs are trained and updated on reporting requirements;
- Providing assistance and guidance to DROLs on the reportability of events and on consideration for early notification of potentially reportable situations;
- Reviewing for quality and content the drafts of submission letters and preliminary, full, and combined reports;
- Reporting events that are CRL site-wide (e.g., site-wide power outage, flood, fire, stay-in);
- Managing/supervising the development of the CNL/CRL ACMRs, and support any other scheduled reporting submissions as required by the applicable licence/LCH.

5.6 Licensing Managers

Site/Projects Licensing Managers and designates are responsible for:

- Providing assistance and guidance to DROLs on the reportability of events;

- Providing focused training to licensing staff and/or DROLs on reporting requirements related to their site;
- Reviewing for quality and content the drafts of the preliminary, full, combined reports, and submission letters;
- Managing/supervising the development of ACMRs, and support any other scheduled reporting submissions as required by the applicable licence/LCH.

5.7 Corporate Communications

Corporate Communications staff are responsible for:

- Reviewing content of reports and submission letters, as per the DROLs' request;
- Evaluating and appropriately disclosing to the public information about unplanned situations and events; and
- Informing CNSC on public disclosures.

5.8 Subject Matter Experts

The responsibilities of SME in response to DROLs' requests, include:

- Assisting DROLs in the determination of reportability;
- Reviewing the technical correctness of event reports; and
- Assisting DROLs in the completion of the ACMRs and any other scheduled reporting submissions as required by the applicable licence/LCH.

5.9 Correspondence Coordinator/Administrative Staff

When dealing with correspondence to and from a regulator, the Correspondence Coordinators or DROL's administrative staff assigned as Correspondence Coordinator are responsible for filing regulatory correspondence in ATOM, and for providing a link to the author/DROL for future reference, as per [14].

5.10 Responsibilities in Reporting to Regulatory Agencies other than the CNSC

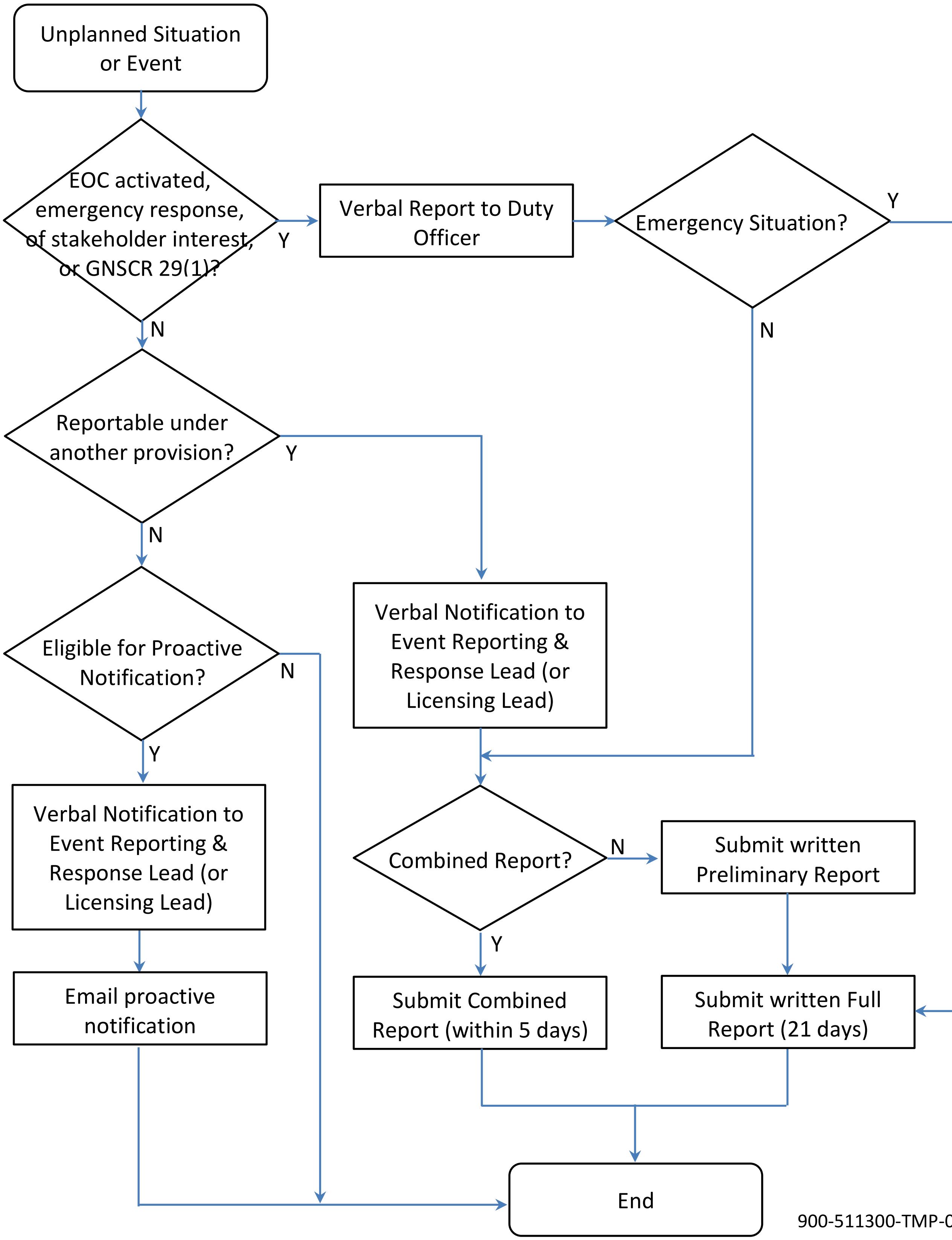
Reporting to other regulatory agencies is carried out by the designated CNL representatives as per the requirements of the different CNL compliance programs, and as per the information in Appendix A of this procedure.

5.11 Signing Authority

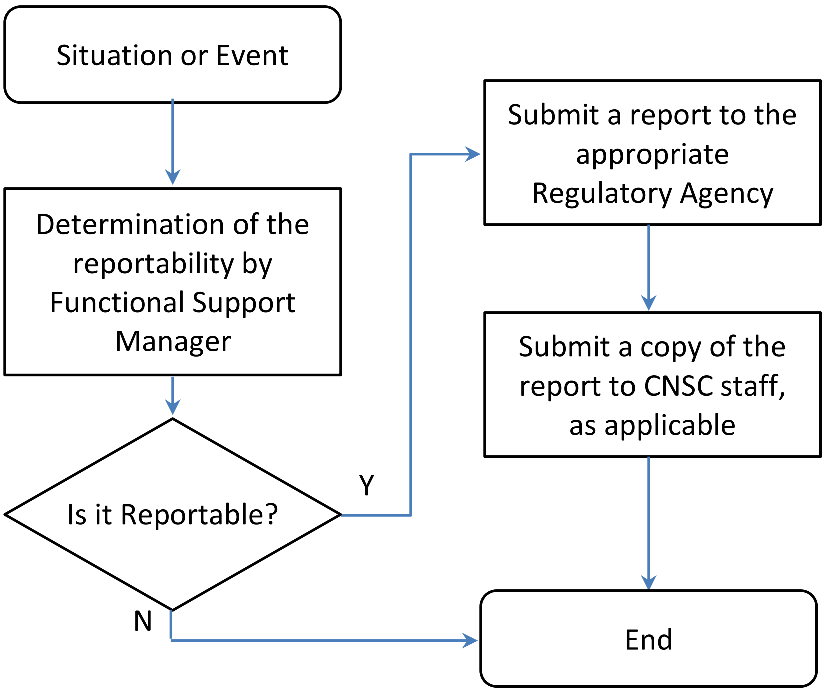
The relevant signing authority is responsible for ensuring that the reports and pertinent materials are reviewed, and sent for final review and comments to CNL Regulatory Affairs staff prior to submission to the regulatory agency.

6. Flowchart

6.1 Flowchart for Reporting to the CNSC



6.2 Flowchart for Reporting to Other Agencies



7. Process

Canadian Nuclear Laboratories reports to Regulatory Agencies in accordance with the requirements stated in section 3 of this procedure.

7.1 Process for Reporting to the CNSC

This section details the process of capturing and documenting unplanned situations and events at CNL, the determination of their reportability, and the preparation and submission of the relevant reports.

The effective date of filing of any report is the date it is received by the CNSC staff.

The DROLs are to ensure that as per section 8 of this procedure, copies of all report submissions are filed in ATOM and either a reference is provided or copy of the correspondence is attached to the originating ImpAct.

7.1.1 ImpAct Process

The reporting process utilizes ActionWay to create ImpActs, and comprises the actions as detailed below.

All Employees

1) Initiate an ImpAct as per the *Improvement Action (ImpAct) Corrective Action Program* [4] when an unplanned situation or event occurs or is discovered, and notify supervision.

2) Verbally notify the appropriate DROL on discovery or occurrence of a situation or event that could be reportable.

DROL

3) Determine reportability and declare a situation or event reportable accordingly. Consider if the event qualifies for proactive notification (see requirements in section 3.1.5.1).

   Note: Ensure that the ImpAct indicates either YES for "Notification to Regulator", when a proactive notification is submitted, or YES for "Is it Reportable?", when the event is recognized as reportable.

4) Solicit assistance from the Regulatory Affairs Manager, Licensing Managers, and SMEs (including SCA DROLs and Facility DROLs), as needed.
5) As appropriate, submit to CNSC staff a notification, verbal and written reports for the unplanned event, within the prescribed timeframe. (See the following sections for detailed information on submitting verbal and written reports for events and notifications.)
6) Initiate and authorize cause analysis effort, as appropriate.
7) Submit information for events of potential public interest to CNL Corporate Communications.

DST

8) Review that the ImpAct has sufficient information with regard to reportability and the significance level.

MRM

9) Confirm the reportability and the ImpAct significance level.
10) IF proactive notification to the relevant CNSC Event Reporting and Response Lead (or Licensing Lead) has not been made

    THEN consider independently from the DROLs' decision whether the event qualifies for proactive notification under section 3.1.5.1.

11) Provide the DROLs with recommendations according to the conclusions of the MRM.

7.1.2 Preliminary Reporting

7.1.2.1 Verbal Report to CNSC Duty Officer

In accordance with the requirements stated in section 3.1.2.1, situations and events of high significance are reported through the CNSC Duty Officer.

The CNSC Duty Officer emergency telephone lines 1-844-879-0805 and 613-995-0479 are available 24 hours a day, 7 days a week. Information on how to report nuclear incidents is available online at: http://nuclearsafety.gc.ca/eng/contact-us/report-a-nuclear-incident.cfm.

DROL

1) Contact the CNSC Duty Officer via telephone at 1-844-879-0805 or 613-995-0479.

2) Report the situation/event and ensure that the information has been properly understood by the CNSC Duty Officer in direct verbal contact using three-way communication. (**Note**: leaving only a voicemail is not sufficient).

7.1.2.2 Verbal Report to CNSC Event Reporting and Response Lead (or Licensing Lead)

For all unplanned situations and events which fall outside of the requirements identified in section 3.1.2.1, the initial report is communicated verbally to the CNSC Event Reporting and Response Lead (or Licensing Lead) within the timeline determined by the applicable requirements outlined in section 3.1.2.2.

DROL

1) Contact the appropriate CNSC Event Reporting and Response Lead (or Licensing Lead) via telephone.
2) IF neither the CNSC Event Reporting and Response Lead (or Licensing Lead) nor their backup contact are available

   THEN contact the relevant CNSC Director, CNL Regulatory Program Division (CNLRPD) or designate.

   Note: the message has to be acknowledged by a CNSC representative within a reasonable time, leaving a voicemail is not sufficient.
3) Communicate verbally the preliminary report. As this is an initial report, it typically includes only readily available or provisional information on the situation or the event being reported.
4) IF it has been determined that the report can be submitted as a combined report

   THEN advise the CNSC Event Reporting and Response Lead (or Licensing Lead) of the intent to submit the report as a combined Report. This is to ensure the CNSC Event Reporting and Response Lead (or Licensing Lead) is not anticipating a written preliminary report the following day.
5) Ensure that the information has been properly understood by the CNSC Event Reporting and Response Lead (or Licensing Lead), using three-way communication.

7.1.3 Preparation and Submission of Written Reports

7.1.3.1 Preliminary Report

The requirements for a written preliminary report are detailed in section 3.1.3.1.

A written preliminary report is followed by a full report.

The process of preparation and submission of a written preliminary report entails the steps shown below.

DROL

1) Prepare a draft for a written preliminary report using the form *Unplanned Event Report* [9].

   Note: If an emergency is reported to the CNSC duty officer, a written preliminary report is not required, only a full report, as per [2].

2) Ensure that all fields in the form are filled out. Enter "Nothing to Report" when there is nothing to report under a specific item, or "N/A" (not applicable) when an item is not applicable to the selected type of report.
3) If any regulatory actions have been identified in the preliminary report, ensure that they are dated, and the person responsible for each action is identified (by role or job title only).
4) For any actions identified in the previous step, ensure that they are captured in ActionWay as REG-I actions under the source ImpAct, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].
5) Raise a REG-R action for the submission of the full report in ActionWay under the source ImpAct, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].
6) Submit for review to Licensing Managers or designates, and on as-needed basis to Corporate Communications and SMEs.

Licensing Managers, SMEs, and Corporate Communications

7) Review the submitted report and return to DROL with any comments or corrections.

DROL

8) Revise the reviewed report and submit the final, signature ready version to Regulatory Affairs for review.

Regulatory Affairs

9) Review the submitted report and return to DROL with any comments.

Correspondence Coordinator

10) Code the email and provide the correspondence number to the author.
11) File the final email and report in ATOM, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].

DROL

12) Ensure that the appropriate report type (preliminary) is selected in the completed form *Unplanned Event Report* [9], and that the form is signed and submitted to the CNSC Event Reporting and Response Lead (or Licensing Lead) within the prescribed timeframe via email as separate pdf enclosure, and copied to the Director, CNLRPD.
13) Ensure that the submission is filed in ATOM, and a link or copy of the preliminary report is attached to the originating reportable ImpAct.

14) Confirm that any commitments or actions made in the preliminary report are entered into ActionWay as Regulatory Actions, including target completion date, responsible manager, and closure criteria.
15) Ensure that a REG-R action for the submission of the full report is raised under the original ImpAct.

7.1.3.2 Combined Report

The requirements for written combined reports are detailed in section 3.1.3.2.

The submission of a combined report (enclosed with a formal letter for regulatory close-out) concludes the reporting process and no full report is required to follow.

The process of preparation and submission of a written combined report entails the steps shown below.

DROL

1) Prepare a draft for written combined report using the form *Unplanned Event Report* [9].
2) Ensure that all fields in the form are filled out. Enter “Nothing to Report” when there is nothing to report under specific item, or “N/A” (not applicable) when an item is not applicable to the selected type of report.
3) For any regulatory actions identified in the report, ensure that they are dated, and the person responsible for each action is identified (by role or job title only).
4) For all actions identified in the previous step, raise REG-I actions in ActionWay under the source ImpAct, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].
5) Prepare a cover letter for regulatory close-out including the following:
    - the reason(s) why the preliminary report is submitted as combined;
    - a statement that CNL considers that the correspondence with the enclosed reporting form completes the reporting requirement for the event.
6) Submit the completed form *Unplanned Event Report* [9] and cover letter for review to Licensing Managers or designates, and on as-needed basis to Corporate Communications and SMEs.

Licensing Managers, SMEs, and Corporate Communications

7) Review the submitted report and cover letter, and return to DROL with any comments or corrections.

DROL

8) Revise the reviewed report and cover letter, and submit the final, signature ready versions to Regulatory Affairs for review.

Regulatory Affairs

9) Review the submitted report and return to DROL with any comments.

Regulatory Affairs

10) Review the submitted report and correspondence, including attachments and enclosures.

Correspondence Coordinator

11) Code the cover letter and provide the file number to the author.

12) File the final letter and report in ATOM, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].

DROL

13) Ensure that the appropriate report type (combined) is selected in the completed form *Unplanned Event Report* [9], and that the form and the cover letter, is signed and submitted to the CNSC Event Reporting and Response Lead (or Licensing Lead) within the prescribed timeframe via email as separate pdf enclosure, and copied to the Director, CNLRPD.

Note: All correspondence must be addressed to the appropriate contact person as per details provide from the Regulator or the most recent CNSC Points of Contact list on the Regulatory Affairs – Correspondence SharePoint site or the Regulatory Affairs/Licensing – CNL Distribution List page on myCNL. This page also provides a CNL distribution list of personnel for mandatory distribution of all letters and formal emails sent to a regulator.

CNSC has specifically identified the distribution list to ensure all pertinent CNSC staff have been included in the correspondence. It is imperative that the following contacts are also included for all CNSC correspondence:

- Monitoring Officer CNLRPD (fname.lname@cnsc-ccsn.gc.ca)
- forms-formulaires@cnsc-ccsn.gc.ca,
- >CR Licensing; and
- >CR CNSC Site Officer (cnlrpdsiteoffice-bureauregionaldedprlnc@cnsc-ccsn.gc.ca

14) Ensure that the submission is filed in ATOM, and a link or copy of the combined report is attached to the originating reportable ImpAct.

15) Confirm that any commitments or actions made in the combined report are entered into ActionWay as Regulatory Actions, including target completion date, responsible manager, and closure criteria.

7.1.3.3 Full Reports

The full report is a written report, submitted to CNSC staff after the submission of a written preliminary report, within the timeframe required by the applicable regulatory requirement (21 calendar days in most cases). The DROL determines the submission timeline as per the requirements of section 3.1.1. A delay in submission of a full report to CNSC staff constitutes a separate reportable event**.**

Note: If a Root Cause Analysis or an Apparent Cause Analysis was conducted in support of a full report, these apparent cause or root cause analyses must not be declared in the cover letter or referenced in the report. The CNO and the CRO shall be contacted if a formal request to submit an apparent cause or root cause analysis is received from CNSC staff.

The process of preparation and submission of a full report entails the steps shown below.

DROL

1) Prepare draft full report using the form *Unplanned Event Report* [9].
2) Ensure that all fields in the form are filled out. Enter "Nothing to Report" when there is nothing to report under specific item, or "N/A" (not applicable) when an item is not applicable to full report.
3) For all regulatory actions identified in the report, ensure that they are dated, and the responsibility for each action is identified (by role or job title only).
4) For all actions identified in the previous step, raise REG-I actions in ActionWay under the source ImpAct, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].
5) IF complete detailed information cannot be obtained within the specified reporting timeframe,

   THEN the final report is still to be submitted and note in the report:

   - the reason for the incomplete detailed information (e.g., the investigation is ongoing, and
   - a date for when an updated (revised) report will be issued.
6) Prepare a cover letter:

   IF the full report is complete and it is not anticipated there will be a revised report,

   THEN prepare a cover letter for regulatory close-out which includes:

   - a statement that CNL considers that the correspondence with the enclosed reporting form completes the reporting requirement for the event.

   IF the full report is incomplete and there will be a revised report,

   THEN prepare a cover letter which includes:

   - a statement that CNL is submitting the full report, but as there is incomplete detailed information, a revised report will be forthcoming, and
   - an action commitment table

   AND ensure that a REG-C action for the submission of the revised report is raised under the original ImpAct.

7) Submit the cover letter and the completed *Unplanned Event Report* [9] form for review to Licensing Managers, or designates, and on as-needed basis to Corporate Communications and SMEs.

Licensing Managers, SMEs, and Corporate Communications

8) Review the submitted report and cover letter, and return to DROL with any comments or corrections.

DROL

9) Revise the reviewed report and cover letter, and submit the final, signature ready versions to Regulatory Affairs for review.

Regulatory Affairs

10) Review the submitted report and cover letter, including attachments and enclosures, and return to DROL with any comments.

Correspondence Coordinator

11) Code the cover letter and provide the file number to the author.

12) File the final letter and report in ATOM, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].

DROL

13) Confirm that 'full report' is selected in the completed form *Unplanned Event Report* [9], and ensure that the form and the cover letter are signed and submitted to the CNSC Event Reporting and Response Lead (or Licensing Lead) within the prescribed timeframe via email as separate pdf attachments, and copied to the Director, CNLRPD.

14) Confirm that any commitments or actions made in the full report are entered into ActionWay, including their projected completion date, responsible manager, and closure criteria.

15) IF the full report is incomplete and there will be a revised report.

    THEN ensure that a REG-C action for the submission of the revised report is raised under the original ImpAct.

16) Ensure that the submission is filed in ATOM, and a link or copy of the full report is attached to the originating reportable ImpAct.

7.1.3.4 Revised Report

The process shown below is followed for the submission of a revised report.

DROL

1) Prepare draft for the revised report using the form *Unplanned Event Report* [9].

2) Update the Revision number to show this is a revised report to the original submitted report.

3) Ensure that all fields in the form are filled out. Enter “Nothing to Report” when there is nothing to report under specific item, or “N/A” (not applicable) when an item is not applicable to the selected type of report.

4) Prepare a cover letter for regulatory close-out which:

   - indicates that the revised submission (include report revision #) has become the official report for the event and it supersedes the previous submission; and
   - IF the revised submission is for an incomplete full report

     THEN includes a statement that CNL considers that the correspondence with the enclosed reporting form completes the reporting requirement for the event.

5) Submit the cover letter and the completed *Unplanned Event Report* [9] form for review to Licensing Managers, or designates, and on as-needed basis to SMEs and Corporate Communications.

Licensing Managers, SMEs, and Corporate Communications

6) Review the submitted report and cover letter, and return to DROL with any comments or corrections.

DROL

7) Revise the reviewed report and cover letter, and submit the final, signature ready versions to Regulatory Affairs for review.

Regulatory Affairs

8) Review the report correspondence, including attachments and enclosures, and return to DROL with any comments.

Correspondence Coordinator

9) Code the regulatory close-out cover letter and provide the file number to the author.

10) File the letter and the report in ATOM, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].

DROL

1) Ensure that any regulatory actions identified in the report are dated, and the responsibility for each action is identified (by job title only).

2) Ensure that the completed form *Unplanned Event Report* [9], with the full report checkbox checked, the revision number has been updated, and the cover letter are signed and submitted to the CNSC Event Reporting and Response Lead (or Licensing Lead) via email as separate pdf attachments, and copied to the Director, CNLRPD.

3) Ensure that any new commitments or actions made in the revised full report are entered into ActionWay, including their projected completion date, responsible manager, and

closure criteria. Close any unnecessary actions previously assigned in ActionWay with a justification that a revised report has been submitted.

4) Ensure that the submission is filed in ATOM, and a link or copy of the revised report is attached to the originating reportable ImpAct.

7.1.4 Preparation of Other Written Submissions

7.1.4.1 Request for Retraction of a Preliminary or Full Report

If further investigation concludes that a situation or event that has been reported does not meet the requirements of a reportable event, the DROL may request the retraction of the preliminary, combined, or full report.

If CNSC staff grants the request for the retraction, the information on the situation or event that has already been submitted to CNSC staff will remain a part of the CNSC records.

The steps in the process are shown below.

DROL

1) Prepare a formal written request for retraction indicating the following:
    - the title, the identifying file number, and the date of the submission of the report to which the request pertains; and
    - the description of the grounds for the request for retraction and the reasons why the event is no longer considered reportable.
2) Submit for review to Regulatory Affairs.

Regulatory Affairs

3) Review the report correspondence, including attachments and enclosures, and return to DROL with any comments.

DROL

4) Submit request for retraction to the relevant CNSC Event Reporting and Response Lead (or Licensing Lead).
5) IF CNSC staff rejects the request for retraction of the report

   THEN follow the regular reporting process in accordance with this procedure[3].

7.1.5 Additional Guidance for Reporting to the CNSC

Appendix B provides general guidance on information on the content of an *Unplanned Event Report* [9], use form [9] for the actual report.

[3] Note: The reporting timeline for full reports resumes from the original timeline of the event report.

Guidelines for reviewing event reports and for the use of appropriate language are provided in Appendix D.

7.2 Proactive Notifications

7.2.1 Process for Submission of Proactive Notification for Unplanned Events

A proactive notification is sent if is it determined than an event that may not initially appear to fall under any reporting provision (see section 3.1.1), but is relevant to the safety of operation, significant as an operating experience, or that may have an impact on the reputation of CNL or the nuclear industry.

The process below is followed for events that fall under the requirements of section 3.1.5.1.

DROL

1) Contact the appropriate CNSC Event Reporting and Response Lead (or Licensing Lead) via telephone.
2) IF neither the CNSC Event Reporting and Response Lead (or Licensing Lead) nor their backup contact are available

   THEN contact the relevant CNSC Director, CNLRPD or designate.

   Note: the message must be acknowledged by a CNSC representative within a reasonable time, leaving a voicemail is not sufficient.
3) Communicate verbally that CNSC is being provided notification of an event that does not appear to be reportable but is of regulatory interest.
4) Ensure that the information has been properly understood by the CNSC Event Reporting and Response Lead (or Licensing Lead), using three-way communication.
5) IF, after discussion with the CNSC Event Reporting and Response Lead (or Licensing Lead), it is felt that the event is reportable

   THEN follow the process for submission of a reportable event (7.1)
6) Prepare a draft proactive notification using the template in Appendix C.
7) Ensure that any actions identified in the report are dated, and the responsibility for each action is identified (by role or job title only).
8) Follow the steps under section 7.1.1 to indicate in the relevant ImpAct that notification has been provided.
9) Ensure that the actions identified in the previous step are captured in ActionWay as under the source ImpAct, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].
10) Submit the completed form *Proactive Notification* Template (Appendix C) for review to Regulatory Affairs.

Regulatory Affairs

11) Review the submitted proactive notification, and return to DROL with any comments.

Correspondence Coordinator

12) Code the email and provide the correspondence number to the author.
13) File the final email in ATOM, as per the requirements of procedure *Managing Regulatory Communications and Commitments* [14].

DROL

14) Copy the information from the *Proactive Notification* template into an email and submit to the CNSC Event Reporting and Response Lead (or Licensing Lead) and copying the Director, CNLRPD.
15) Ensure that the submission is filed in ATOM, and a link is attached to the originating reportable ImpAct.

7.2.2 Process for Upgrading a Proactive Notification to a Reportable Event

An event that was previously identified and submitted to CNSC staff as a Proactive Notification can be upgraded to a Reportable Event in 2 ways:

- CNL staff determine, through investigation or other information, that the event is now considered reportable as per the requirements in section 3.1.1, or
- CNL receives comments back from CNSC staff regarding a Proactive Notification and have requested it be deemed reportable.

In either case, the process for upgrading a Proactive Notification to a Reportable Event is the same as when a Reportable Event had been identified (i.e. if the event would have initially required a call to the Duty Officer, then the DROL must place a call to the Duty Officer advising the Proactive Notification is being upgraded to a Reportable Event).

DROL

IF the event falls under the criteria for reporting directly to the CNSC Duty Officer, (see section 3.1.2.1)

THEN follow the process starting in section 7.1.2.1.

IF the event does not require reporting to the CNSC Duty Officer (see section 3.1.2.2),

THEN follow the process starting in section 7.1.2.2.

7.3 Process for Reporting to other Regulatory Agencies

Correspondence with other regulatory agencies is carried out as shown below.

Functional Support Manager (equivalent to DROL)

1) Prepare the draft of the correspondence.

2) Submit the correspondence and all additional materials for review to Licensing Managers, or designates, and on as-needed basis to Corporate Communications and SMEs.

Licensing Managers, SMEs, and Corporate Communications

3) Review the submitted report and return to DROL with any comments or corrections.

Functional Support Manager

4) Revise the reviewed correspondence and submit the final, signature ready version to Regulatory Affairs for review.

Regulatory Affairs

5) Review the submitted correspondence, including attachments and enclosures, and return to Functional Support Manager with any comments.

Correspondence Coordinator

6) Code cover letter, provide the file number to the author, and file the final letter in ATOM.

Functional Support Manager

7) Ensure that any regulatory actions identified in the correspondence are dated, and the responsibilities are identified (by job title only).

8) Ensure that any commitments or actions made in the correspondence are entered into ActionWay, including their projected completion date, responsible manager, and closure criteria.

7.4 Process for Other Requirements when reporting to CNSC

7.4.1 Significance Level 1 or 2 Events or Event that has a high probability of triggering an Administrative Monetary Penalty

See section 3.1.9.3 for examples of events that could trigger an Administrative Monetary Penalty.

DROL

1) Ensure an ImpAct has been raised as per the *Improvement Action (ImpAct) Corrective Action Program* [4].

2) Immediately schedule a meeting with the CNO, CRO and CNL's Legal Department to discuss path forward

3) Further procedures will be identified as part of the meetings and/or discussions with CNO, CRO, and CNL's Legal Department

7.4.2 Events requiring an Event Initial Report, an Order, or GNSCR 12(2) request

See section 3.1.9.3 for examples of events that could trigger an EIR, an order, or a GNSCR 12(2) letter.

An Order or GNSCR 12(2) letter are regulatory tools issued by CNSC to compel a licensee to do something, while an EIR is a request by the CNSC to appear before the Commission to discuss an event. All of these will be sent to the licensee by the CNSC, either the CNO or DROL.

Addressee (CNO, CRO or DROL)

1) Acknowledge receipt of correspondence from the regulator.
2) Ensure that correspondence has been saved in ATOM as per [14]
3) Ensure an ImpAct has been raised as per the *Improvement Action (ImpAct) Corrective Action Program* [4].
4) Further procedures will be identified as part of the meetings and/or discussions with CNO, CRO, and CNL's Legal Department.

8. Documented Information

Creation, Capture and Use of Information Assets [25] provides current information on the storage, preservation, turnover and retention requirement for records.

All letters and emails submitting preliminary and full reports shall be filed in the correspondence module of ATOM, as per *Managing Regulatory Communications and Commitments* [14].

9. References

[1] *Nuclear Safety and Control Act*, S.C. 1997, c. 9, Canada.

[2] Canadian Nuclear Safety Commission, *Reporting Requirements - Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*, REGDOC-3.1.2.

[3] Canadian Nuclear Safety Commission, *Reporting Requirements for Waste Nuclear Substance Licensees, Class ll Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices*, REGDOC-3.1.3

[4] *Improvement Action (ImpAct) Corrective Action Program*, 900-514000-MCP-004, 40772346.

[5] *Packaging and Transport of Nuclear Substances Regulations*, SOR/2015-145.

[6] *General Nuclear Safety and Control Regulations,* SOR/2000-202.

[7] Canadian Nuclear Safety Commission, *Nuclear Emergency Preparedness and Response*, REGDOC-2.10.1.

[8] Letter, C. Cianci to S. Cotnam, "CNSC Staff Response to CNL Letter Request for an Exemption with Regard to Reporting of Routine Actions under Emergency Response

Programs Triggered by False Alarms – 145-CNNO-21-0016-L", 145-NOCN-21-0009-L, 2021 April 19, 54333071.

[9] *Unplanned Event Report*, Form, 900-514300-FM-002, 43929127.

[10] Letter, H. Tadros to S. Cotnam, "CNSC points of contact for Canadian Nuclear Laboratories", 145-NOCN-18-0006-L, 2018 Aug 17, 40487846 .

[11] Canadian Nuclear Safety Commission, *Public Information and Disclosure*, REGDOC-3.2.1.

[12] *Public Information Program for Canadian Nuclear Laboratories (CNL),* CW-513430-REPT-001, 53749225.

[13] *PHAI Phase 2 Public Information Program,* 4500-513000-PLA-003, 51386022.

[14] *Managing Regulatory Communications and Commitments*, 900-514300-MCP-005, 50978336.

[15] Canadian Nuclear Safety Commission, *Guidance Document on Confidential Filings*, Edocs 4604633, http://www.nuclearsafety.gc.ca/eng/the-commission/pdf/guidance-document-on-confidential-filings-eng.pdf.

[16] *Protection of Information*, 900-508710-STD-002, 12497604.

[17] *Site Annual Compliance Monitoring Report*, 900-514300-TMP-001, 51416020

[18] *CNL Annual Compliance Monitoring Report*, 900-514300-TMP-002, 51416431

[19] *Preparation and Content of CNL Annual Compliance Monitoring Reports*, 900-514300-STD-003, 51473160.

[20] *Nuclear Substances and Radiation Devices Regulations*, SOR/2000-207.

[21] *Administrative Monetary Penalties Regulations*, SOR/2013-139.

[22] Glossary of Controlled Terms and Acronyms, https://cnllnc.sharepoint.com/sites/TermsandDefinitions.

[23] *Site Licences, Certificates, Permits, Building/Facility Contacts, & Licence Representatives*, 900-514300-LST-001, 49255143.

[24] *CNL Management System Manual*, 900-514100-MAN-001, 12489834.

[25] *Creation, Capture and Use of Information Assets,* 900-511300-STD-003, 50746207.

Appendix A Regulatory Agencies other than the Canadian Nuclear Safety Commission

Regulatory Agency	Type of Arrangement	Functional Support Area or Department
Federal		
Department of Fisheries and Oceans	Reporting requirements: - Environmental Acts and Regulations, includes unplanned, emergency, and scheduled reporting.	Environmental Protection
Environment and Climate Change Canada	Reporting requirements: - Environmental Acts and Regulations (such as CEPA, SARA, CEAA 2012, Migratory Birds, Federal Halocarbons, etc) includes unplanned, emergency, and scheduled reporting. - Asbestos Containing Products Regulations	Environmental Protection
Employment and Social Development Canada	Reporting requirements: - Canada Labour Code Part II; - Employer Annual Hazardous Occurrence Report; - Workplace Committee Report; - Hazardous Occurrence Investigation Record; - Assurance of Voluntary Compliance. - Hours of Work issues (under the Canada Labour Code)	Occupational Health and Safety and Human Resources
Global Affairs Canada	Dual-Use material permitting	Supply Chain and Transportation of Dangerous Goods
Government Employees Compensation Regulations	Reporting requirements: - Employer’s Report of Injury/Disease.	Occupational Health and Safety
Impact Assessment Agency	Came into effect in 2019 August.	Environmental Protection
International Atomic Energy Agency (IAEA)	Safeguards Reporting through arrangements with CNSC, as required.	Nuclear Materials and Safeguards

Regulatory Agency	Type of Arrangement	Functional Support Area or Department
Natural Resources of Canada (NRCan)	NRCan (and can be via AECL) requests CNL, through formal correspondence to Vice-President and General Manager of Decommissioning and Waste Management, to provide updated data for the inventory of radioactive waste in CNL. This information is used for the preparation of the Inventory of Radioactive Waste in Canada report published by NRCan.	Waste Management
Treasury Board	Notification of revocation of a security clearance; Government of Canada Security Policy.	Security
Transport Canada	Transportation events, reported as required.	Transportation of Dangerous Goods
Provincial		
Emergency Management Ontario	Reporting requirement during an emergency.	Emergency Preparedness
Sécurité Civile du Quebec	Reporting requirement during an emergency.	Emergency Preparedness
Emergency Measures Organization - Manitoba	Reporting requirement during an emergency.	Emergency Preparedness
Province of Ontario, Police of Jurisdiction	Reporting requirements of business firearm licence: - Immediate reporting of firearms discharge other than scheduled range practice to Police of Jurisdiction and the Chief Firearms Office for the Province of Ontario. - Notification of any employee handling firearms weapons devices or ammunition covered by the Firearms Act that has been charged or convicted of an offence referred to in section 5 of the Firearms Act, treated for mental illness, or has exhibited violent behaviour that may make them ineligible for a licence. - Notification within 24 hours if an employee licensed under the act is suspended from firearms carrying duties.	Security

Regulatory Agency	Type of Arrangement	Functional Support Area or Department
	- Notification of any employee handling firearms weapons devices or ammunition covered by the Firearms Act that has terminated employment.	
Chief Firearms Officer – Manitoba (CNSC is prime regulator as of Fall 2020)	Reporting requirements of business firearm licence: - Immediate reporting to a Peace Office and the Chief Firearms Office of Manitoba of any firearms discharge that causes injury to a person or damage to property. - Notification of any new employee hired by the business who handles or would handle firearms, weapons, devices or ammunition covered by the Firearms Act. - Notification of any employee who ceases to be employed by the business in the capacity, or at all, of handling firearms, weapons, devices or ammunition covered by the Firearms Act. - Immediate reporting to a Peace Officer and the Chief Firearms Office of Manitoba of any theft or loss of firearms, weapons, devices or ammunition covered by the Firearms Act.	Security
Ministry of Transportation, Ontario	Reporting requirements: - Changes to Licences of CNL fleet of Ontario licenced vehicles	Infrastructure and Transportation of Dangerous Goods
Ministry of Environment, Conservation & Parks – Ontario	Protection of Ontario's air, land, water, species at risk and their habitats, enforce compliance with environmental laws Reporting requirements: - Spills on non-federal lands	Environmental Protection
Ministry of Labour Ontario	Reporting requirements: - Occupational Health & Safety Act and associated Regulations; - Workplace Safety & Insurance Act.	Occupational Health and Safety
Workplace Safety and Insurance Board (WSIB) – Ontario	Reporting requirements: - Worker's Compensation Act (Ontario)	Health Centre

Regulatory Agency	Type of Arrangement	Functional Support Area or Department
Worker's Compensation Board of Manitoba	Reporting requirements: - Worker's Compensation Act (Manitoba)	Health Centre
Ontario Energy Board	Electricity Wholesaler Licence – *expires 2027 Dec 14*	Infrastructure
Technical Standards and Safety Authority (Boilers and pressure vessels division)	Authorized Inspection Agency Services Agreement between Technical Standards and Safety Authority and CNL (Revised Agreement, effective 2022 April 01).	Engineering - Pressure Boundary
Technical Standards and Safety Authority (Elevating devices division)	Authorized Inspection Agreement between Technical Standards and Safety Authority and CNL for inspection and licensing of elevators.	Infrastructure
Manitoba Department of Labour and Immigration	Reporting requirements: - The Steam and Pressure Plants Act (Manitoba), C.C.S.M. c. S210	Engineering - Pressure Boundary

Appendix B General Content of Event Report

#	Required Information
1	***Report Details:*** - ImpAct number and title - Type of report – preliminary/combined/full - Reference to the preliminary report or notification (in full reports) - Date and the time of the initial verbal report - Name and signature of the Designated Representative of the Licensee - Name of CNSC staff member contacted for the situation/event - Reporting provision (from NSCA, the Regulations, licence/LCH)
2	***Details on event circumstances:*** - Date and time of the onset - Indication if the situation is ongoing - Date and time of discovery - Event duration (known or estimated) - Location, where the situation or event occurred - The effective dose and equivalent dose of radiation received by any person as a result of the situation or event, including the measured or estimated doses to the public - Any problem with a radiation device, if applicable - Action Levels reached
3	***Consequences of the event:*** - Effects on the health, safety and security of persons or the environment, any releases of radioactive and/or hazardous substances to the environment - Effects on the maintenance of security - International obligations that have resulted or may result from the situation or event, If applicable - Qualifications of the workers, including trainees, for any situation or event which involved an exposure device - Information on the nuclear substance and the name, model, and serial number of the radiation device involved, where applicable - Names of persons involved and the details of the packaging and packages, for dangerous occurrences under PTNSR 2015
4	***Actions:*** - Immediate actions resulting from the event - Further actions taken or proposed to be taken to correct or prevent recurrence of the event, including the delivery date and the responsibility (by title).

#	Required Information
	- Whether an Extent-of-Condition evaluation will be performed.

Appendix C Proactive Notification Template

Proactive Notification **(Information for Item of Regulatory Interest)**	
ImpAct Title	/Impact title as it appears in ActionWay/
ImpAct Number	/Impact ID number as in ActionWay/
Date of Occurrence	/YYYY-MM-DD/
Summary of Occurrence	/Short description of the occurrence/
Actions Taken by Licensee	/Bulleted list of actions taken/

- *Populate the above table and submit in MS-Word format to Regulatory Affairs for review after it has been reviewed by management and Subject Matter Experts (email to: >>RegAff).*
- *The 'Summary of Occurrence' should include brief description of the occurrence; should avoid irrelevant information. All acronyms must be developed at first use.*
- *The 'Actions Taken by Licensee' should be described clearly, with clear objectives. The actions that are complete should be identified.*
- *After the Regulatory Affairs review is complete, include the above table in an email to CNSC staff.*
- *Set security designation of the email as appropriate (Unrestricted or Protected-Sensitive).*
- *Address as appropriate (refer to the information on CNSC contacts and the CNL Distribution List for Regulatory Correspondence available at the Regulatory Affairs intranet site).*
- *Definition of Proactive Notification is available in procedure 900-514300-MCP-006, CNL Reporting to Regulatory Agencies.*
- *For reportable events use the form 900-514300-FM-002, Unplanned Event Report.*

Appendix D Language Used in Unplanned Event Reports

a) Is the title appropriate?
  1) Could the title shock the reader or cause undue alarm?
b) Is the language clear and concise?
  1) The full report is to state facts only.
  2) There shall not be any slang used in the report.
c) Is the language free of editorial opinions?
  1) There shall not be any language that is speculative or tentative.
    i) e.g., speculative language: I think, Could be, Assumedly, Seems to.
      a) Use →At this time the root cause is linked to…
    ii) e.g., tentative language: I would like to, By any chance, hope, supposedly, probably, sometimes.
  2) There shall not be any language that is emotional. Value statements shall not be added to the language.
    i) e.g., emotional language:
      a) Words like "always, only, very" should be avoided.
      b) e.g., This branch always hands in their reports late.
      Use →The report was handed in late.
      c) e.g., The data showed that only 5% of the liquid contained heavy water.
      Use →The data showed that 5% of the liquid contained heavy water.
      d) e.g., The RP signage was very hard to see.
      Use →The RP signage was hard to see due to boxes placed in front of it.
d) There shall not be any inflammatory statements regarding individual staff or programs/policies.
  1) e.g., Employee X has been repeatedly asked not to do this.
  2) e.g., We have asked for this piece of equipment to be fixed but no one ever listens.
  3) e.g., This problem seems to arise every other month.
  4) e.g., That department does not cooperate with other departments.
  5) e.g., This problem arises due to the silos that exist on site.
  6) e.g., This issue has been brought to the attention of management but they have yet to act on it.
e) The language used shall not be shocking or causing any undue fear.
f) The title or text shall not admit or imply guilt.
  1) e.g., Use "non-compliance" or "non-conformance" as appropriate instead of "violation".

The report shall present the information as facts and not add value statements. The information provided in the report shall be accurate and truthful.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Program Description Document

Safety Analysis

Management System Document

900-508770-PDD-001

Revision 5

Information Use

Approved by: [signature] 2022/10/07

David Garrick
Functional Support Manager
Safety Analysis

Date

Effective date: 2022/10/24

Mandatory Review by Date: 2025/10/24

Revision History

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
5	2022/10/07	Issued as “Approved for Use”.	M. Karam	A. Bakewell	D. Garrick
5D1	2022/08/12	Issued for “Review and Comment”. Minor Changes. General updates to formatting and alignment to a new template. Minor editorial changes: • Addition of the first paragraph in Section 1 to align with the latest version of the template. • The order of the first and second paragraph in Section 1 (of Rev 4) is switched to align the content with the added paragraph in the above bullet. • The complete definition of “safety analysis” from reference [1] is added in the fourth paragraph. • Moved the bullets and last two paragraphs from Section 2 (Purpose) to Section 5 (Functional Programs) to align with the description in the new template. • Rearranged the references in chronological order to align with the after mentioned text move in the above bullet. References [8], [9] and [7] are rearranged to be [7], [8] and [9], respectively. • Added “Chief Safety & Licensing Officer” as the Safety Analysis Functional Support Manager in Section 4.1. This is done to align with CNL Management System Manual which states that the Chief Safety & Licensing Officer responsibilities are described in PDD for Safety Analysis. • Rephrasing the wording of the six bullet in Section 4.2 to clarify the meaning. • Added a new reference [12] for the Safety Review Committee in Section 5.1.1 and rearranged existing references [12] and [13] to [13] and [14], respectively.	M. Karam	A. Dash D. Garrick Y. Dube R.Kingsbury	

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
		• Added the following text to Section 5.1.1 to clarify requirements for planning small vs complex projects as follows: "The level of documentation is commensurate to the level of work. For simple projects, no documentation may be required apart from discussion and confirmation from the stakeholders. For more complex projects with multiple deliverables, a detailed plan may be prepared". • Wording for the first two bullets in Section 5.1.2 is updated for clarity of the meaning. • Added "including Design Extension Conditions (DEC)' to the last bullet in Section 5.1.2. • Replaced "key phenomena" with "postulated initiating events, hazards" in the second paragraph of Section 5.1.3. • Replaced Operations with Nuclear Facilities in the third and fourth bullets in Section 5.1.4. • Added a new internal interface group "Nuclear Criticality Safety" in Section 6.1. • Corrected the name of IAEA in the table in Section 6.2 from International Atomic Energy Association to International Atomic Energy Agency.			
4	2021/07/22	Issued as "Approved for Use". Minor Changes. General updates to formatting and alignment to a new template. Minor editorial changes: • Table in Section 6.1: replaced Operations with Nuclear Facilities. Removed Change Control Committee meetings and added TOE. Changed HSSE&Q to HSSE. • Table in Section 6.2: changed primary interface contact with CNSC to Manager of Canadian Nuclear Laboratories Regulatory Affairs Branch. Changed primary interface contact with	M. Karam		D. Garrick

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
		International Groups to Office of Safety and Licensing. • Update to references [1], [8], [12] & [13].			
3	2020/07/30	Issued as "Approved for Use". Minor Changes. Updated to incorporate minor editorial changes.	M. Karam		D. Garrick
2	2019/09/19	Issued as "Approved for Use".	M. Karam		D. Garrick
2D1	2019/08/22	Issued for "Review and Comment". Minor editorial changes.	M .Karam	A. Coulas D. Cram J. DeRuiter Y. Dube D. Garrick G. Hamilton V. Mihaylov N. Mantifel S. Mistry J. Slade	
1	2018/11/30	Issued as "Approved for Use". Replaced "Manager, Safety Analysis" by "Designated Safety Analysis Manager". Added reference to 900-508120-MCP-003 for verification activities. Added Configuration Management to the internal interfaces table.	M. Karam		D. Garrick
1D1	2018/09/20	Issued for "Review and Comment". Minor editorial changes. Minor change to Section 1 to align with the PDD. Replaced sub-section numbering by table caption as per latest template. Updated requirements to latest CRL LCH.	M. Karam	S. Brewer A. Coulas Y. Dube D. Garrick G. Hamilton S. Karivelil N. Mantifel S. Mistry S. Sanders J. Slade	
0	2017/02/03	Issued as "Approved for Use". Cancels and Supersedes: 145-508770-OV-001, Safety Engineering and Licensing		D. Garrick	D. Garrick
D2	2017/01/10	Issued for "limited Review and Comment".		A. Coulas J. West	
D1	2016/12/15/31	Issued for "Review and Comment".	A. Writer	A. Bellil A. Caron S. Celovsky D. Garrick G. Hamilton S. Karivelil H. Khartabil K. Lundie N. Mantifel S. Mistry B. Orbanski R. Ponnan K. Schruder	

Table of Contents

1. Scope and Applicability

This Company-wide Interpretation document applies to all activities unique to the Safety Analysis Functional Support Area (FSA), performed by Canadian Nuclear Laboratories (CNL) across all sites.

The Safety Analysis FSA processes apply to all safety analysis activities involving CNL structures, systems and components (SSCs), and all management, supervision and staff across all CNL sites.

The Safety Analysis FSA develops and controls the suite of nuclear safety analysis documents required to support the execution of safety analysis at CNL.

As defined by Canadian Nuclear Safety Commission (CNSC) [1], safety analysis is a systematic evaluation of the potential hazards that is associated with the conduct of a proposed activity or facility and that considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards or with respect to deterministic safety analysis, analysis by means of appropriate analytical tools that confirms the design basis for the items important to safety and ensures that the overall nuclear facility design is capable of meeting specified acceptance criteria. The relevant hazards, include radiological, nuclear criticality, fire, and chemical. However, with respect to compliance with the Nuclear Safety and Control Act (NSCA) and the pertinent regulations, the CNSC requirements are limited to consideration of the effects of all relevant hazards to radiological safety, and prevention of nuclear criticality accidents, or chemical hazards directly associated with CNSC licensed radioactive material.

Assessment of non-radiological hazards is included in the scope of other FSAs, such as Occupational Safety & Health [2] and Fire Protection [3] with aspects relevant to nuclear safety taken into account in Safety Analysis. The assessment of Nuclear Criticality Safety is governed by the Nuclear Criticality Safety FSA [4] and the results are an input to the safety case. Radiological hazards related to protection of workers and the public from ionizing radiation, is covered under the Radiation Protection FSA [5].

Any questions regarding the content or application of this document should be directed to the Functional Support Manager for Safety Analysis as identified in the *Functional Authorities* controlled list [6].

2. Purpose

The purpose of this document is to define how to conduct and maintain nuclear safety analysis to permit the successful completion of safe engineering design in support of new build, facility modification, facility operation, research and product development, decommissioning and disposal.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [7] and the *Glossary of CNSC Terminology* [1] contain specific meanings for those words that require further clarification.

4. Roles and Responsibilities

4.1 Safety Analysis Functional Support Manager

The Chief Safety & Licensing Officer is the Safety Analysis Functional Support Manager (FSM) and is responsible for:

- The preparation and maintenance of the safety and licensing basis for all facilities at CNL.
- Ensuring the quality of all safety analysis and the compliance with all policies, procedures, regulations and site licensing requirements.
- Ensuring the oversight of any safety analysis being conducted at CNL following the Safety Analysis FSA processes.
- Delegation of the Safety Analysis Authority (Safety Analysis FSA) [8].

4.2 Safety Analysis FSM Designate

A Safety Analysis FSM Designate is a person to whom the accountability for Safety Analysis activities have been delegated by the CNL Safety Analysis FSM, and is responsible for:

- Managing and supervising the execution of safety analysis work.
- Ensuring compliance with all policies, procedures, regulations and site licensing requirements.
- Ensuring the use of qualified personnel and appropriate procedures.
- Reviewing safety analysis FSA processes and procedures.
- Approving safety analyses.
- Providing safety analysis to support response to emergency events.
- The overall responsibility for technical work executed within Safety Analysis FSA.
- Providing advice / guidance to CNL personnel on nuclear safety matters.

4.3 Technical Lead

A Technical Lead (demonstrated technical competencies in a subject matter area) is responsible for:

- Providing guidance and mentorship to Analysts / Engineers conducting safety analyses.
- Ensuring compliance with company procedures.
- Reviewing safety analyses.

4.4 Safety Analyst / Engineer / Subject Matter Expert

A Safety Analyst / Engineer / Subject Matter Expert (SME) undertakes work related to nuclear safety. A Safety Analyst / Engineer / SME is responsible for:

- Performing work in accordance with Safety Analysis processes and procedures.
- Providing advice and guidance to CNL personnel on nuclear safety matters as required.

5. Functional Programs

The objectives of safety analysis include:

- Confirming that the design of the nuclear facility meets its nuclear safety requirements.
- Characterizing the events that are applicable to the site and facility design; deriving or confirming operational limits and conditions (OLCs).
- Analyzing and evaluating event sequences that result from the failure of SSCs.
- Confirming the range of conditions and events taken into account in the design basis.
- Demonstrating that the management of the anticipated operational occurrences (AOOs) and design basis accidents (DBAs) is possible by automatic response of either the control systems or safety systems in combination with prescribed operator actions.
- Confirming that the results of a safety analyses are within design basis limits and radiological dose acceptance criteria.

The Safety Analysis FSA also manages requirements and processes and provides advice to all safety analysts to ensure that safety analysis activities are performed in a manner that considers protection of workers, the public, and the environment, and are in compliance with applicable regulatory and licence requirements. The Safety Analysis FSA documents the requirements for planning, performing and documenting safety analyses for the full lifecycle of nuclear facilities from design through to decommissioning or disposal.

The Safety Analysis FSA requirements are listed in the Program Requirements Document [9].

5.1 Process Description

The Safety Analysis FSA supports the execution of complex technical safety analyses and independent routine hazard assessment activities. It includes activities such as:

- Hazard analysis
  - Identification of hazards using systematic processes.
  - Risk ranking and classification of hazards.
- Safety analysis
  - Radiological consequence assessment of accidents/hazards/postulated initiating events.
  - Analytical modelling of event sequences such as, atmospheric dispersion, thermal hydraulic, reactor physics, etc.
  - Probabilistic modeling of event sequences, such as fault tree analysis (FTA), event tree analysis (ETA), reliability analysis, etc.
  - Uncertainty analysis of safety analyses.
- Safety assurance
  - Specification of safety analysis processes and procedures.
  - Verification and validation of safety analyses.
  - Verification and validation that the design meets the safety requirements.

Activities are executed in accordance with the procedures and instructions that can be found in the *Safety Analysis* procedure [10], the *Safety Analysis for Decommissioning and Waste Management* standard [11], and the procedural documents referenced within.

All safety analysis activities are performed using:

- Systematic analysis methodology with justified assumptions and inputs.
- Verified and validated computer codes.
- Accounted for uncertainties in the safety analysis models and inputs.
- Traceable and reproducible degrees of conservatism commensurate with the severity of the analyzed event and associated uncertainties.
- Accepted review process.

The safety analysis processes allow for development, maintenance, oversight and effectiveness reviews of all work related to nuclear safety. These ensure all analysis is compliant with the requirements of the Safety Analysis FSA.

5.1.1 Define Safety Analysis Plan

Prior to executing safety analysis, the scope, purpose, requirements, acceptance criteria and a suitable methodology are defined and documented in conjunction with stakeholders. This includes the operating organization and relevant safety and licensing organization. The level of documentation is commensurate to the level of work. For simple projects, no documentation may be required apart from discussion and confirmation from the stakeholders. For more complex projects with multiple deliverables, a detailed plan may be prepared. The plan is developed by determining if an independent safety review is required, identifying deliverables, determining required Safety Review Committee (SRC) [12] and CNSC involvement, outlining relevant quality and verification activities.

A consistent graded approach can be used in determining the scope and detail of safety analysis consistent with the risk associated with the activity. CNL safety analysis covers a wide range of facilities and projects and hence a wide range of risks and hazards. A higher level of rigour is applied for complex analyses, if there are large uncertainties, or if margins to acceptance criteria are expected to be small. Less rigour can be applied to addressing each of the requirements for safety analysis when the scope, hazards, consequences, and risk are reduced.

5.1.2 Identify and Classify Hazards and Events

A systematic process, based on regulatory requirements, operational experience, engineering judgement, and design review is used to define events, event sequences and event combinations that can potentially challenge the safety or control functions of the nuclear facility. These events include credible SSC failures or malfunctions, operator errors, as well as common-cause internally and externally initiated events.

Hazards are identified and classified prior to the execution of safety analysis and can include:

- Radiological hazards related to production, possessing, processing, storing and disposing of nuclear substances at the facility.

- Chemical hazards associated with the nuclear substances.
- Facility hazards that could affect the safety of nuclear substances and thus present an increased radiological risk.
- Potential accident sequences caused by process deviations or other events internal to the facility and credible external events, including natural phenomena.
- Consequence and the frequency of occurrence of each potential accident sequence, and the methodology used to determine the consequences and frequency.
- Each item relied on for safety, the characteristics of its preventive, mitigating, or other safety function, and the assumptions and conditions under which the item is relied upon to support compliance with the performance requirements.
- Common-cause failures initiated by internal and/or external events.
- Classify the events selected for analysis into: AOOs, DBAs and beyond design basis accidents (BDBAs) including Design Extension Conditions (DEC).

5.1.3 Execute Safety Analysis and Assess Results

Work is executed by following the developed plan and in accordance with procedures and instructions that can be found in the Safety Analysis documentation [10] and [11], and the procedural documents referenced within.

The scenarios, postulated initiating events, hazards and event sequences are analyzed. The results of each safety analysis are assessed for parameters directly related to acceptance criteria and margins are assessed relative to the uncertainties. The safety assessment needs to clearly identify any requirements for a change in design or operations, including identification of OLCs as appropriate. The execution of safety analysis can also include confirmation that the defence in depth of the facility or site meets expectations.

Where there is uncertainty regarding an event sequence or safety case, the uncertainty are addressed through means, such as sensitivity analysis, additional assessment and justification of assumptions and key parameters, or in the case of long term assessments, natural analogues can be used to demonstrate system robustness.

5.1.4 Execute Design and Operational Support Activities

Depending on the reason for the analysis, additional activities could be identified in the analysis plan and carried out after completion of the initial analysis, sometimes as an input to further analysis. This can include specification of OLCs, confirmation or recommendation of safety measures, redefinition of events to be analyzed, determination of failure event sequences, and specification of automatic response of either the control systems or safety systems.

Design and operational support includes activities such as:

- Interfacing with Design (can be CNL Engineering or an external contractor) during definition phase for design requirements, component requirements, pressure boundary, etc., to specify safety requirements.

- Providing support to Design with document reviews, formal and informal communications, etc., to confirm safety requirements.
- Interface with Nuclear Facilities to specify safety requirements, such as OLCs, trip and alarm (T&A) set points, etc.
- Providing support to Nuclear Facilities with document reviews, formal and informal communications, etc., to confirm safety requirements.
- Defining safety envelope for new and modified operations, such as job reviews, experimental/infrequently performed operations approvals, conditional release request (CRR), technical operability evaluation (TOE), operational decision making (ODM), etc.

5.1.5 Verify, Approve and Release Results

After events have been analyzed, the results are verified against the acceptance criteria of initial classification and grouping. Should the results of an analysis be less consequential than initially postulated, or likelihood of occurrence change upon development of the event sequence, the initial classification and grouping can be examined/revised.

Verification activities are carried out in accordance with the *Design and Development Review and Design Verification* procedure [13] and include:

- Independent review of technical work, analysis methods and calculations.
- Review of both technical and process documentation for safety-related activities.

All work conducted in accordance with the Safety Analysis FSA processes is subject to management review and approval. Where required by provincial legislation, formal documents produced may require signing and sealing by a professional engineer. Any such endorsement is carried out in accordance with the *Preparation of Design Document* procedure [14].

6. Interfaces

6.1 Internal Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Design Engineering	Design drawings, technical notes, safety requirements, Independent Safety Assessments	Visits, meetings, phone calls, e-mails	Chief Engineer Director, Engineering Services Design Authority
Configuration Management	Engineering Change Control (ECC)	ECC process	Designated Engineering Manager for CM
Nuclear Criticality Safety	Criticality hazard identification (CHI) study	Meetings, documentation of CHI study	Nuclear Criticality Safety Program Manager

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Nuclear Facilities	TOE and ODM support License amendment support Safety Analysis Report (SAR) Development and update	Visits, meetings, phone calls, e-mails	Facility Authorities Facility Managers
Science & Technology	Safety analysis documentation in support of new Research & Development facilities and modification to existing Research & Development facilities	Visits, meetings, phone calls, e-mails	Facility Authorities Facility Managers
Regulatory Affairs	Safety analysis documentation in support of submissions to CNSC, license renewals / extensions	Visits, meetings, phone calls, e-mails	Manager, Regulatory Affairs
Environmental Remediation Management	Independent verification of safety analyses conducted by Environmental Remediation Management (ERM)	Visits, meetings, phone calls, e-mails	Director, ERM Safety, Licensing & Engineering Manager, ERM Safety & Licensing
Health, Safety, Security and Environment (HSSE) FSAs	Information pertinent to Safety Analysis activities that have an effect on HSSE FSAs. Information pertinent to HSSE FSAs that have an effect on Safety Analysis activities.	Visits, meetings, phone calls, e-mails Document review and comment	FSM from Functions in HSSE Lead area

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Canadian Nuclear Safety Commission (CNSC)	Licensing and regulatory compliance issues	Annual meetings, Quarterly meetings	Manager of Canadian Nuclear Laboratories Regulatory Affairs Branch
Canadian Standards Association (CSA)	Information exchange and collaboration	Nuclear Standards Steering Committee and Technical Committees	Nuclear Technical Committee Secretariat
International Groups: • CANDU Owners Group (COG) • International Atomic Energy Agency (IAEA)	Information exchange and collaboration	Working groups, Peer reviews	Office of Safety and Licensing

7. References

[1] *Glossary of CNSC Terminology*, REGDOC-3.6, Canadian Nuclear Safety Commission, 2021 May.

[2] *Occupational Safety & Health*, 900-510400-PDD-001, 40761159.

[3] *Fire Protection*, 900-508720-PDD-001, 40793276.

[4] *Nuclear Criticality Safety*, 900-508550-PDD-001, 42019403.

[5] *Radiation Protection*, 900-508740-PDD-001, 12487852.

[6] *Functional Authorities*, 900-514100-LST-001, 51965478.

[7] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions

[8] *Assigning a Delegation of Safety Analysis Authority*, 900-508770-MCP-003, 42080247.

[9] *Safety Analysis*, 900-508770-PRD-001, 52738121.

[10] *Safety Analysis*, 900-508770-MCP-001, 50035305.

[11] *Safety Analysis for Decommissioning and Waste Management*, 900-508770-STD-001, 40772318.

[12] *Independent Technical and Readiness Reviews*, 900-514300-MCP-002, 52058514.

[13] *Execution of Design Review and Verification*, 900-508120-MCP-003, 43929122.

[14] *Production and Acceptance of Design Documents*, 900-508120-MCP-002, 49231096.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Safety Analysis

900-508770-PRD-001

Revision 6.1

Information Use

Approved by:	David Garrick	2024/03/20
	Sr Director, Nuclear & Critica	Date

Effective Date: 2024/04/30
Expiry Date: 2027/03/20

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Revision History

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
6.1	2024/03/13	Issued as “Approve for Use”	M. Karam	A. Bakewell	D. Garrick
6.1D1	2024/03/07	Issued for “Review and Comment”. Minor Changes. Revised in response to CNSC Staff comments received in 145-NOCN-23-0055-L (e-Doc-7179596), and aligned with CNL's disposition to the comments as documented in 145-CNNO-24-0003-L (e-Doc 7210661) and accepted by the CNSC staff in 145-NOCN-24-0009-L (e-Doc 7214133). Minor changes are as follows: • Sentences are added to Sections 3.2.1 and 3.2.2 to clarify the area of applicability of REGDOC-2.11.1 (Volume III) and REGDOC-2.4.4, respectively. • Added Section 1.2 (Scope) of REGDOC-2.11.1 Volume III to Table 4. • A note is added to Table 12 to clarify the applicability of REGDOC-2.4.4 vs. REGDOC-2.11.1 (Volume III). • Added two missing clauses (4.3.1 Identification of postulated initiating events) from REGDOC-2.4.4 into Table 5.	M. Karam	A. Bakewell	
6	2023/10/30	Issued as “Approved for Use”.	C. Popistas	A. Bakewell	D. Garrick
6D1	2023/10/09	Issued for “Review and Comment”. Major changes: General updates to formatting and alignment to a new template, including addition of Table 12. Included REGDOC-2.4.4 requirements (Section 3.1.3). Included CSA N292.0, N292.2, N292.3 and N292.6 requirements (Section 3.2).	C. Popistas	A. Bakewell M. Karam S. Melnyk S. Mackie T. Pehkonen	D. Garrick

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
		Also, the following were included: • *Deterministic Safety Analysis*, REGDOC 2.4.1. • *Safety Assessment for Facilities and Activities*, IAEA GSR Part 4. • *Safety Analysis and Licensing Documentation for Nuclear Fuel Cycle Facilities*, IAEA SRS No. 102. • *Procedures for Conducting Probabilistic Safety Assessment for Non-reactor Nuclear Facilities*, IAEA TECDOC-1267. • *Safety of Nuclear Fuel Cycling Facilities*, IAEA SSR-4.			
5	2022/11/02	Issued as “Approved for Use”.	M. Karam	A. Bakewell	D. Garrick
5D1	2022/09/02	Issued for “Review and Comment”. Minor Changes. General updates to formatting and alignment to a new template. Minor changes: • Section 1 is updated to align with the latest version of the new template. • The second paragraph in Section 3 is deleted to align with new template. • Last three bullets are added to Section 4 to identify requirements from REGDOC-2.11.1 Volume I, Volume III and REGDOC-2.11.2, respectively • Table 2 changes: • document 900-508770-FID-005 is voided, removed from Table 2 and replaced by the applicable suite of safety analysis documents • document 900-508770-FID-007 is canceled and	M. Karam	A. Bakewell	D. Garrick

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
		superseded by 900-508770-MCP-004 (added to Table 2) • document 900-508770-MCP-002 is added to Table 2 • document 900-508770-LST-001 is added to Table 2 • Two rows (3 and 4) are added to Table 2 to list clauses for Safety Analysis Program in the CRL LCH • Added the last two rows in Table 3 to list clauses for Safety Analysis Program in the WL LCH • Table is updated to provide the applicable clauses from the LCHs for G-1, NPD and DP Waste Facilities • Added a new table (Table 5) to include applicable clauses from REGDOC-2.11.1 Volume I and Volume III and REGDOC-2.11.2 as they fall under Safety Analysis scope. These REGDOCs are listed in the LCHs of various CNL sites • Added a new table (Table 6) to include applicable clauses from CSA N294-19 as they fall under Safety Analysis scope. These CSA N294-19 is listed in the LCHs of various CNL sites • Added a new table (Table 7) to include an applicable clause from the Site Operating Company Agreement (SOCA) • Section 6 (References) is deleted to align with the new template			
4	2021/06/21	Issued as “Approved for Use”. Minor Changes. Updated to include applicable requirements from CSA N286-12 (R2017) and editorial changes.	M. Karam		D. Garrick
3	2020/09/25	Issued as “Approved for Use”. Minor Changes. Updated to include applicable	M. Karam		D. Garrick

Rev. No.	Date	Details of Revision	Prepared By	Reviewed By	Approved By
		requirements from CSA N286-12 (R2017) and editorial changes.			
2	2019/09/19	Issued as “Approved for Use”.	M. Karam		D. Garrick
2D1	2019/08/22	Issued for “Review and Comment”. Minor editorial changes.	M .Karam	C. Ball D. Cram Y. Dube G. Hamilton N. Mantifel J. Slade A. Coulas J. DeRuiter D. Garrick V. Mihaylov S. Mistry	
1	2018/11/30	Issued as “Approved for Use”.	M. Karam		D. Garrick
1D1	2018/09/20	Issued for “Review and Comment”. Minor editorial changes. Minor change to Section 1 to align with the PDD. Replaced sub-section numbering by table caption as per latest template. Updated requirements to latest CRL LCH.	M. Karam	C. Ball A. Coulas D. Garrick S. Karivelil S. Mistry J. Slade S. Brewer Y. Dube G. Hamilton N. Mantifel S. Sanders	
0	2017/02/03	Issued as “Approved for Use”.		D. Garrick	D. Garrick
D2	2017/01/10	Issued for “limited Review and Comment”.		A. Coulas J. West	
D1	2016/12/15/31	Issued for “Review and Comment”.	A. Writer	A. Bellil S. Celovsky G. Hamilton H. Khartabil N. Mantifel B. Orbanski K. Schruder A. Caron D. Garrick S. Karivelil K. Lundie S. Mistry R. Ponnan	

Table of Contents

1. Scope and Applicability

This Company-wide Document applies to all activities unique to the Safety Analysis Functional Support Area (FSA), performed by Canadian Nuclear Laboratories' (CNL) employees, contractors, and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

2. Purpose

This document identifies the requirements for conducting safety analysis activities at CNL in order to demonstrate conformance to all applicable laws, regulations, company policies and procedures.

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business and the dynamic nature of the regulatory environment and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

The specific requirements to be addressed by the Safety Analysis FSA originate from the relevant acts and regulations, and licences that CNL holds. The process for implementation of requirements for the Safety Analysis FSA requirements is described in the relevant Management System Documents, as provided in the follow-on tables.

- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028,* Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 4/CRL-508760-HBK-002 Revision 4, Canadian Nuclear Safety Commission, January 31, 2024 (Table 1).
- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-8.00/2024*, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1, Canadian Nuclear Safety Commission, 2023 April 03 (Table 2).
- *Prototype Waste Facilities – Waste Facility Decommissioning License, Gentilly-1 Waste Facility, WFDL-W4-331.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-331.00/2034 Revision 1/61-00580-HBK-001, Revision 0, Canadian Nuclear Safety Commission, 2019 July 18 (Table 3).
- *Prototype Waste Facilities – Waste Facility Decommissioning Licence Nuclear Power Demonstration Waste Facility WFDL-W4-342.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-342.00/2034 Revision 2/64-508760-HBK-001, Revision 2, Canadian Nuclear Safety Commission, 2023 August 15 (Table 3).
- *Prototype Waste Facilities – Waste Facility Decommissioning Licence Douglas Point Facility WFDL-W4-332.03/2030*, Licence Conditions Handbook, WFDL-LCH-W4-332.02/2030 Revision 1/22-508760-HBK-002, Revision 0, Canadian Nuclear Safety Commission, 2021 June 11 (Table 3).

- *Waste Management, Volume I: Management of Radioactive Waste*, REGDOC-2.11.1, Canadian Nuclear Safety Commission, 2021 (Table 4).
- *Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste, Version 2*, REGDOC-2.11.1, Canadian Nuclear Safety Commission, January 2021 (Table 4).
- *Decommissioning*, REGDOC-2.11.2 Canadian Nuclear Safety Commission, 2021 (Table 4).
- REGDOC-2.4.4, *Safety Analysis for Class 1B Nuclear Facilities,* Version 1.0, 2022 October (Table 5).
- *Management system requirements for nuclear facilities*, CSA N286, Canadian Standards Association, 2012 June (Table 6).
- *General principles for the management of radioactive waste and irradiated fuel,* CSA N292.0, March 2019 (Table 7).
- *Interim dry storage of irradiated fuel,* CSA N292.2-13 January 2015 (Table 8).
- *Management of low and intermediate level radioactive waste*, CSA N292.3-14, May 2014.
- *Long-term management of radioactive waste and irradiated fuel,* CSA 292.6-18, 2018 (Table 9).
- *Decommissioning of facilities containing nuclear substances*, N294-19, Canadian Standards Association, 2019 November (
- Table 10).
- *Agreement for the Management and Operation of Certain Properties and Assets that are the Responsibilities of Atomic Energy of Canada Limited, Site Operating Company Agreement (SOCA)*, 2015 (Table 11).
- *Deterministic Safety Analysis*, REGDOC 2.4.1.
- *Safety Assessment for Facilities and Activities*, IAEA GSR Part 4.
- *Safety Analysis and Licensing Documentation for Nuclear Fuel Cycle Facilities*, IAEA SRS No. 102.
- *Procedures for Conducting Probabilistic Safety Assessment for Non-reactor Nuclear Facilities*, IAEA TECDOC-1267.
- *Safety of Nuclear Fuel Cycling Facilities*, IAEA SSR-4.

3.1 Licence Conditions Handbooks

3.1.1 Licence Condition Handbooks (LCHs)

Table 1: Licence Conditions Handbook for Chalk River Laboratories, NRTEOL-LCH-01.00/2028

Licence Conditions Handbook for Chalk River Laboratories, NRTEOL-LCH-01.00/2028		
Source, Section and Title	**Description**	**Implementing Document(s)**
4.1: Safety Analysis Program	The licensee shall implement and maintain a safety analysis program.	900-508770-PDD-001, *Safety Analysis* 900-508770-MCP-001, *Safety Analysis*

Licence Conditions Handbook for Chalk River Laboratories, NRTEOL-LCH-01.00/2028		
Source, Section and Title	**Description**	**Implementing Document(s)**
		900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-MCP-003, *Assigning a Delegation of Safety Analysis Authority* 900-508770-MCP-004, *Consequence of Failure* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-STD-002, *Hazard Identification and Analysis* 900-508770-FID-001, *Safety Related Equipment List Preparation* 900-508770-FID-002, *Safety Requirements Derivation and Verification in Support of Engineering Change Control* 900-508770-FID-003, *Preparation of Operational Limits and Conditions* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety* 900-508770-FID-008, *Dose Calculations Pertaining to Respirable Radiation Sources* 900-508770-FID-009, *Dose Calculations Pertaining to External Gamma Radiation Sources* 900-508770-FID-010, *CAFTA Processing for Event Tree and Fault Tree Analysis* 900-508770-MCP-001680, *Recommended Inputs for RESRAD offsite Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report* 900-508770-MCP-001387, Preparing a Safety Analysis Report 900-508770-FID-014, Preparation of Facility Authorization Document 900-508770-FID-015, *Dose Calculations Pertaining to Skin Exposure* 900-508770-FID-016, *Dose Calculations for Ground Level Releases from Facilities at CRL* 900-508770-FID-017, *Determining Bounding Accident Scenarios* 900-508770-FID-018, *Recommended Inputs for the Calculation of On-Site and Off-Site Doses Following Hypothetical Accidental Atmospheric Radioactive Releases*

Licence Conditions Handbook for Chalk River Laboratories, NRTEOL-LCH-01.00/2028		
Source, Section and Title	**Description**	**Implementing Document(s)**
		900-508770-FID-019, *Reliability Analysis* 900-508770-LST-001, *Safety Analysis Authorities*
4.1: Safety Analysis Program	All event sequences which can occur in a nuclear facility must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the facility's responses to such events by using predetermined rules and assumptions. The objectives of the deterministic safety analysis are stated in REGDOC-2.4.1. Part II and Appendix C of REGDOC-2.4.1 are applicable to Research Reactors at CRL.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-004, *Consequence of Failure* 900-508770-STD-002, *Hazard Identification and Analysis* 900-508770-FID-003, *Preparation of Operational Limits and Conditions* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety* 900-508770-MCP-001387, Preparing a Safety Analysis Report
4.1: Safety Analysis Program	The General Nuclear Safety and Control Regulations require that a licence application contain a description and the results of any analyses performed. The Class I Nuclear Facilities Regulations require, amongst other requirements, that an application for a licence to operate a Class I nuclear facility contains a final safety analysis report, and additional supporting information.	900-508770-MCP-001387, *Preparing a Safety Analysis Report*
4.1: Safety Analysis Program	The licensee holds the responsibility for ensuring that the safety analysis is accurate and meets the regulatory requirements, and shall maintain adequate capability to perform or procure safety analysis and to train safety analysts.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report* 900-508770-LST-001, *Safety Analysis Authorities*
4.1: Safety Analysis Program	Where probabilistic safety assessments (PSA) are performed, the licensee shall ensure that	900-508770-STD-002, *Hazard Identification and Analysis*

Licence Conditions Handbook for Chalk River Laboratories, NRTEOL-LCH-01.00/2028		
Source, Section and Title	**Description**	**Implementing Document(s)**
	1. the limitations of the PSA are understood, recognized and taken into account in all its use, and the adequacy of a particular probabilistic safety assessment application is always checked with respect to these limitations; 2. when the PSA is used for evaluating or changing the requirements on periodic testing and allowed outage time for a system or component, all relevant items, including states of the systems and components and safety functions they participate in, are included in the analysis; and 3. the operability of components, that have been found by the PSA to be important to safety, is ensured and their role is recorded in the safety analysis report.	900-508770-FID-010, *CAFTA Processing for Event Tree and Fault Tree Analysis* 900-508770-FID-019, *Reliability Analysis*

Table 2: Whiteshell Laboratories Licence Conditions Handbook, NRTEDL-LCH-08.00/2024

Whiteshell Laboratories Licence Conditions Handbook, NRTEDL-LCH-08.00/2024		
Source, Section and Title	**Description**	**Implementing Document(s)**
4.1 - Safety Analysis Program	The licensee shall implement and maintain a safety analysis program.	900-508770-PDD-001, *Safety Analysis,* 900-508770-MCP-001, *Safety Analysis*
4.1 - Safety Analysis Program	All event sequences which can occur in a nuclear facility must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the facility's responses to such events by using predetermined rules and assumptions. The	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-MCP-004, *Consequence of Failure*

Whiteshell Laboratories Licence Conditions Handbook, NRTEDL-LCH-08.00/2024		
Source, Section and Title	**Description**	**Implementing Document(s)**
	objectives of the deterministic safety analysis are stated in CSA N292.0.	900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-FID-003, *Preparation of Operational Limits and Conditions* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety* 900-508770-MCP-001387, Preparing a Safety Analysis Report
4.1 - Safety Analysis Program	The General Nuclear Safety and Control Regulations require that a licence application contain a description and the results of any analyses performed. The Class I Nuclear Facilities Regulations require, amongst other requirements, that an application for a licence to operate a Class I nuclear facility contains a final safety analysis report, and additional supporting information.	900-508770-MCP-001387, *Preparing a Safety Analysis Report*
4.1 - Safety Analysis Program	The licensee holds the responsibility for ensuring that the safety analysis is accurate and meets the regulatory requirements, and shall maintain adequate capability to perform or procure safety analysis and to train safety analysts	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report* 900-508770-LST-001, *Safety Analysis Authorities*

Table 3: Licence Conditions Handbooks for Gentilly-1, Nuclear Power Demonstration and Douglas Point

Licence Conditions Handbooks (Gentilly-1, Nuclear Power Demonstration, Douglas Point)		
Source, Section and Title	**Description**	**Implementing Document(s)**
Gentilly-1, WFDL-LCH-W4-331.00/2034 /Nuclear Power Demonstration, WFDL-LCH-W4-342.00/2034		

Licence Conditions Handbooks (Gentilly-1, Nuclear Power Demonstration, Douglas Point)		
Source, Section and Title	**Description**	**Implementing Document(s)**
6.1 - Safety Analysis Program	The licensee shall maintain a safety report for the facility.	900-508770-PDD-001, *Safety Analysis* 900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001387, Preparing a Safety Analysis Report
6.1 - Safety Analysis Program	All event sequences which can occur in a nuclear facility must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the facility's responses to such events by using predetermined rules and assumptions. The objectives of the deterministic safety analysis are stated in CSA N292.0.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-MCP-004, *Consequence of Failure* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-FID-003, *Preparation of Operational Limits and Conditions* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety*
Douglas Point, WFDL-LCH-W4-332.02/2030		
4.1 - Safety Analysis Program	The licensee shall implement and maintain a safety analysis program	900-508770-PDD-001, *Safety Analysis,* 900-508770-MCP-001, *Safety Analysis*
4.1 - Safety Analysis Program	All event sequences which can occur in a nuclear facility must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the facility's responses to such events by using predetermined rules and assumptions. The objectives of the deterministic safety analysis are stated in CSA N292.0.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-MCP-004, *Consequence of Failure* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-FID-003, *Preparation of Operational Limits and Conditions* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety* 900-508770-MCP-001387, Preparing a Safety Analysis Report

3.2 Regulatory Documents

3.2.1 REGDOC-2.11.1 (Volume I and III) and REGDOC-2.11.2

REGDOC-2.11.1 (Volume III) applies to Class IB waste management facilities for the development of a safety case and supporting safety assessment for the post-closure phase of disposal facilities. For the pre-closure phase, only REGDOC-2.4.4 applies, and REGDOC-2.4.4 does not apply to post-closure.

Table 4: Waste Management, Volume I: Management of Radioactive Waste -REGDOC-2.11.1, Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management-REGDOC-2.11.1 and Decommissioning-REGDOC-2.11.2

Source, Section and Title	Description	Implementing Document(s)
REGDOC 2.11.1 Volume III Section 1.2 Scope	This regulatory document addresses the development of a safety case and supporting safety assessment for the post-closure phase of disposal facilities, which includes locations or sites, for all classes of radioactive waste. This document also applies to long-term radioactive waste management facilities, locations or sites where there is no intention to retrieve the waste.	900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*
REGDOC 2.11.1 Volume III Section 7.9 Institutional Controls	The licensee or applicant shall identify the role that institutional controls play in disposal facility safety, and how that role is taken into account in the safety case and its supporting safety assessment. The presence of institutional controls should not be used to justify a reduction in the level of design of the containment and isolation system. While long-term safety of the disposal facility should not be dependent on institutional controls, these should be used to the extent practicable to confirm that the disposal system is performing as designed. Given the uncertainties associated with future human activities and the evolution and stability of societies, licensees or applicants should limit reliance on institutional control as a safety feature to a few hundred years. For uranium mine and mill waste, the large volume of the waste and the longevity of some of the radionuclides might necessitate longer periods of institutional control as a means of providing safety. Reliance on such	900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*

Source, Section and Title	Description	Implementing Document(s)
	longer-term institutional control (beyond a few hundred years) should be justified in the safety case through an optimization process taking into account technical and socio-economic factors. REGDOC 2.11.1, Waste Management, Volume I: Management of Radioactive Waste, provides guidance on institutional control	
REGDOC 2.11.1 Volume I Section 10.1 General Requirements	The licensee shall develop, implement and maintain a safety case for the entire lifecycle of the radioactive waste storage facility in accordance with applicable regulations.	900-508770-MCP-001, *Safety Analysis*
REGDOC 2.11.1 Volume I Section 11.1 General Requirements	The licensee shall develop, implement and maintain a safety case for the entire lifecycle of the radioactive waste disposal facility, and a post-closure safety assessment, in accordance with applicable regulations. The licensee shall ensure that each of the stages in the lifecycle of a disposal facility is supported, as necessary, by evaluations of the site, design, construction, operation and closure of the facility, and of the performance and safety of the disposal system. Each of these stages shall be supported as necessary by an iterative evaluation of the disposal system. The licensee shall ensure the safety of the facility by means of multiple safety functions including the use of multiple barriers and controls; for example, the host environment, engineered barriers, and operating the facility within the limits and conditions derived from the safety assessments. The licensee shall site, design, construct, commission, operate and close the disposal facility: in such a way that safety is ensured by passive means to the fullest extent possible so as to minimize the need for actions to be taken after closure of the facility. The licensee shall identify SSCs important to safety. For radioactive waste disposal facilities, REGDOC-2.11.1, Waste Management, Volume III: Safety Case for Disposal of Radioactive Waste, provides requirements and guidance for licensees and applicants	900-508770-MCP-001, *Safety Analysis* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*
REGDOC 2.11.1 Volume I Section 8.6 Disposal	The licensee shall dispose of radioactive waste safely, in a manner that provides for the protection of people, the environment and national security, and that is in accordance with regulatory requirements. The licensee shall carry out disposal activities in accordance with its documented procedures. The licensee shall consider the impact	900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*

Source, Section and Title	Description	Implementing Document(s)
	of any modification to these activities on the safety of the disposed waste. For additional criteria for the disposal of radioactive waste, refer to section 11, Radioactive Waste Disposal Facility.	
REGDOC 2.11.2 Decommissioning; Section 7.2 Safety Assessment for Decommissioning	The licensee shall perform a safety assessment to identify any radiological or non-radiological hazards to workers, the environment and the public from both routine decommissioning activities and credible potential accidents during decommissioning. The safety assessment should support the activities listed in the DDP. The safety assessment should be conducted in accordance with a graded approach. The safety assessment may be a stand-alone document or may be included in the DDP. The results of the safety assessment should be used to: support the development of the decommissioning plan and selection of the decommissioning strategy specify the program for maintenance, surveillance and inspection specify the procedures to be put in place for all decommissioning activities significant to safety for responding to accidents or any identified risks specify the necessary competencies for the staff involved in the decommissioning of the facility, location or site make decisions using an integrated, risk-informed approach. The safety assessment should be updated as necessary in light of revised regulatory requirements, advances in decommissioning technology, changes in site characteristics, modifications to the design or operations, effects of aging, and operational experience and lessons learned. For a nuclear facility with a Class I or uranium mines and mills licence, the licensee shall ensure that the safety assessment: identifies hazards to workers, the public and the environment from planned decommissioning activities, accidents and natural events that may arise during decommissioning and potential initiating events describes the relative importance of the hazards and identifies the methods for mitigating their risks determines the safety functions necessary throughout decommissioning, and ensures that the related SSCs are suitable and will deliver these safety functions demonstrates adequate defence	900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*

Source, Section and Title	Description	Implementing Document(s)
	in depth and defines limits, controls and conditions for managing hazards demonstrates that adequate measures have been taken to prevent accident conditions and whether any consequences can be mitigated if accidents do occur determines the site characteristics related to the safety of the facility demonstrates that adequate measures have been taken to control hazards to an acceptable level, both in the present and in the long term, and to optimize protection and safety in decommissioning considers the combined and additive effects of hazards demonstrates that interdependencies between planned decommissioning actions are taken into account, and that any negative impacts of one action on another, as well as the possible generation of additional hazards, are properly taken into account Class II nuclear facilities and nuclear substances and radiation devices licensees may consult the above list for guidance, in accordance with a graded approach. For in situ decommissioning resulting in a disposal facility, location or site, a post-closure safety case (see section 5.1) shall be provided, in addition to the decommissioning safety assessment.	

3.2.2 REGDOC 2.4.4

REGDOC 2.4.4 describes the requirements for Safety Analysis for Class 1B nuclear facilities. The intent of this regulatory document is to clarify requirements and provides guidance for applicants and licensees on how to demonstrate the safety of a Class IB nuclear facility to the regulator. Table 5 depicts the implementation of the new standard within the Safety Analysis program, including actions that will be taken to ensure that requirements will be fully implemented. As indicated in Table 12, the REGDOC 2.4.4 is currently identified as a guidance document within numerous CNL licenses. Once it is fully implemented, it is proposed to become a Compliance Verification Criteria [See Footnote 3].

REGDOC-2.4.4 applies to the safety analysis of all Class IB facilities. This includes, waste management facilities for the pre-closure phase of disposal facilities. For the post-closure phase, REGDOC-2.11.1 (Volume III) applies instead of REGDOC-2.4.4.

Table 5: REGDOC-2.4.4, Safety Analysis for Class IB Nuclear Facilities

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
2 Safety Objectives	As stated in paragraphs 5(f) and 6(c) of the Class I Nuclear Facilities Regulations: "An application for a licence to construct a Class I nuclear facility shall contain the following information... (f) a preliminary safety analysis report demonstrating the adequacy of the design of the nuclear facility;" "An application for a licence to operate a Class I nuclear facility shall contain the following information... (c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;	Preparing a Safety Analysis Report, 900-508770-MCP-001387
2.1 Defence in depth	The licensee shall address the concept of defence in depth when developing a safety analysis for a nuclear facility	Safety Analysis, 900-508770-MCP-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387
2.2 Safety analysis objectives Requirements	The licensee shall maintain adequate capability to perform or procure a safety analysis	Safety Analysis, 900-508770-PDD-001 Procurement and Contracting, 900-505210-STD-001166
2.2 Safety analysis objectives Requirements	The licensee shall establish a process to assess and update the safety analysis	Scoping Review of a Safety Analysis Report, 900-508770-MCP-001460 Preparing a Safety Analysis Report, 900-508770-MCP-001387
2.2 Safety analysis objectives Requirements	The licensee shall systematically review the safety analysis results to ensure that they remain valid and continue to meet the safety goals, objectives and acceptance criteria	Scoping Review of a Safety Analysis Report, 900-508770-MCP-001460
3 Safety Analysis Program Requirements	The licensee shall develop, implement, conduct and maintain a safety analysis program for the nuclear facility	Safety Analysis, 900-508770-PRD-001 Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-GDI-001 (A complete list of the Safety Analysis Program documentation is included in the Governing Document Index).
3 Safety Analysis Program Requirements	In support of the program, the licensee shall establish one or more internal safety committees to advise the organization's management on safety issues related to the commissioning, operation and modification of the facility. The licensee shall ensure that the committee has the necessary breadth of knowledge and experience to provide appropriate advice. The	Independent Technical and Readiness Reviews, 900-514300-MCP-002.

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	members shall, to the extent necessary, be independent of the operations management raising the safety issue.	
3 Safety Analysis Program Requirements	The licensee shall provide these statements (safety, health and environmental policies) in the licence application as a declaration of the organization's objectives and the public commitment of corporate management	CNL Health and Safety Policy Committee, 900-510400-TOR-002. Environment, 900-509200-POL-001. "Application for Renewal of the Nuclear Research and Test Establishment Operating Licence for the Chalk River Laboratories – 2018", CRL-CNNO-17-0005-L, 22438143, Revision 0, 2017 March 30. "Application for Renewal of the Nuclear Research and Test Establishment Decommissioning Licence for the Whiteshell Laboratories", WLD-CNNO-18-0033-L, 43924589, Revision 0, 2018 November 15. Licence submission for Prototype Reactor Waste Facilities, "Request to Separate the Waste Facility Decommissioning Licence, WFDL-W4-332.01/2034 to Three Separate Licences for Douglas Point, Gentilly-1, and Nuclear Power Demonstration Waste Facilities", 140-CNNO-18-0003-L, 40540388, Revision 0, 2018 July 11.
3 Safety Analysis Program Requirements	The licensee shall also specify and put in place organizational structures, standards and management arrangements capable of meeting the organization's objectives and public commitments.	CNL Management System Manual, 900-514100-MAN-001
3 Safety Analysis Program Requirements	The licensee shall demonstrate that the safety analysis program is governed by the licensee's management system and is consistent with the applicable requirements of CSA N286-12, Management System Requirements for Nuclear Facilities	CNL Management System Manual, 900-514100-MAN-001 Safety Analysis, 900-508770-PRD-001
4. Safety Analysis Requirements	The licensee shall perform a safety analysis for normal operation, and for internal and external events that deviate from normal operation and belong to a category of credible	Preparing a Safety Analysis Report, 900-508770-MCP-001387

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	abnormal events	
4.1 Safety Analysis Requirements	The licensee shall classify events into one of the facility states: anticipated operational occurrence (AOO), design-basis accident (DBA), beyond-design-basis accident (BDBA) and specific ranges within BDBA referred to as design extension conditions (DEC), or equivalent classification scheme	Preparing a Safety Analysis Report, 900-508770-MCP-001387 Safety Analysis for Environmental Remediation Management, 900-508770-STD-001
4.1 Safety Analysis Requirements	The licensee shall ensure that the safety analysis examines the following facility states: Normal operational modes (including maintenance and shutdown), AOO, DBA, DEC.	Preparing a Safety Analysis Report, 900-508770-MCP-001387 Safety Analysis for Environmental Remediation Management, 900-508770-STD-001
4.2 Safety analysis assumptions Requirements	The licensee shall not credit systems that are not qualified to operate in a post-accident environment.	Preparing a Safety Analysis Report, 900-508770-MCP-001387
4.2 Safety analysis assumptions Requirements	To credit operator action, the licensee shall demonstrate that the following are in place: • clear, well-defined, validated and readily available operating procedures that identify the necessary actions • instrumentation at the control location to provide clear and unambiguous indications of the need for operator action • a credible, protected and accessible path for the operator to safely carry out the actions required in the procedures • training for any person who may be expected to perform the operator actions	Safety Analysis, 900-508770-MCP-001
4.2 Safety analysis assumptions Requirements	The licensee shall set operator action times. The licensee shall add additional time to include, as appropriate, dressing in protective equipment; accessing remote equipment; and transporting, connecting and operating temporary equipment	Safety Analysis, 900-508770-MCP-001
4.2 Safety analysis assumptions Requirements	The SAR shall justify the operator action time	Safety Analysis, 900-508770-MCP-001
4.3 Postulated initiating events Guidance	The safety analysis and design for the nuclear facility shall consider not only the facility itself, but also the	Safety Analysis, 900-508770-PDD-001. Preparing a Safety Analysis Report, 900-

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	interfaces with other facilities and installations that may affect its safety	508770-MCP-001387
4.3.1 Identification of postulated initiating events	The licensee shall identify PIEs (both internally and externally initiated) that could lead to: • radiation exposure to workers or to the public • a release of significant amounts of nuclear substances • a release of hazardous substances (such as hazardous chemicals) associated with the nuclear substances	Safety Analysis, 900-508770-PDD-001. Preparing a Safety Analysis Report, 900-508770-MCP-001387 Hazard Identification and Analysis, 900-508770-STD-002.
4.3.1 Identification of postulated initiating events	The licensee shall describe the methods used to identify the PIEs	Safety Analysis, 900-508770-PDD-001. Preparing a Safety Analysis Report, 900-508770-MCP-001387 Determining Bounding Accident Scenarios, 900-508770-FID-017 Hazard Identification and Analysis, 900-508770-STD-002
4.3.1 Identification of postulated initiating events	The licensee shall document and maintain the resulting list of PIEs.	Safety Analysis, 900-508770-PDD-001. Preparing a Safety Analysis Report, 900-508770-MCP-001387 Safety Analysis, 900-508770-MCP-001. Hazard Identification and Analysis, 900-508770-STD-002. Determining Bounding Accident Scenarios, 900-508770-FID-017
4.3.1 Identification of postulated initiating events	With input from technical specialists and experts in safety analysis, the licensee shall conduct a review of the list of PIEs, initially, to determine that the list is comprehensive and that the events include: • all credible failures of the facility's SSCs • all credible human errors thatcould occur in any of theoperating conditions of thefacility	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387 Hazard Identification and Analysis, 900-508770-STD-002
4.3.1 Identification of postulated initiating events	the licensee shall conduct areview of the list of PIEsregularly, to confirm therelevance of the current listand revise it as necessary,given that relevant PIEs maychange as the facility goesthrough different phases of itslifecycle (for example, as aresult	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002 Safety Requirements Derivation and Verification in Support of Engineering Change Control, 900-508770-FID-002

REGDOC-2.4.4 Clause Number	**Clause Description**	**Implementing Document(s)**
	of aging effects)	Scoping Review of a Safety AnalysisReport, 900-508770-MCP-001460
4.3.2 Classification of postulated initiating events Requirements	During the safety assessment, the licensee shall classify PIEs and event sequences upon identification, for the purpose of demonstrating that the acceptance criteria and the safety goals are met.	Safety Analysis, 900-508770-PDD-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387. Determining Bounding Accident Scenarios, 900-508770-FID-017
4.4.1 Assessment of consequences Requirements	The licensee shall perform a deterministic safety analysis (that is, an assessment of the consequences) to identify the physical process occurring in the nuclear facility during an event and to assess the consequences.	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002 Dose Calculations Pertaining to Respirable Radiation Sources, 900-508770-FID-008 Dose Calculations Pertaining to External Gamma Radiation Sources, 900-508770-FID-009 Dose Calculations Pertaining to Skin Exposure, 900-508770-FID-015 Dose Calculations for Ground Level Releases from Facilities at CRL, 900-508770-FID-016 Recommended Inputs for the Calculation of On-Site and Off-Site Doses Following Hypothetical Accidental Atmospheric Radioactive Releases, 900-508770-FID-018
4.4.1 Assessment of consequences Requirements	The licensee shall justify the assumptions and the actions of qualified mitigating measures (such as safety systems and operator actions) used in the deterministic analysis.	Safety Analysis, 900-508770-MCP-001.
4.4.1 Assessment of consequences Requirements	When the deterministic analysis is quantitative, the licensee shall develop models of the physical processes to calculate the consequences of the event.	Dose Calculations Pertaining to Respirable Radiation Sources, 900-508770-FID-008 Dose Calculations Pertaining to External Gamma Radiation Sources, 900-508770-FID-009 Dose Calculations Pertaining to Skin Exposure, 900-508770-FID-015 Dose Calculations for Ground Level Releases from Facilities at CRL, 900-508770-FID-016 Recommended Inputs for the Calculation of On-Site and Off-Site Doses Following Hypothetical Accidental Atmospheric Radioactive Releases, 900-508770-FID-

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
		018
4.4.1 Assessment of consequences Requirements	The licensee shall validate the computational tools used to calculate the consequences.	Safety Analysis, 900-508770-MCP-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387 Use of Analytical, Scientific and Design Computer Programs, 900-514200-MCP-022
4.4.2 Assessment of likelihood Requirements	The licensee shall perform an assessment of likelihood to establish the likelihood of PIEs or event sequences to occur.	Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002 CAFTA ™ Processing for Event Tree and Fault Tree Analysis Tasks, 900-508770-FID-010. Determining Bounding Accident Scenarios, 900-508770-FID-017 Reliability Analysis, 900-508770-FID-019
4.5 Identification of structures, systems and components important to safety Requirements	The licensee shall use a safety assessment, or an equivalent methodology, to identify event sequences that may lead to an AOO, DBA, DEC or BDBA.	Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002. Preparing a Safety Analysis Report, 900-508770-MCP-001387 Determining Bounding Accident Scenarios, 900-508770-FID-017
4.5 Identification of structures, systems and components important to safety Requirements	For each event sequence, the licensee shall identify the safety functions, the corresponding SSCs important to safety, and the administrative safety requirements that are used to implement the defence-in-depth concept.	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002 Identifying Structures, Systems and Components Important to Safety, 900-508770-FID-006
4.5 Identification of structures, systems and components important to safety Requirements	To be consistent with the safety analysis results, the licensee shall ensure that: • SSCs important to safety are designed to withstand the effects of extreme loadings and environmental conditions (such as extremes of temperature, humidity, pressure and radiation levels) that may be encountered in operational states and in accident conditions. • the required intervals for periodic testing and inspection of SSCs important to safety are defined. • the codes and standards applicable to SSCs important to safety are identified, and their use is justified. • the necessary levels of availability and reliability of SSCs important to	Safety Analysis, 900-508770-MCP-001 Design Authority and Design Engineering, 900-508120-PDD-001 Fitness for Service, 900-508230-PDD-001. Codes, Regulations, Standards, and other Documents, 900-514100-LST-002. Reliability Analysis, 900-508770-FID-019.

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	safety, as established in the safety analysis, are attained.	
4.5 Identification of structures, systems and components important to safety Requirements	In protecting against potential hazards, the licensee shall ensure that the following hierarchy of design and administrative measures is used to the extent practicable: 1. selection of the process (to eliminate the hazard) 2. passive design features 3. active design features 4. administrative controls	Identifying Structures, Systems and Components Important to Safety, 900-508770-FID-006
4.6 Operational limits and conditions Requirements	The licensee shall derive the OLCs from the safety analysis. The licensee shall document the OLCs before starting operation of the facility.	Preparation of Operational Limits and Conditions, 900-508770-FID-003. Preparing a Safety Analysis Report, 900-508770-MCP-001387
4.7 Acceptance criteria Requirements	The licensee shall establish explicit criteria for the level of safety to be achieved to demonstrate that the licensee is making adequate provision for the protection of the environment and the health and safety of persons.	Safety Analysis, 900-508770-MCP-001. Preparing a Safety Analysis Report, 900-508770-MCP-001387.
4.7 Acceptance criteria Requirements	The licensee shall set limits on the radiological consequences and associated chemical consequences for workers and the public of direct exposures to radiation or discharges of radionuclides to the environment. These limits shall: • be set equal to, or below: • the provisions of the Radiation Protection Regulations, when applicable and as far as practicable; otherwise • criteria established by national or international standards as triggers for protective measures during radiological or chemical emergencies (for example, for sheltering or for distribution of iodine pills) • apply to the consequences of operational states and the possible consequences of AOO and DBA at the facility • apply at the site boundaries of the licensed facility when offsite consequences to the public are	Safety Analysis, 900-508770-MCP-001 Recommended Inputs for the Calculation of On-Site and Off-Site Doses Following Hypothetical Accidental Atmospheric Radioactive Releases, 900-508770-FID-018 **Note** The CNL Safety Analysis program does not yet include a requirement to establish limits on the chemical consequences associated with radiological discharges to the environment, in terms of “acceptance criteria for offsite consequences to the public of pertinent accidents”. **Action REG-23-5623** Develop a guidance document for identifying postulated initiating events (PIEs) that can lead to a release of hazardous chemicals and analyzing risks from associated accidents for class 1B facilities, and describing them in Safety Analysis Reports, as per REGDOC 2.4.4. It should consider standards such as the Canadian Environmental Emergency

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	considered	Regulations and the associated Technical Guidelines. It will provide guidance for establishing limits on the chemical consequences associated with radiological discharges to the environment, in terms of "acceptance criteria for offsite consequences to the public of pertinent accidents". It will provide guidance for identifying Systems Structures and Components important to safety that prevent or mitigate the release of hazardous chemicals associated with the release of nuclear substances. To be completed by 2025 April 30.
4.7 Acceptance criteria Requirements	For new designs, the licensee shall consider targets that are below these limits.	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001
4.7 Acceptance criteria Requirements	The licensee shall establish derived acceptance criteria to demonstrate that the barriers to prevent the release of nuclear or associated hazardous substances are effective; that is, the barriers: • avoid the potential for consequential failures resulting from an initiating event • maintain SSCs important to safety in a configuration that prevents releases of nuclear or associated hazardous substances to the environment or in the facility • prevent consequences that extend beyond the site boundaries of the licensed facility • are consistent with the design requirements for the facility's SSCs	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002 Identifying Structures, Systems and Components Important to Safety, 900-508770-FID-006
4.8 Safety goals Requirements	The licensee shall demonstrate that the offsite consequences, as calculated at the site boundaries of the licensed facility, of a BDBA included in the DEC do not exceed criteria established as a trigger for temporary evacuation, for long-term relocation of the local population.	Preparing a Safety Analysis Report, 900-508770-MCP-001387 **Note:** The CNL Safety Analysis Program includes a requirement for analyzing DEC, but does not yet include all of the requirements and guidelines for how to conduct the analysis, as provided in REGDOC-2.4.4. **Action REG-23-5623:** Develop a guidance document for assessing Design Extension

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
		Conditions for class 1B facilities, and describing them in Safety Analysis Reports, as per REGDOC 2.4.4. It will provide guidance for assessing the offsite consequences against the criteria for triggering temporary evacuation and long-term relocation of the local population. It will include examples of naturally occurring events (consistent with the guidance of Appendix C in REGDOC-2.4.4). Extended loss of AC power shall be assessed. To be completed by 2025 April 30.
4.8 Safety goals Requirements	In addressing the concept of defence in depth, the licensee shall include events from BDBAs in the DEC. As a minimum, the licensee shall include the following events in the DEC: • an extended loss of AC power (ELAP) • PIEs and event sequences, including those that are specific or unique to the facility, that belong to a category of credible abnormal events	Safety Analysis, 900-508770-PDD-001 Safety Analysis, 900-508770-MCP-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387 Hazard Identification and Analysis, 900-508770-STD-002. Determining Bounding Accident Scenarios, 900-508770-FID-017 **Note:** The CNL Safety Analysis Program includes a requirement for analyzing DEC, but does not yet include all of the requirements and guidelines for how to conduct the analysis, as provided in REGDOC-2.4.4. **REG-23-5623:** Develop a guidance document for assessing Design Extension Conditions for class 1B facilities, and describing them in Safety Analysis Reports, as per REGDOC 2.4.4. It will provide guidance for assessing the offsite consequences against the criteria for triggering temporary evacuation and long-term relocation of the local population. It will include examples of naturally occurring events (consistent with the guidance of Appendix C in REGDOC-2.4.4). Extended loss of AC power shall be assessed. To be completed by 2025 April 30.
4.8 Safety goals Requirements	For naturally occurring PIEs (for example, seismic events, flooding and severe weather), when selection of credible abnormal events is not practical, the licensee shall include in the DEC events that are more severe	Safety Analysis, 900-508770-PDD-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387 Safety Analysis for Environmental Remediation Management, 900-508770-STD-001

REGDOC-2.4.4 Clause Number	**Clause Description**	**Implementing Document(s)**
	than considered in analyses of DBAs consistent with the guidance of national or international standards (appendix C).	Hazard Identification and Analysis, 900-508770-STD-002. **Note:** The CNL Safety Analysis Program includes a requirement for analyzing DEC, but does not yet include all of the requirements and guidelines for how to conduct the analysis, as provided in REGDOC-2.4.4. **Action REG-23-5623:** Develop a guidance document for assessing Design Extension Conditions for class 1B facilities, and describing them in Safety Analysis Reports, as per REGDOC 2.4.4. It will provide guidance for assessing the offsite consequences against the criteria for triggering temporary evacuation and long-term relocation of the local population. It will include examples of naturally occurring events (consistent with the guidance of Appendix C in REGDOC-2.4.4). Extended loss of AC power shall be assessed. To be completed by 2025 April 30.
4.8 Safety goals Requirements	The classification shall be based on likelihood, as specified in section 4.4.2	Safety Analysis, 900-508770-MCP-001 Hazard Identification and Analysis, 900-508770-STD-002. CAFTA ™ Processing for Event Tree and Fault Tree Analysis Tasks, 900-508770-FID-010 Determining Bounding Accident Scenarios, 900-508770-FID-017 Reliability Analysis, 900-508770-FID-019.
5.2 Content of safety analysis documents and records Requirements	The licensee shall report the safety analysis results in sufficient detail to permit review by CNSC staff	Preparing a Safety Analysis Report, 900-508770-MCP-001387
5.2 Content of safety analysis documents and records Requirements	The licensee shall ensure that the content of the safety analysis documents and records for a facility includes, as a minimum, the SAR and the OLCs	Preparing a Safety Analysis Report, 900-508770-MCP-001387
5.2 Content of safety analysis documents and records Requirements	The SAR shall contain a representative summary of the safety analysis documents and records.	Preparing a Safety Analysis Report, 900-508770-MCP-001387
5.2 Content of safety analysis documents and records	The SAR shall: • describe the site characteristics • identify nuclear and associated	Preparing a Safety Analysis Report, 900-508770-MCP-001387 Hazard Identification and Analysis, 900-

REGDOC-2.4.4 Clause Number	**Clause Description**	**Implementing Document(s)**
Requirements	hazardous substances and their locations • identify applicable acceptance criteria for offsite consequences to the public of pertinent accidents (some examples of pertinent accidents are radiological, nuclear criticality, fire and chemical accidents, including explosions) • identify SSCs that prevent or mitigate release of nuclear or associated hazardous substances, or prevent accidental exposure to high radiation fields (to the extent appropriate for the facility, in accordance with a graded approach) • classify SSCs in accordance with their importance to safety • identify operating and emergency procedures and actions that prevent or mitigate release of nuclear or associated hazardous substances • identify the safety analysis assumptions (some examples are boundary conditions, facility configuration, and time for operator actions); many of these assumptions may be documented in the operational limits and conditions • identify credible initiating events that may affect the licensee's control of nuclear or associated hazardous substances, including: o internal events (for example, component failures, human error, fire or flood) o external events (for example, earthquake, fire, flood or extreme weather) • group together all initiating events that have similar characteristics and identify bounding events for analysis • provide the results of the analysis of the consequences of the analyzed events • include uncertainty and sensitivity analysis results, when applicable • compare the results to acceptance criteria	508770-STD-002. **Note** The CNL Safety Analysis program does not yet include a requirement to establish limits on the chemical consequences associated with radiological discharges to the environment, in terms of "acceptance criteria for offsite consequences to the public of pertinent accidents". **Action REG-23-5623**: Develop a guidance document for identifying postulated initiating events (PIEs) that can lead to a release of hazardous chemicals and analyzing risks from associated accidents for class 1B facilities, and describing them in Safety Analysis Reports, as per REGDOC 2.4.4. It should consider standards such as the Canadian Environmental Emergency Regulations and the associated Technical Guidelines. It will provide guidance for establishing limits on the chemical consequences associated with radiological discharges to the environment, in terms of "acceptance criteria for offsite consequences to the public of pertinent accidents". It will provide guidance for identifying Systems Structures and Components important to safety that prevent or mitigate the release of hazardous chemicals associated with the release of nuclear substances. To be completed by 2025 April 30.

REGDOC-2.4.4 Clause Number	Clause Description	Implementing Document(s)
	• provide results and conclusions • be independently reviewed as per the management system of the licensee • provide references to detailed analyses that support the safety analysis results	
5.3 Documenting and recording postulated initiating events and design-basis accidents Requirements	The licensee shall describe the facility's behaviour following a PIE and compare it to the analysis acceptance criteria.	Safety Analysis, 900-508770-PDD-001. Safety Analysis, 900-508770-MCP-001 Preparing a Safety Analysis Report, 900-508770-MCP-001387 Determining Bounding Accident Scenarios, 900-508770-FID-017
5.4 Maintaining safety analysis documents and records Requirements	The licensee shall perform an ongoing site evaluation. If the ongoing site evaluation identifies new information about the site characteristics (that is, changing the results of the identification and classification of PIEs), then safety precautions (such as engineering controls and emergency arrangements) may need to be reviewed and revised	Safety Analysis, 900-508770-MCP-001. Hazard Identification and Analysis, 900-508770-STD-002. Safety Analysis for Environmental Remediation Management, 900-508770-STD-001

3.2.3 REGDOC-2.4.1

REGDOC 2.4.1 Deterministic Safety Analysis, sets out the requirements of the Canadian Nuclear Safety Commission (CNSC) for deterministic safety analysis for nuclear power plants (in part I) and small reactor facilities (in part II). It sets-out the requirements and technical criteria for the selection of events to be analyzed, acceptance criteria, deterministic safety analysis methods, and safety analysis documentation, review and update, and quality control.

REGDOC 2.4.1 is identified as a compliance verification criteria in the Chalk River Laboratories License Condition Handbook, which also clarifies the scope and applicability. As such, the implementing documents for REGDOC 2.4.1 are identified in the CRL LCH section of this PRD.

3.3 Standards

3.3.1 CSA N286

Table 6: Management System Requirements for Nuclear Facilities, CSA N286-12 (R2017)

Management System Requirements for Nuclear Facilities, CSA N286-12 (R2017)		
Source, Section and Title	**Description**	**Implementing Document(s)**
6.4 Safety Analysis	The safety analysis process shall be established and controlled. A safety analysis shall be	900-508770-PDD-001, *Safety Analysis*

Management System Requirements for Nuclear Facilities, CSA N286-12 (R2017)		
Source, Section and Title	**Description**	**Implementing Document(s)**
	performed and documented for the design and carried through the life of the nuclear facility. The safety analysis shall be periodically reviewed to ensure it is current.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report*
7.4.1 General	The safety analysis process shall be established and controlled. Safety analysis shall be performed and documented for the design basis accident scenarios. Safety analysis shall be performed for the design and carried through the life of the facility. The safety analysis shall be periodically reviewed to ensure it is current.	900-508770-PDD-001, *Safety Analysis* 900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report*
7.4.2 Control	Safety analysis activities shall be controlled and include (a) identification of the following: (i) safety analysis inputs; (ii) the degree of conservatism; (iii) the mathematical models used to simulate the physical processes and their limitations; (iv) the acceptance criteria applicable to safety analysis results; and (v) the tools, analytical software, and test apparatus used in the safety analysis. The selected tools shall be validated to confirm that they are suitable for performing the safety analysis; (b) evaluation of the results against the established acceptance criteria to determine whether the design being analyzed is safe; (c) severe accident management considerations; and (d) repetition of the analysis (i.e., Items (a) to (c)), where the design is found to be inadequate, using one or both of the following: (i) analysis tools with a greater degree of accuracy (justifying a reduced level of conservatism); or (ii) revised design parameters.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001387, *Preparing a Safety Analysis Report*

Management System Requirements for Nuclear Facilities, CSA N286-12 (R2017)		
Source, Section and Title	**Description**	**Implementing Document(s)**
7.4.3 Safety Analysis Tools	Safety analysis tools shall be appropriate for the application and controlled. Scientific and analytical computer programs shall be controlled in accordance with CSA N286.7.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001387, *Preparing a Safety Analysis Report* 900-514200-MCP-020, *Acquisition of Analytical, Scientific and Design Computer Programs*
7.9.5 Surveillance testing	Structures, systems, and components credited in the safety analysis shall be identified and periodically tested to ensure the following: (a) They will function as required; (b) Testing frequency is related to the results of reliability analysis and operational experience; (c) Performance that is inconsistent with that assumed in the safety analysis is identified; and (d) Test requirements are re-evaluated following a modification.	900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety* 900-508770-FID-019, *Reliability Analysis* 900-508230-PRD-001, *Fitness for Service.*
7.11.1 Completion Assurance	Site selection, design (including safety analysis), supply chain, construction, commissioning, or decommissioning shall be deemed sufficiently complete and the results deemed safe for the intended use and include (a) the identification of the critical characteristics applicable to the work being assessed; (b) a review of the objective evidence to demonstrate that the critical characteristics have been satisfied; (c) the identification of any outstanding items and confirmation that these items do not compromise the intended use; and (d) the schedule for completion of outstanding items.	900-508770-MCP-001, *Safety Analysis*
8.4 Safety Analysis	The safety analysis process shall be established and controlled. A safety analysis shall be performed and documented for the design and carried through the life of the nuclear facility. The safety analysis shall be periodically reviewed to ensure it is current.	900-508770-PDD-001, *Safety Analysis* 900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report*
9.4 Safety Analysis	The safety analysis process shall be established and controlled. A safety analysis shall be performed and documented for the design and	900-508770-PDD-001, *Safety Analysis*

Management System Requirements for Nuclear Facilities, CSA N286-12 (R2017)		
Source, Section and Title	**Description**	**Implementing Document(s)**
	carried through the life of the nuclear facility. The safety analysis shall be periodically reviewed to ensure it is current.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001460, *Scoping Review of a Safety Analysis Report*

3.3.2 CSA N292.0

CSA N292.0-19 provides General principles for the management of radioactive waste and irradiated fuel. The CSA N292 series of documents represents the principles for the management of radioactive waste and irradiated fuel. As indicated in Table 12, these standards are identified as being applicable to some of CNL's licenses, and are identified as a Compliance Verification Criteria (CVC) or Guidance Document (G) in the Waste Management Safety Control Area (SCA) in those Licenses. As such, they are mapped to CNL implementing documents in more detail in the Waste Management Program Requirements Document. However, the requirements pertaining to Safety Analysis are included in this PRD as well. The latest Version (CSA N292.0-19) is used to map implementing documents in Table 7.

Table 7: CSA N292.0-19 Requirements

Section and Title	Description	Implementing Document(s)
4.1.3 Safety measures	The safety measures implemented shall be commensurate with the nature and level of the hazards and the degree of risk associated with the radioactive waste and inventory.	900-508770-STD-001 *Safety Analysis for Environmental Remediation* *Management* 900-580770-MCP-001387 *Preparing a Safety Analysis Report*
4.1.6 Non-radiological hazards	Consideration shall be given to industrial health and safety and environmental protection with respect to non-radiological hazards associated with the waste.	900-508770-STD-001 *Safety Analysis for Environmental Remediation* *Management* 900-580770-MCP-001387 *Preparing a Safety Analysis Report*
4.5.9.1 Safety concerns	Management of radioactive waste shall reflect fundamental safety concerns related to Criticality; radiation exposure;	900-508770-STD-001 *Safety Analysis for Environmental Remediation* *Management* 900-508770-MCP-001, *Safety Analysis*

Section and Title	Description	Implementing Document(s)
	heat control; and containment and retrievability[1].	
4.8.3.1 System implementation	A radioactive waste classification system that is based on the safety case shall be implemented.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
4.10.1.1 Safety	Safety requirements for the management of radioactive waste and irradiated fuel shall provide for protection of the environment and the health and safety of workers and the public.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001, *Safety Analysis*
4.10.1.3 Safety	All reasonable efforts shall be made to prevent accidents.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001, *Safety Analysis* 900-509770-STD-002, *Hazard Identification and Analysis*
4.10.1.4 Safety	Detailed analysis shall identify precursors for postulated accidents and measures for their prevention.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001, *Safety Analysis* 900-509770-STD-002, *Hazard Identification and Analysis*
4.10.2.1 Nuclear Safety Requirements	Radioactive waste management system performance under normal operating conditions shall be assessed to maintain waste containment for the duration of facility operation.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
4.10.2.2 Nuclear Safety Requirements	The radioactive waste management system performance expected during credible	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*

[1] Note: Retrievability and aging management to be discussed in future revisions of safety documents

Section and Title	Description	Implementing Document(s)
	abnormal events shall be assessed for the following events: -seismic activity (i.e., design basis earthquake for that location); -severe meteorological conditions (e.g., extreme temperatures, tornadoes, hurricane-force winds, lightning strikes, or extreme rainfall leading to foundation instability); -fires (at the waste management facility, adjacent facilities, or surrounding area, including forest fires); -flooding; -missile impacts as a result of vehicle collisions, aircraft crashes, pressure-boundary failures, or explosion-driven debris; and -equipment failure or operator error.	900-508770-MCP-001, *Safety Analysis*
4.10.6.1.1 Design	A safety assessment shall be performed as part of the design process of the waste management facility.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
4.10.6.1.2 Design	The time frame for safety assessments shall be clearly justified, delineated, and commensurate with the hazard of the waste.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
4.10.6.2 Assessment prior to transition	In order to determine if a transition is feasible, a safety assessment for the proposed transition shall be conducted	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
4.10.6.2.2 Transition within the same facility	The safety assessment shall include a review of the current facility programs to demonstrate that the programs remain valid for	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*

Section and Title	Description	Implementing Document(s)
	the new state, or that further updates or new operational programs are implemented.	
4.10.6.2.3 Transition to another facility	The safety assessment shall consider the -condition of the waste package that is moved to another facility; -condition of the receiving facility; -WAC of the receiving facility; -transportation requirements; and -programs in place at the receiving facility.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
4.10.6.3 Assessment objectives and considerations	The anticipated radiation exposure to workers, the public, and the environment arising from both normal conditions and credible abnormal events shall be considered in the safety assessment.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-509770-STD-002, *Hazard Identification and Analysis*
4.10.6.3.2 Assessment objectives and considerations	The safety assessment shall demonstrate that -containment, shielding, and heat removal is maintained for the duration of facility operation;	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001, *Safety Analysis*
4.10.6.3.3 Assessment objective and considerations	The safety assessment shall, at a minimum, consider the following: -the radioactive waste or irradiated fuel and its characteristics, including decay products and potential for gas generation; -seismic activity and any subsequent effects; severe meteorological conditions; **Note:** *Severe meteorological conditions can include, but are not limited to, the following: extreme temperatures;* *-extreme winds (e.g., hurricane-force winds) and tornadoes;* *-lightning strikes;* *-drought and low water levels;* *-fog;*	900-508770-MCP-001, *Safety Analysis* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*

Section and Title	Description	Implementing Document(s)
	-hail; *-extreme winter conditions such as ice cover, frost, or heavy snowfall;* *-storm surge; and* *-extreme rainfall leading to foundation instability or external flooding.* -fires (e.g., forest fires) (at the facility, adjacent facilities, or utility supply services such as a heating or cooling plant); flooding; -missile impacts as a result of vehicle collisions; -aircraft crashes; -pressure-boundary failures; or -explosion-driven foreign material (e.g., shrapnel). -equipment failure or operator error; -loss of off-site power; and impact of maintenance activities.	
5.6.2 Gas generation potential	Where relevant, gas generation shall also be accounted for in the safety assessment.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-580770-MCP-001387 *Preparing a Safety Analysis Report*
7.1 Waste Management Facility	The design of the waste management facility shall consider relevant requirements for nuclear safety, radiological safety, industrial safety, security, and safeguards.	900-508770-MCP-001, *Safety Analysis* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
7.2.1.1 Site selection for new facilities	Site selection for a new facility shall consider: -the site-related factors likely to affect safety performance;	900-508770-MCP-001, *Safety Analysis* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
7.2.2 Site characterization	Waste management facility sites shall be characterized at a level of detail sufficient to support a general understanding of the current site characteristics and how the site is anticipated to	900-508770-MCP-001, *Safety Analysis* 900-580770-MCP-001387 *Preparing a Safety Analysis Report* 900-508770-STD-001

Section and Title	Description	Implementing Document(s)
	evolve over the duration of the facility life cycle. The focus of the site characterization shall be on features, events, and processes that could have an impact on safety.	*Safety Analysis for Environmental Remediation Management*
7.26.1. Operational Limits	Waste management facilities should be operated in accordance with a set of operational limits and conditions derived from safety assessments.	900-508770-FID-014, *Preparation of a Facility Authorization Document* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*

3.3.3 CSA N292.2

CSA N292.2-13 provides the requirements for Interim dry storage of irradiated fuel. The CSA N292 series of documents represents the principles for the management of radioactive waste and irradiated fuel. As indicated in Table 12, these standards are identified as being applicable to some of CNL's licenses and are identified as a Compliance Verification Criteria (CVC) or Guidance Document (G) in the Waste Management Safety Control Area (SCA) in those Licenses. As such, they are mapped to CNL implementing documents in more detail in the Waste Management Program Requirements Document. However, the requirements pertaining to Safety Analysis are included in this PRD as well. The latest Version (CSA N292.2-13) is used to map implementing documents in Table 8.

Table 8: CSA N292.2-13 Requirements

Section and Title	Description	Implementing Document(s)
5.2.1.2 Environment, Health and Safety	Safety requirements for the dry storage of irradiated fuel shall ensure the protection of the environment, and the health and safety of workers and the public. Requirements may be grouped under the areas of a) nuclear safety; b) radiation safety; c) occupational health and safety; and d) environmental protection.	900-509200-POL-001 *Environment Policy* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
5.3.1 Normal operating conditions	The dry storage system safety analysis shall demonstrate that	900-508770-STD-001

Section and Title	Description	Implementing Document(s)
	under normal operating conditions, a) fuel is maintained in a dry state; b) the container is not over-pressurized; c) decay heat is dissipated preventing degradation of the fuel assembly and containment barriers; d) nuclear criticality is prevented; e) the structural integrity of the storage structures is maintained; f) adequate shielding is maintained; g) the integrity of the fuel is maintained to facilitate retrieval for duration of storage; and h) containment is provided for the duration of the facility operation.	*Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
5.3.2.1 Abnormal operating conditions	The design and operating requirements for dry storage systems shall address credible abnormal events that might lead to abnormal operating conditions.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis* 900-509770-STD-002, *Hazard Identification and Analysis*
6.1.2 Specific requirements for the interim dry storage of irradiated fuel	Site selection for a dry storage facility shall consider the site-related factors likely to affect safety performance during construction, commissioning, operation, and decommissioning. Seismic risk shall be considered as per Clause 6.2.3.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001387 *Preparing a Safety Analysis Report* 900-508770-MCP-001 *Safety Analysis*
6.3.1.7 Dry storage system design	SSCs important to safety that are credited to withstand design basis events shall be qualified accordingly.	900-508770-MCP-001, *Safety Analysis* 900-508770-MCP-001 *Safety Analysis* 900-508770-MCP-004 *Consequence of Failure*

Section and Title	Description	Implementing Document(s)
6.3.4.2.1. Design requirements	The design of the fuel handling facility shall consider relevant requirements for nuclear safety, radiological safety, and industrial safety.	900-580770-MCP-001387 *Preparing a Safety Analysis Report*
6.3.4.2.6 Design requirements	An emergency electrical power supply and distribution system shall be provided for essential equipment and services where loss of power could result in a safety hazard.	900-580770-MCP-001387 *Preparing a Safety Analysis Report* 900-508770-MCP-001 *Safety Analysis*
6.3.5.2.6 Design requirements	Loads on irradiated fuel from any source during transfer shall be considered. Abnormal operating conditions shall be postulated and analyzed in the safety analysis	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001, *Safety Analysis* 900-509770-STD-002, *Hazard Identification and Analysis*
6.5.4.1 Modification control	Before making changes to the dry storage system or associated procedures, consideration should be given to whether the safety analysis will be valid for the modifications in question.	900-508770-MCP-001 *Safety Analysis* 900-508770-FID-002 *Safety Requirements Derivation and Verification in Support of Engineering Change Control*

3.3.4 CSA N292.3

CSA N292.3-14 provides the requirements for the Management of low and intermediate level radioactive waste. The CSA N292 series of documents represents the principles for the management of radioactive waste and irradiated fuel. As indicated in Table 12, these standards are identified as being applicable to some of CNL's licenses, and are identified as a Compliance Verification Criteria (CVC) or Guidance Document (G) in the Waste Management Safety Control Area (SCA) in those Licenses. As such, they are mapped to CNL implementing documents in more detail in the Waste Management Program Requirements Document. However, the requirements pertaining to Safety Analysis are included in this PRD as well.

No nuclear safety analysis program requirements identified.

3.3.5 CSA N292.6

CSA N292.6-18 provides the requirements for Long-term management of radioactive waste and irradiated fuel. The CSA N292 series of documents represents the principles for the management of radioactive waste and irradiated fuel. As indicated in Table 12, these standards are identified as being applicable to some of CNL's licenses, and are identified as a Compliance Verification Criteria (CVC) or Guidance Document (G) in the Waste Management Safety Control Area (SCA) in those Licenses. As such, they are mapped to CNL implementing documents in more detail in the Waste Management Program Requirements Document. However, the requirements pertaining to Safety Analysis are included in this PRD as well. The latest Version (CSA N292.6-18) is used to map implementing documents in Table 9.

Table 9: CSA N292.6-18 Requirements

Section and Title	Description	Implementing Document(s)
5.1.3 Waste characterization	The detail and depth of characterization or re-characterization shall be commensurate with the potential for future radiological, physical, and chemical changes and their consequences as identified in the safety assessment	900-508770-MCP-001 *Safety Analysis*
7.1.2 Site characterization	The facility site shall be characterized at a level of detail sufficient to support a general understanding of the current site characteristics and how the site is anticipated to evolve over the duration of the facility life cycle. The focus of the site characterization shall be on features, events, and processes that could have an impact on safety.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-580770-MCP-001387 *Preparing a Safety Analysis Report*
7.2.1 Design selection	Facility design selections shall be based upon radioactive material characteristics; ability of the system to fulfill basic design functions such as receipt, handling, storage, inspection, monitoring, and retrieval of waste packages; ability of the system to fulfill functions of radiological protection, containment, and isolation over the required performance period; and safety assessment results that model the system's performance over the period of potential hazard considering changes in the waste form, SSCs, barriers, and environmental and social conditions.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
8.1 Design	A safety assessment shall be performed as part of the design	900-508770-STD-001

Section and Title	Description	Implementing Document(s)
	process of the long-term storage facility.	*Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
8.2.1 General	In order to determine if a transition is feasible, a safety assessment for the proposed transition shall be conducted.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
8.2.2 Transition within the same facility	The safety assessment shall include a review of the current facility programs to demonstrate that the programs remain valid for the new state or that further updates or new operational programs are implemented.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
8.2.3 Transition to another facility	The safety assessment shall consider the condition of the radioactive material and waste package to be moved to another facility; condition of the receiving facility; waste acceptance criteria of the receiving facility; transportation requirements; and programs in place at the receiving facility.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*
8.3.1 Assessment objective and considerations	The anticipated radiation exposure to workers, the public, and the environment arising from both normal conditions and credible abnormal events shall be considered in the safety assessment.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*
8.3.3	The safety assessment shall demonstrate that containment, shielding, and heat removal is maintained for the duration of facility operation;	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*

Section and Title	Description	Implementing Document(s)
8.3.4	The safety assessment shall, at a minimum, consider the following: the radioactive material and its characteristics, including decay products and potential for gas generation; seismic activity and any subsequent effects; severe meteorological conditions; **Note:** *Severe meteorological conditions can include, but are not limited to, the following: extreme temperatures;* *extreme winds (e.g., hurricane-force winds) and tornadoes;* *lightning strikes;* *drought and low water levels;* *fog;* *hail;* *extreme winter conditions such as ice cover, frost, or heavy snowfall;* *storm surge; and* *extreme rainfall leading to foundation instability or external flooding.* fires (at the long-term storage facility, adjacent facilities, or utility supply services such as a heating or cooling plant); flooding; missile impacts as a result of vehicle collisions; aircraft crashes; pressure-boundary failures, where applicable; or explosion-driven foreign material (e.g., shrapnel). equipment failure or operator error; loss of off-site power; and impact of maintenance activities.	900-508770-STD-001 *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-001 *Safety Analysis*

3.3.6 CSA N294

CSA N294-19 provides the requirements for Decommissioning of Facilities containing nuclear substances. As indicated in Table 12, this standards is identified as being applicable to some of CNL's licenses. As such, it is mapped to CNL implementing documents in more detail in the Clean-up Program Requirements Document. However, the requirements pertaining to Safety Analysis are included in this PRD as well.

Table 10: Decommissioning of Facilities Containing Nuclear Substances, CSA N294-19

Source, Section and Title	Description	Implementing Document(s)
5.6 Hazard assessment	A hazard assessment commensurate with the tasks to be performed shall be completed prior to decommissioning	900-508770-STD-002, *Hazard Identification and Analysis* 900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management*
7.1.1	Preparation for decommissioning shall include c) a safety assessment for decommissioning	900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment*
7.5.1 General	An assessment of the state of the facility shall be performed to provide baseline information for condition of the building and SSC, and evaluation of the hazards to be controlled during decommissioning. A thorough survey shall be performed and supplemented by a review of existing records, as applicable. Relevant information should be archived and should be made available to the staff who will perform the decommissioning	900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety*
7.5.2.1	The following hazards shall be investigated and assessed: a) radiological hazards	900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-STD-001, *Safety Analysis for Environmental Remediation Management* 900-508770-FID-006, *Identifying Structures, Systems and Components Important to Safety*

Source, Section and Title	Description	Implementing Document(s)
7.6.4 Safety assessment of the facilities undergoing decommissioning	A safety assessment shall be performed to identify potential hazards to workers, the public, and the environment, from both routine decommissioning activities and credible accidents during decommissioning. The level of the safety assessment should be commensurate with the type and complexity of the facility, and the maturity of the proposed decommissioning activities. The assessment shall describe the relative importance of the potential hazards and identify the methods for mitigating the risks associated with such hazards. If fissile material is involved, a criticality safety assessment and the planned actions involving fissile material shall be included. The assessment shall also address the residual risks to the public, if any, after decommissioning is completed. The safety assessment may be a stand-alone document or may be included in the DDP. In-situ decommissioning may result in a waste disposal site. In such a case, an applicant shall	900-508770-MCP-002, *Hazard Identification/Analysis for Decommissioning Facilities in Support of Safety Assessment* 900-508770-STD-001 *Safety Analysis for Environmental Remediation Management*[2] 900-508770-MCP-001680, *Recommended Input for RESRAD- OFFSITE Analysis* 900-508550-PDD-001, *Nuclear Criticality Safety*

[2] Implementation document (900-508770-STD-001) was updated to Revision 2, in May 2023, to cover the applicable requirements for post-closure safety assessment of a disposal facility

Source, Section and Title	Description	Implementing Document(s)
	satisfy all regulatory requirements for a radioactive waste disposal facility and demonstrate safety via a safety case and post-closure safety assessment of a disposal facility	

3.4 Contractual Agreements

3.4.1 Site Operating Company Agreement (SOCA)

Table 11: Site Operating Company Agreement (SOCA)

Source, Section and Title	Description	Implementing Document(s)
A1.4 Waste Management	1.4.4.7 CNL shall engage with the Regulatory Authority to determine the requirements for long-term Historic LLW management and disposal. 1.4.4.7.1 The safety basis and engineering design will be prepared as necessary to proceed through the licensing process. 1.4.4.7.2 CNL's recommendation will be included in the Proposed Annual Program of Work and Budget	900-508770-PDD-001, *Safety Analysis* 900-508770-MCP-001, *Safety Analysis*

3.5 Guidance Documents

Table 12 illustrates the publications that have been identified as Guidance Documents in CNL's licenses. Guidance documents are intended to provide non-mandatory information on how to comply with licence conditions. This section describes the Guidance Documents and their application.

3.5.1 IAEA GSR Part 4

Safety Assessment for Facilities and Activities, IAEA GSR Part 4, is a guidance document for: Gentilly-1 Waste Facility, Whiteshell Laboratories, Douglas Point Waste Facility and for the NPD Waste Facility.

The objective of General Safety Requirements Part 4, Safety Assessment for Facilities and Activities is to establish the generally applicable requirements that should be fulfilled in safety analysis for facilities and activities, with special attention paid to deterministic and probabilistic approaches, defence in depth, quantitative analyses and the application of a graded approach. The publication also addresses the independent verification, maintenance, and use of the safety analysis that should be carried out by the originators and users of the safety analysis. This publication is intended to provide a consistent and coherent basis for safety analysis across all facilities and activities, to facilitate the transfer of good practices between organizations conducting safety assessments and regulators, enhancing the confidence with regulators that an adequate level of safety has been achieved for facilities and activities.

Requirements for these areas have been specified in the Canadian regulatory framework, including REGDOCs 2.4.4 and 2.4.1, which have been mapped to CNL Safety Analysis program implementing documents in this PRD. However, GSR Part 4 can be applied as a Guidance Document where additional clarity is needed.

IAEA GSR-4 includes 24 general requirements, and information on how apply those requirements, and makes extensive use of mandatory language (e.g. shall, must). However, it should be applied as a guidance document that is intended to provide non-mandatory information on how to comply with licence conditions where additional clarity is desired, where the application of GSR-4 would not conflict with licence condition requirements.

3.5.2 IAEA SRS No. 102

The Safety Analysis and Licensing Documentation for Nuclear Fuel Cycle Facilities, IAEA SRS No. 102 is identified as a guidance document for CRL and the NPD Waste Facility.

The objective of Safety Report Series 102, Safety Analysis and Licensing Documentations for Nuclear Fuel Cycle Facilities, is to provide information on methods and practices, based on the IAEA safety standards and current international good practice, for performing safety analysis and preparing licensing documentation for nuclear fuel cycle facilities. It provides a systematic methodology covering the establishment of acceptance criteria, hazard identification, and identification of postulated initiating events, analysis of accident sequences and consequences, and the use of a graded approach. Information is also provided on application of the results of the safety analysis, including safety classification of Structures Systems and Components, derivation of Operating Limits and Controls, and the content of Safety Analysis Reports. The approaches provided in this publication can be applied to different types of nuclear fuel cycle facility with use of a graded approach that is commensurate with the potential hazards and risks posed by the facility.

Requirements for these areas are specified in the Canadian regulatory framework, including REGDOCs 2.4.4 and 2.4.1, which have been mapped to CNL Safety Analysis program implementing documents in this PRD. IAEA SRS 102 can be applied as a Guidance Document where additional clarity is needed. When it is applied as an alternate method that deviates from the CNL Safety Analysis implementing documents, 900-508770-MCP-003 Assigning a Delegation of Safety Analysis Authority, describes the provisions for assessing the proposed deviation.

3.5.3 IAEA TECDOC-1267

The Procedures for conducting Probabilistic Safety Assessment (PSA) for non-reactor nuclear facilities, IAEA TECDOC-1267, is a guidance document identified for application to the Whiteshell Laboratories.

This publication is intended as guidance for conducting probabilistic safety assessment (PSA) for non-reactor nuclear facilities. The main emphasis is on the general procedural steps for conducting a PSA for a non-reactor nuclear facility, rather than the details of the corresponding methods. The report is intended to assist technical experts performing or managing PSAs, and aims to promote a standardized framework, terminology, and form of documentation for PSAs.

3.5.4 IAEA SSR-4

The Safety of Nuclear Fuel Cycling Facilities, IAEA SSR-4, is a guidance document identified for application the Whiteshell Laboratories and for the Douglas Point Waste Facility.

The objective Specific Safety Requirements 4, Safety of Nuclear Fuel Cycle Facilities, is to establish a basis for safety and safety analysis for all stages in the lifetime of a nuclear fuel cycle facility by establishing specific requirements for site evaluation, design, construction, commissioning, operation and preparation for decommissioning that should be satisfied to ensure safety.

IAEA SSR-4 includes 75 specific requirements, and makes extensive use of mandatory language (e.g. shall, must). However, it should be applied as a guidance document that is intended to provide non-mandatory information on how to comply with licence conditions where additional clarity is desired, where the application of SSR-4 does not conflict with licence condition requirements.

4. Requirements Applicability

Table 12: Requirements Applicability across CNL Sites

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Waste Storage Facility**	**Gentilly-1 Waste Management Facility**
CRL Licence Condition Handbook	CVC	N/A	N/A	N/A		N/A		N/A	N/A
G-1 Licence Condition Handbook	N/A	N/A	N/A	N/A		N/A		N/A	CVC
NPD Licence Condition Handbook	N/A	N/A	CVC	N/A		N/A		N/A	N/A
DP Licence Condition Handbook	N/A	N/A	N/A	CVC		N/A		N/A	N/A
WL Licence Condition Handbook	N/A	N/A	N/A	N/A		CVC		N/A	N/A
HAI Licence Condition Handbook	N/A	CVC	N/A	N/A		N/A		N/A	N/A
*REGDOC-2.4.4** *Current (proposed)*[3]	G (CVC)	N/A	G (CVC)	N/A (CVC)		G (CVC)		N/A	N/A (CVC)
CSA N292.0	CVC	CVC	CVC	CVC		CVC		N/A	CVC

[3] CNL has proposed that REGDOC-2.4.4 can be changed to a CVC once the planned implementation has been completed [S.Brewer, letter to K.Campbell, "SUBMISSION OF GAP ANALYSIS AND IMPLEMENTATION PLAN OF REGDOC-2.4.4, SAFETY ANALYSIS FOR CLASS IB NUCLEAR FACILITIES", 145-CNNO-23-0065-L, 2023 October 13]

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Waste Storage Facility**	**Gentilly-1 Waste Management Facility**
CSA N292.2	CVC	N/A	N/A	CVC		CVC		N/A	N/A
CSA N292.3	CVC	CVC	CVC	CVC		CVC		N/A	CVC
CSA N292.6	CVC	G	G	G		CVC		N/A	N/A
CSA N292.6	CVC	G	G	G		CVC		N/A	N/A
CSA N286-12	CVC	CVC	CVC	CVC		CVC		N/A	CVC
CSA N294-19	CVC	CVC	CVC	CVC		CVC		N/A	CVC
REGDOC-2.11.1 Vol I	CVC	CVC	CVC	G		CVC		N/A	N/A
*REGDOC-2.11.1 Vol III**	CVC	G	CVC	G		CVC		N/A	G
REGDOC-2.11.2	CVC	CVC	CVC	G		CVC		N/A	N/A
REGDOC-2.4.1	CVC	N/A	N/A	N/A		N/A		N/A	N/A
IAEA SRS No 102	G	N/A	G	N/A		N/A		N/A	N/A
IAEA SSR-4	N/A	N/A	N/A	G		G		N/A	N/A
IAEA Tecdoc-1267	N/A	N/A	N/A	N/A		G		N/A	N/A
IAEA GSR PART 4, rev 1	N/A	N/A	G	G		G		N/A	G
SOCA	Applicable	Applicable	Applicable	Applicable		Applicable			Applicable

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Waste Storage Facility**	**Gentilly-1 Waste Management Facility**
* REGDOC-2.4.4 applies to the safety analysis of all Class IB facilities, including waste management facilities, during the pre-closure phase of disposal facilities. For the post-closure phase, REGDOC-2.11.1 (Volume III) applies to Class IB waste management facilities for the development of a safety case and supporting safety assessment.									

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment. There are no assessment activities for requirements.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Design Authority and Design Engineering

900-508120-PDD-001

Revision 5.3

Information Use

Approved by:	John Slade	2024/04/30
	Chief Engineer	Date

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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
5.3	2024/04/26	Issued as "Approved for Use". "Review and Comment" not required. Minor revision to 6.1 to include Nuclear Cyber Security as an internal interface.	M. Gogulapati	Y. Dube J. Slade	J. Slade
5.2	2023/12/13	Issued as "Approved for Use". "Review and Comment" not required. Minor revision to section 6.2: • Added external interface with ITSM. • Rephrased "interface activity/purpose" for TSSA to match the one for ITSM.	M. Gogulapati	A. Dash J. Slade	J. Slade
5.1	2023/06/19	Issued as "Approved for Use". "Review and Comment" not required. Minor revision: • Added 4.1 and 4.2. • 4.3: added that the CNL Design Authority is also the FSM. • Moved "Electrical Safety Authority" external interface to "Electrical Safety" internal interface. • Changed "Technical Standards and Safety Authority" external interface to design registration only. Added "Pressure Boundary" to internal interface for requirements interpretation. • Minor editorial changes.	M. Gogulapati	A. Dash J. Slade	J. Slade
5	2022/05/04	Issued as "Approved for Use". "Review and Comment" not required. Minor revision: • Aligned purpose to 900-514100-MCP-001. • Replaced "Designated Engineering Manager" by "Delegated Design Authority". • Updated references.	M. Gogulapati	A. Dash J. Slade	J. Slade
4	2021/05/04	Issued as "Approved for Use". Minor editorial changes.	M. Gogulapati	C. Ball	J. Slade

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3	2020/06/15	Issued as “Approved for Use”. Minor editorial changes. No formal R&C required.	M. Gogulapati		J. Slade
2	2019/09/16	Issued as “Approved for Use”. Minor editorial changes. No formal R&C required.	M. Gogulapati		J. Slade
1	2018/11/30	Issued as “Approved for Use”	J. Bailey		J. Slade
1D1	2018/09/13	Issued for “Review and Comment”. Minor editorial changes. Minor changes to Section 1 and 2 to align with 900-508120-PRD-001. Moved all definitions and acronyms to the Glossary of Controlled Terms and Acronyms on myCNL. Added responsibilities for Designated Engineering Manager and Customer Representative. Added introduction to Section 5. Formalized reference to Design Engineering MCPs. Internal Interfaces table.	J. Bailey	E. Ballachey D. Campbell A. Caron C. Charbonneau A. Coulas J. deRuiter Y. Dube A. Eyvindson D. Garrick G. Hamilton J. Heal D. Hill N. Mantifel J. Mitock D. Murphy M. Burger R. Ponnan S. Sanders U. Senaratne J. Slade K. Summers D. Trylinski	
0	2016/01/04	Issued as “Approved for Use” Cancels and Supersedes: 145-508120-PRO-003, Conduct of Design Engineering		J. Slade	
D1	2016/12/16	Issued for “Review and Comment”		E. Ballachey A. Bellil A. Caron S. Celovsky J. deRuiter A. Eyvindson	

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				D. Garrick G. Hamilton J. Heal G. Hersak S. Karivelil H. Khartabil L. Leung K. Lundie N. Mantifel S. Mistry B. Orbanski R. Ponnan J. Sallis B. Sanderson K. Schruder J. Slade	

Table of Contents

Section **Page**

1. Scope and Applicability

This Company-wide Interpretation document applies to all activities unique to the Design Authority and Design Engineering functional support area (FSA), performed by Canadian Nuclear Laboratories (CNL) across all sites.

The Design Authority and Design Engineering FSA maintains and controls the design basis of CNL within approved safety margins and regulatory requirements. It establishes the requirements for CNL design work.

Any questions regarding the content or application of this document should be directed to the Functional Support Manager for Design Authority and Design Engineering as identified in the *Functional Authorities* controlled list [1].

2. Purpose

The Design Authority and Design Engineering FSA manages the organizational responsibility to ensure the technical integrity of designs and design processes, establishing the requirements for CNL design work.

Design Authority and Design Engineering FSA ensures that design is planned, executed, verified, and documented according to applicable codes, standards, regulatory, and design customer requirements.

The Design Authority and Design Engineering FSA controls the design basis of CNL within approved safety margins and regulatory requirements.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [2] contains specific meanings for those words that require further clarification.

There are no definitions or acronyms applicable to this document.

4. Roles and Responsibilities

4.1 Responsible Executive

The responsibilities for the Responsible Executive are as defined in *CNL Management System Manual* [3].

4.2 Functional Support Manager

The responsibilities for the Functional Support Manager are as defined in *CNL Management System Manual* [3].

4.3 CNL Design Authority

The CNL Design Authority is ultimately responsible for the design and engineering decisions made by CNL for all CNL activities, facilities and practices. The CNL Design Authority holds Professional Engineers Ontario (PEO) accountability for the design process. This role is assigned to the Chief Engineer through their accountability statement. The CNL Design Authority is also the Functional Support Manager for Design Authority and Design Engineering FSA.

The CNL Design Authority is responsible for:

- Evaluating the technical competency of the Delegated Design Authorities (DDAs) and delegating qualified individuals as DDAs.
- Ensuring an appropriate design basis is maintained for approved designs.
- Providing oversight of execution of the design work by the DDAs.
- Maintaining PEO status in good standing.
- Maintaining knowledge and understanding of key regulatory, licensing and quality requirements for a nuclear operating site.

4.4 Delegated Design Authority

A DDA is a person to whom accountability for specific engineering activities has been delegated by the CNL Design Authority. A DDA is responsible for:

- Assigning competent staff to perform engineering activities, such as Lead, Designer, Design Planner, and Design Reviewer.
- Providing oversight of execution of the design work by the staff under their supervision.
- Approving procedures used in their organization to execute design activities.
- Reviewing and approving informal and formal Design Grading and design planning documents.
- Ensuring that documentation has been prepared and evaluated by qualified staff according to established procedures.
- Validating that review and verification have been adequately documented.
- Resolving disputes arising during the review and comment process and the design and development process.

- Approving technical documents and drawings and their release.
- Acting as approval authority for changes to the design configuration of CNL facilities with regard to nuclear safety, performance, functionality, constructability, operability, and maintainability within the scope of their delegation.
- Maintaining knowledge and understanding of CNL processes, projects, and programs.
- Maintaining knowledge and understanding of key regulatory, licensing, and quality requirements for a nuclear operating site.

4.5 Lead

The Lead is a CNL employee who is the single point of contact for a project. The Lead is responsible for ensuring that the following activities are performed:

- Identification of input information relevant to the design work.
- Monitoring and communication of progress to the customer.
- Identification and communication of potential changes to the customer.
- Recommendation for review activities.
- Following the change control process.

The Lead is also responsible for:

- Having knowledge of technical and operational aspects of any structures, systems, and components (SSCs) being modified or created.
- Maintaining knowledge of the requirements of the Design Authority and Design Engineering FSA.

4.6 Designer / Design Planner

A Designer / Design Planner is responsible for:

- Gathering design inputs.
- Defining design requirements.
- Preparing design plans.
- Ensuring configuration management.
- Providing technical consultation and guidance for the work performed by other designers.
- Executing design/drafting activities as required.
- Maintaining knowledge and understanding of codes and standards and practical experience in area being reviewed.
- Maintaining knowledge and understanding of key regulatory, licensing, and quality requirements for a nuclear operating site.

4.7 Design Reviewer

A Design Reviewer is responsible for:

- Reviewing design outputs.
- Ensuring verification of design deliverables as required.
- Maintaining knowledge and understanding of codes and standards and practical experience in area being reviewed.
- Maintaining knowledge and understanding of key regulatory, licensing, and quality requirements for a nuclear operating site.

5. Functional Programs

5.1 General Concepts

The following concepts support the proper implementation of the Design Engineering processes and are understood before embarking on design work.

Graded Approach

Design engineering activities implement the consistent use of a graded approach depending on the safety significance and on the nature of the design work to be performed, as per paragraph 4.1.3 of CSA N286, *Management system requirements for nuclear facilities* [4]. The graded approach is applied when choosing the degree of rigor for design engineering activities during the design planning phase [5].

Design Records

Design records provide documented evidence of compliance with applicable codes, standards, regulatory, and customer requirements. Design records are retained for the lifetime of the SSC or facility, and include documents that do any of the following:

- Specify design requirements and the critical characteristics of the design.
- Identify the sources of design inputs.
- Demonstrate the capability for safe operation, and are valuable in facilitating troubleshooting and determining the causes of accidents, malfunctions, or unplanned events.
- Contain technical information needed for fabrication, construction, installation, operation, and decommissioning; and provide the information needed to facilitate maintenance, rework, repair, replacement, or modification.
- Substantiate the technical adequacy of the design.
- Provide baseline data for pre-service and periodic in-service inspections.
- Are required to support the facility licensing requirements.

Delegation of Design Authority

The concept of delegation of Design Authority from the Chief Engineer to staff members of CNL is the foundation for the deployment of the Design Authority and Design Engineering FSA throughout all sites at CNL. Delegations of Design Authority are granted based on consistent high standards, appropriate training to function safely and effectively, and understanding of duties and responsibilities. Delegation of Design Authority is performed in accordance with *Assigning a Delegation of Design Authority* [6].

5.2 Design Initiation

The design initiation phase may include requests for changes to an approved design configuration, requests for engineering assistance, requests for commercial proposals, definition of initial design requirements, and assignment of the planning work to appropriate individuals. The design work requests are assessed for the complexity, priority, risk involvement, and interfaces. Design initiation is described in more detail in *Design Planning* [5].

5.3 Design Planning

The following activities are undertaken during the design planning phase in accordance with *Design Planning* [5]:

- Developing the problem statement.
- Preparing Risk Assessments.
- Performing walk downs (as required).
- Reviewing existing documents and drawings.
- Identifying codes and standards.
- Identifying customer requested design completion activities.
- Obtaining budget and schedule constraints from customer.
- Securing additional planning resources (SMEs, Safety Analysis, etc.)
- Reviewing Operational Experience.
- Considering procurement risks.
- Gathering customer inputs and design inputs.
- Identifying assumptions.
- Performing Design Grading of work.
- Verifying design inputs and requirements (as per the ISO 9001:2015 requirement).
- Defining deliverables and specifying their configuration management and revision control requirements.
- Identifying verification requirements (what, who, when, how, and acceptance criteria).
- Defining design milestones (as required).
- Defining design completion activities.
- Defining resource competencies required to complete design.
- Preparing cost and schedule estimate and giving an estimate class.
- Producing, reviewing, and approving Design Plan.

Design inputs may not be fully defined at that time and may extend into the design phase.

The design planning phase ends when approved design planning documentation is turned over to the design responsible organization.

5.4 Design

The design requirements and design concepts are translated into design output documents that satisfy the customer and design requirements. Design Guides and Drawing Office Manuals support the production of design outputs. Content and preparation, as well as signing and sealing, of design documents is controlled through *Production and Acceptance of Design Documents* [7]. Formal design documents may be revised as required to provide current information. Revisions are controlled and subjected to review, verification and approval.

5.5 Design Review and Verification

Verification measures are applied at defined stages during the design phase in accordance with *Production and Acceptance of Design Documents* [7] and *Execution of Design Review and Verification* [8]. These verification measures evaluate the adequacy of a design or technical design decisions and confirm that the design satisfies the defined design requirements, as defined in the design verification requirements set out during the planning phase. Results of design review and design verification are documented.

The method, nature and extent of design verification required for design work is determined based on the safety significance (nuclear safety, industrial safety) of the work, complexity of the design used, degree of standardization of the product and process, state of the art, and use of previously issued designs. These factors are all considered in the Design Grading during the design planning phase.

5.6 Design Completion

Depending on the complexity of the design work or as identified during the planning stage, the designer prepares a statement to document completion of the design work, in accordance with *Production and Acceptance of Design Documents* [7]. For large, complex designs, a Design Completion Assurance Certificate may be required confirming that the design meets all design and technical requirements and satisfies all regulatory and compliance requirements, as outlined during the design planning process [5].

5.7 Design Changes

Design changes are controlled by the responsible designer during all stages of design development and implementation of permanent or temporary changes to facility equipment, SSC, processes, and controlled computer software. Design changes during initial design process are controlled in accordance with *Production and Acceptance of Design Documents* [7] and *Execution of Design Review and Verification* [8].

Changes occurring outside of the design process are controlled through *Configuration Management* [9].

5.8 Outsourced Design Work

Outsourced design work is managed through *Oversight of Engineering Agencies* [10]. However, the Design Authority and Design Engineering FSA covers the review of outsourced design work in accordance with *Production and Acceptance of Design Documents* [7] and *Execution of Design Review and Verification* [8].

6. Interfaces

6.1 Internal Interfaces

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Business Lines	Customers of design services	Email, telephone, meetings, and design planning forms	Customer Representative
HSSE	Identification of requirements	Email, telephone, meetings	Employees
Quality	Identification of requirements	Email, telephone, meetings	Employees
Business Management	SME advisory role	Email, telephone, meetings	SMEs
Safety Analysis	SME and service supplier for nuclear safety related design	Email, telephone, meetings, document preparation and review, and design forms	Safety Analyst/Engineer

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Nuclear Cyber Security	Identification of requirements and SME advisory role	Email, telephone meetings, document preparation and review, and design forms	Nuclear Cyber Security Specialist
Safety Review Committee	Review and Confirmation of Category 1 Changes	Memos and meetings	General Manager, Directors, and Managers
Electrical Safety	Interpretations on jurisdictional requirements for electrical systems	Email, telephone, meetings	Electrical Safety Functional Support Manager and SMEs
Pressure Boundary	Interpretations on jurisdictional requirements for pressure retaining systems	Email, telephone, meetings	Pressure Boundary Functional Support Manager and Specialists

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Canadian Nuclear Safety Commission (CNSC)	Licensing and regulatory compliance issues	Annual meetings, Quarterly meetings	Managers
Canadian Standards Association (CSA)	Information exchange and collaboration	Nuclear Standards Steering Committee and Technical Committees	General Manager, Engineering, Chief Engineer, and Management

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Technical Standards and Safety Authority (TSSA)	Design Registration submission to Authorized Inspection Agency (AIA)	Email, online submission	Engineering Management, DDAs
Inspection and Technical Services Manitoba (ITSM)	Design Registration submission to AIA	Email, online submission	Engineering Management, DDAs
International Groups: • CANDU Owners Group (COG) • International Atomic Energy Association (IAEA)	Information exchange and collaboration	Working groups, Peer reviews	General Manager, Engineering, Chief Engineer, and Management

7. References

[1] *Functional Authorities*, 900-514100-LST-001, 51965478.

[2] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions.

[3] *CNL Management System Manual*, 900-514100-MAN-001, 12489834.

[4] *Management system requirements for nuclear facilities*, N286-12 (R2022), Canadian Standards Association, June 2012.

[5] *Design Planning*, 900-508120-MCP-001, 49241785.

[6] *Assigning a Delegation of Design Authority*, 900-508120-MCP-005, 40776568.

[7] *Production and Acceptance of Design Documents*, 900-508120-MCP-002, 49231096.

[8] *Execution of Design Review and Verification*, 900-508120-MCP-003, 43929122.

[9] *Configuration Management*, 900-508130-PDD-001, 52736168.

[10] *Oversight of Engineering Agencies*, 900-508120-MCP-006, 53628016.

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John Slade	Chief Engineer	2023/10/16

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5.1	2023/10/12	Issued as "Approved for Use". "Review and Comment" not required. Minor revision: • Updated to latest PRD template: removed former section 3, Definitions and Acronyms; added section 4. • Updated LCH for Chalk River to latest version; moved to National Building Code of Canada, 2020; added National Fire Code of Canada, 2020. • Updated LCH for Nuclear Power Demonstration to latest version; moved to National Building Code of Canada, 2020. • Updated LCH for Whiteshell and Port Hope to latest version; no changes in requirements. • Added implementing documents to Table 7 LCH for Port Hope. • Added tables for ASME NQA-1, CSA N286.6-98 (R2003), and CSA N299-16 series. • Updated Engineers Act (Quebec): no changes in requirements. • Added list of guidance documents.	M. Gogulapati	J. Slade S. Toelly	J. Slade
5	2022/05/05	Issued as "Approved for Use". "Review and Comment" not required. Minor revision: Added requirements to Table 1 SOCA to align with Requirement Management database. Updated Table 5 NPD and Table 6 Douglas Point to new licences (no changes in requirements). Added new Table 8 REGDOC-2.6.3 Clause 4.4.2 to align with Requirement Management database.	M. Gogulapati	J. Slade S. Toelly	J. Slade

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3	2020/06/15	Issued as "Approved for Use" Minor editorial changes. Included requirement from Pressure Boundary PRD. No formal R&C required.	M. Gogulapati	S. Deighton J. deRuiter J. Slade	J. Slade
2	2019/09/16	Issued as "Approved for Use" Minor editorial changes such as template, updating references.	M. Gogulapati		J. Slade
1	2018/11/30	Issued as "Approved for Use"	J. Bailey		J. Slade
1D1	2016/03/31	Issued for "Review and Comment". Aligned Scope and Applicability, and Purpose sections with PDD. Replaced sub-section numbering by table caption as per latest template. Removed some requirements not applicable to the program. Updated to latest version of all Licence Conditions Handbooks and N286. Updated implementing documents. Added specific wording for provincial Engineering Acts requirements. Removed source requirement documents from the reference section.	J. Bailey	C. Ball E. Ballachey M. Burger D. Campbell A. Caron C. Charbonneau A. Coulas J. deRuiter Y. Dube A. Eyvindson D. Garrick G. Hamilton J. Heal D. Hill N. Mantifel J. Mitock D. Murphy R. Ponnan S. Sanders U. Senaratne J. Slade K. Summers D. Trylinski	
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Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
		145-508120-PRO-003, Conduct of Design Engineering, and CW-508740-REQ-114, Radiation Protection Consideration During Design and Modification			
D1	2016/12/16	Issued for "Review and Comment"		E. Ballachey A. Bellil A. Caron S. Celovsky J. deRuiter A. Eyvindson D. Garrick G. Hamilton J. Heal G. Hersak S. Karivelil H. Khartabil L. Leung K. Lundie N. Mantifel S. Mistry B. Orbanski R. Ponnan J. Sallis B. Sanderson K. Schruder J. Slade	

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Section **Page**

1. Scope and Applicability

This company-wide document applies to all activities unique to the Design Authority and Design Engineering Functional Support Area, performed by Canadian Nuclear Laboratories' employees, contractors, and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

2. Purpose

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment, and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

Various procedures control the design engineering work conducted at CNL. The following list presents the requirement source documents for the Design Authority and Design Engineering FSA.

- *Agreement for the Management and Operation of Certain Properties and Assets that are the Responsibilities of Atomic Energy of Canada Limited*, SOC Agreement (SOCA), 2015. Table 1
- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028*, Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023. Table 2
- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-08.00/2024*, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-LCH-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023. Table 3
- *Prototype Waste Facilities – Waste Facility Decommissioning License, Gentilly-1 Waste Facility, WFDL-W4-331.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-331.00/2034 Revision 1/61-00580-HBK-001, Revision 0, Canadian Nuclear Safety Commission, July 15, 2019. Table 4
- *Nuclear Power Demonstration Waste Facility Prototype Waste Facilities – Waste Facility Decommissioning Licence WFDL-W4-342.00/2034*, Licence Conditions Handbook, WFDL-LCH-W4-342.00/2034 Revision 2/64-508760-HBK-001, Revision 2, Canadian Nuclear Safety Commission, August 15, 2023. Table 5
- *Prototype Waste Facilities – Waste Facility Decommissioning Licence Douglas Point Facility WFDL-W4-332.03/2030*, Licence Conditions Handbook, WFDL-LCH-W4-332.03/2030 Revision 1/22-508760-HBK-002, Revision 0, Canadian Nuclear Safety Commission, June 11, 2021. Table 6

- *Port Hope Area Initiative Waste Management Project – Waste Nuclear Substance Licence WNSL-W1-2310.00/2032*, Licence Condition Handbook, LCH-WNSL-W1-2310.00/2032 Revision 0, Canadian Nuclear Safety Commission, January 1, 2023. Table 7
- *Fitness for Service: Aging Management*, REGDOC-2.6.3, Canadian Nuclear Safety Commission, March 2014. Table 8
- *Management system requirements for nuclear facilities*, N286-12 (R2022), Canadian Standards Association, June 2012. Table 9
- *Quality management systems - Requirements*, CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Canadian Standards Association, February 2016. Table 10
- *Quality Assurance Requirements for Nuclear Facility Applications*, ASME NQA-1-2015, American Society of Mechanical Engineers, February 20, 2015. Table 11
- *Decommissioning Quality Assurance for Nuclear Power Plants*, N286.6-98 (R2003), Canadian Standards Association, September 1998. Table 12
- *Quality assurance program requirements for the supply of items and services for nuclear power plants,* N299-16 series, Canadian Standards Association, September 2016. Table 13: CSA N299-16 series, Quality assurance program requirements for the supply of items and services for nuclear power plants.

Quality assurance program requirements for the supply of items and services for nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

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- *Canada Occupational Health and Safety Regulations*, SOR/86-304. Table 14
- *General requirements for pressure retaining systems and components in CANDU nuclear power plants/Material Standards for reactor components for CANDU nuclear power plants, N285.0-17/N285.6 Series-17, Canadian Standards Association, July 2017*. Table 15
- *Boiler, pressure vessel, and pressure piping code*, B51-14 (with no updates), Canadian Standards Association, January 2014. Table 16

- *Boiler, pressure vessel, and pressure piping code*, CSA B51-19 (with no updates), Canadian Standards Association, March 2019. Table 17
- *Professional Engineers Act (Ontario)*, R.S.O. 1990, c. P.28. Table 18
- *The Engineering and Geoscientific Professions Act (Manitoba)*, C.C.S.M. c. E120. Table 19
- *Engineers Act (Quebec)*, CQLR c. I-9. Table 20
- *Engineering and Geoscience Professions Act (New Brunswick)*, BILL 18. Table 21

The following list presents the guidance documents for the Design Authority and Design Engineering FSA not listed in the below tables.

- *General Design Considerations: Human Factors*, REGDOC-2.5.1, Canadian Nuclear Safety Commission, March 2019.
- *Design of Reactor Facilities: Nuclear Power Plants*, REGDOC-2.5.2, Canadian Nuclear Safety Commission, May 2014.
- *Design of Rooms Where Unsealed Nuclear Substances Used*, REGDOC-2.5.6, Canadian Nuclear Safety Commission, May 2023.

Table 1: Site Operating Company Agreement (SOCA).

Site Operating Company Agreement (SOCA)		
Section and Title	**Description**	**Implementing Document(s)**
SCHEDULE A - SOC STATEMENT OF WORK		
1. DECOMMISSIONING AND WASTE MANAGEMENT (DWM) 1.4 Waste Management (WM)	1.4.3.5 CNL shall be responsible for all technical and design aspects of the project under the PHAI program. 1.4.3.6 CNL shall ensure the design, construction and commissioning and operations of the PHAI are consistent with the requirements of the environmental assessment and any other Permits, Licences, Approvals and Agreements, and that projects meet necessary and appropriate Quality Assurance (QA) standards.	900-508120-PDD-001, *Design Authority and Design Engineering*
1. DECOMMISSIONING AND WASTE MANAGEMENT (DWM) 1.4 Waste Management (WM)	1.4.4.7 CNL shall engage with the Regulatory Authority to determine the requirements for long-term Historic LLW management and disposal.	900-508120-PDD-001, *Design Authority and Design Engineering*

Site Operating Company Agreement (SOCA)		
Section and Title	**Description**	**Implementing Document(s)**
	1.4.4.7.1 The safety basis and engineering design will be prepared as necessary to proceed through the licensing process. 1.4.4.7.2 CNL's recommendation will be included in the Proposed Annual Program of Work and Budget.	
4 PROJECT, DESIGN, AND CONSTRUCTION MANAGEMENT	4.5 CNL shall perform project, design and construction management, including: design and risk analysis, value engineering, configuration management and control, conceptual designs, preliminary designs, material testing, and surveying in support of architectural and engineering designs; final designs and construction drawings; and as-built drawings pursuant to construction inspections, surveying, and material-testing services for all of CNL's activities that support AECL and other customer needs.	900-508120-PDD-001, *Design Authority and Design Engineering*

Table 2: NRTEOL-LCH-01.00/2028, Licence Conditions Handbook for Chalk River Laboratories.

Licence Conditions Handbook for Chalk River Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.1: Design Program	The licensee shall implement and maintain a design program.	900-508120-PDD-001, *Design Authority and Design Engineering*
5.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	RD-367, Design of Small Reactor Facilities	Not currently applicable

Licence Conditions Handbook for Chalk River Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	REGDOC-2.5.7, Design, Testing and Performance of Exposure Devices	Not currently applicable
5.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	National Building Code of Canada, 2020 National Fire Code of Canada, 2020	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 3: NRTEDL-LCH-08.00/2024, Licence Conditions Handbook for Whiteshell Laboratories.

Licence Conditions Handbook for Whiteshell Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.1: Design Program	The licensee shall implement and maintain a design program.	900-508120-PDD-001, *Design Authority and Design Engineering*
5.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	CSA N393, Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances, 2013 (2016) National Fire Code of Canada, 2010 National Building Code of Canada, 2010	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 4: WFDL-LCH-W4-331.00/2034, Licence Conditions Handbook for Gentilly-1 Waste Facility.

Licence Conditions Handbook for Gentilly-1 Waste Facility		
Section and Title	**Description**	**Implementing Document(s)**
7.1 Change to Design or Equipment Compliance Verification Criteria: Licensing Basis Publications	National Building Code of Canada, 2015 Changes to the facility structure shall be in compliance with NBCC	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 5: WFDL-LCH-W4-342.00/2034, Licence Conditions Handbook for Nuclear Power Demonstration Waste Facility.

Licence Conditions Handbook for Nuclear Power Demonstration Waste Facility		
Section and Title	**Description**	**Implementing Document(s)**
7.1 Change to Design or Equipment Compliance Verification Criteria: Licensing Basis Publications	National Building Code of Canada, 2020 Changes to the facility structure shall be in compliance with NBCC	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 6: WFDL-LCH-W4-332.03/2030, Licence Conditions Handbook for Douglas Point Waste Facility.

Licence Conditions Handbook for Douglas Point Waste Facility		
Section and Title	**Description**	**Implementing Document(s)**
5.1: Design Program	The licensee shall implement and maintain a design program.	900-508120-PDD-001, *Design Authority and Design Engineering*
5.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	National Building Code of Canada, 2015 Changes to the facility structure shall be in compliance with NBCC	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 7:LCH-WNSL-W1-2310.00/2032, Licence Condition Handbook for Port Hope Area Initiative.

Licence Condition Handbook for Port Hope Area Initiative		
Section and Title	**Description**	**Implementing Document(s)**
4.1: Design Program	The licensee shall implement and maintain a design program.	900-508120-PDD-001, *Design Authority and Design Engineering*
4.1: Design Program Compliance Verification Criteria: Licensing Basis Publications	National Building Code of Canada, 2015 National Fire Code of Canada, 2015	2010-12-22-60154177-DDDR-RA, *Port Granby Project - Detailed Design Description Report* 4502-508120-DBD-001, *Port Granby Project - Detailed Design Description Addendum* PHP-RS3-RPT-002, *Port Hope Project - RS3: Detailed Design Description Report: Long-term Waste Management Facility* 4501-508120-DBD-001, *Port Hope Project - Addendum to the Detailed Design Description Report: Long-term Waste Management Facility* PHP-RS3-RPT-003, *Port Hope Project - RS3: Detailed Design Description Report for Low-Level Radioactive Waste Remediation Sites & Industrial Sites Group 1A* PHP-RS3-RPT-004, *Port Hope Project - RS3: Detailed Design Description Report for Low-Level Radioactive Waste Remediation Sites Group 1B* PHP-RS3-RPT-006, *Port Hope Project - RS3: Detailed Design Description Report for Low-Level Radioactive Waste Remediation Sites & Industrial Sites Group 2A* PHP-RS3-RPT-007, *Port Hope Project - RS3: Detailed Design Description Report for Low-Level Radioactive Waste*

Licence Condition Handbook for Port Hope Area Initiative		
Section and Title	**Description**	**Implementing Document(s)**
		Remediation Sites & Industrial Waste Remediation Sites Group 2C PHP-RS3-RPT-011, *Port Hope Project - RS3: Detailed Design Description Report for Low-Level Radioactive Waste Remediation Sites Group 2D* PHP-RS3-RPT- 005, *Port Hope Project - Detailed Design Description Report for Low-Level Radioactive Waste Remediation Port Hope Harbour* 900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 8: REGDOC-2.6.3, Fitness for Service: Aging Management.

Fitness for Service: Aging Management		
Section and Title	**Description**	**Implementing Document(s)**
4.4.2 Preventive actions to minimize and control aging degradation	Methods to prevent and control aging degradation shall be evaluated to establish appropriate actions that can be taken. Guidance The evaluation should identify: 1. preventive actions to be taken in design, selection of materials and coatings, fabrication and construction practices, commissioning, service conditions, and preventive operation and maintenance practices (including specifications for SSC lay-up conditions) 2. parameters to be monitored or inspected to ensure the preventive actions are effective 3. service conditions (environmental conditions and operating conditions) to be	900-508120-PDD-001, *Design Authority and Design Engineering*

Fitness for Service: Aging Management		
Section and Title	**Description**	**Implementing Document(s)**
	maintained and operating practices aimed at slowing down potential degradation of the structure or component	

Table 9: CSA N286-12, Management system requirements for nuclear facilities.

Management system requirements for nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
4 Generic requirements for the management system		
4.8.3 Independent verification of work	[As it relates to design work] Work activities throughout the life of the nuclear facility shall be independently verified by workers who did not perform the work to confirm that it meets requirements. The extent and timing of the verification shall be based on the potential impact of the work.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-003, *Execution of Design Review and Verification*
6.3.1 General (same as 7.3.1, 8.3.1, 9.3.1)	The design process shall be established and controlled.	900-508120-PDD-001, *Design Authority and Design Engineering* 900-508120-MCP-005, *Assigning a Delegation of Design Authority*
6.3.2 Inputs (same as 7.3.2, 8.3.2, 9.3.2)	Design inputs shall be established. The factors to be considered in determining the design inputs should include (a) functional requirements; (b) location and interfacing requirements; (c) performance requirements; (d) operational requirements; (e) environment considerations;	900-508120-MCP-001, *Design Planning* 900-508120-MCP-024, *Incorporation of Human Factors Engineering into Designs*

Management system requirements for nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
	(f) safety considerations; (g) codes and standards, and jurisdictional requirements; (h) contractual and customer consideration; (i) supply and logistics considerations; (j) stakeholder impact considerations; (k) human factor considerations; (l) experience from previous designs; (m) design requirements for each specific engineering discipline; (n) fabrication considerations; (o) installation considerations; (p) commissioning considerations; (q) in-service considerations; (r) research, technical studies, data, and reports; (s) decommissioning requirements; and (t) economic considerations.	
6.3.3 Requirements (same as 7.3.3, 8.3.3, 9.3.3)	Design requirements shall be defined in sufficient detail to provide reference for making decisions, verifying designs, and evaluating design changes.	900-508120-MCP-001, *Design Planning*
6.3.4 Design (same as 7.3.5, 8.3.4, 9.3.4)	The design shall be carried out based on the design requirements. Calculations, analyses, and studies shall be controlled in such a manner that they are available to subsequent users of the design.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
6.3.5 Documents (same as 7.3.6, 8.3.5, 9.3.5)	Design documents shall be created so the design can be related to the design requirements and used by organizations responsible for construction, commissioning, operation, and decommissioning. The following shall be included in the design documents:	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Management system requirements for nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
	(a) design requirements; (b) inputs, assumptions, methods, modelling, test and development work, and results; (c) jurisdictional requirements, applicable codes and standards, and other classification criteria; (d) purchasing, installation, and construction requirements; (e) design drawings; (f) characteristics of the design that need to be confirmed; and (g) system or equipment operating and maintenance requirements.	
7.3.4 Tools	Design tools shall be appropriate for the application and controlled.	900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 10: CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Quality management system - Requirements.

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
8.3 Design and development of products and services		
8.3.1 General	The organization shall establish, implement and maintain a design and development process that is appropriate to ensure the subsequent provision of products and services.	900-508120-PDD-001, *Design Authority and Design Engineering*
8.3.2 Design and development planning	In determining the stages and controls for design and development, the organization shall consider:	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and*

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
	a) the nature, duration and complexity of the design and development activities; b) the required process stages, including applicable design and development reviews; c) the required design and development verification and validation activities; d) the responsibilities and authorities involved in the design and development process; e) the internal and external resource needs for the design and development of products and services; f) the need to control interfaces between persons involved in the design and development process; g) the need for involvement of customers and users in the design and development process; h) the requirements for subsequent provision of products and services; i) the level of control expected for the design and development process by customers and other relevant interested parties; j) the documented information needed to demonstrate that design and development requirements have been met.	*Acceptance of Design Documents*
8.3.3 Design and development inputs	The organization shall determine the requirements essential for the specific types of products and services to be designed and developed. The organization shall consider:	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
	a) functional and performance requirements; b) information derived from previous similar design and development activities; c) statutory and regulatory requirements; d) standards or codes of practice that the organization has committed to implement; e) potential consequences of failure due to the nature of the products and services. Inputs shall be adequate for design and development purposes, complete and unambiguous. Conflicting design and development inputs shall be resolved. The organization shall retain documented information on design and development inputs.	
8.3.4 Design and development controls	The organization shall apply controls to the design and development process to ensure that: a) the results to be achieved are defined; b) reviews are conducted to evaluate the ability of the results of design and development to meet requirements; c) verification activities are conducted to ensure that the design and development outputs meet the input requirements; d) validation activities are conducted to ensure that the resulting products and services meet the requirements for the specified application or intended use; e) any necessary actions are taken on problems determined during the reviews, or verification and validation activities;	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
	f) documented information of these activities is retained. NOTE Design and development reviews, verification and validation have distinct purposes. They can be conducted separately or in any combination, as is suitable for the products and services of the organization.	
8.3.5 Design and development outputs	The organization shall ensure that design and development outputs: a) meet the input requirements; b) are adequate for the subsequent processes for the provision of products and services; c) include or reference monitoring and measuring requirements, as appropriate, and acceptance criteria; d) specify the characteristics of the products and services that are essential for their intended purpose and their safe and proper provision. The organization shall retain documented information on design and development outputs.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.3.6 Design and development changes	The organization shall identify, review and control changes made during, or subsequent to, the design and development of products and services, to the extent necessary to ensure that there is no adverse impact on conformity to requirements. The organization shall retain documented information on: a) design and development changes; b) the results of reviews;	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
	c) the authorization of the changes; d) the actions taken to prevent adverse impacts.	
8.5 Production and service provision		
8.5.1 Control of production and service provision	The organization shall implement production and service provision under controlled conditions. Controlled conditions shall include, as applicable: a) the availability of documented information that defines: 1) the characteristics of the products to be produced, the services to be provided, or the activities to be performed; 2) the results to be achieved; b) the availability and use of suitable monitoring and measuring resources; c) the implementation of monitoring and measurement activities at appropriate stages to verify that criteria for control of processes or outputs, and acceptance criteria for products and services, have been met; d) the use of suitable infrastructure and environment for the operation of processes; e) the appointment of competent persons, including any required qualification; f) the validation, and periodic revalidation, of the ability to achieve planned results for the processes for production and service provision, where the resulting	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification* 900-508120-MCP-024, *Incorporation of Human Factors Engineering into Designs*

Quality management system-requirements		
Section and Title	**Description**	**Implementing Document(s)**
	output cannot be verified by subsequent monitoring or measurement; g) the implementation of actions to prevent human error; h) the implementation of release, delivery, and post-delivery activities.	

Table 11: ASME NQA-1-2015, Quality Assurance Requirements for Nuclear Facility Applications.

Quality Assurance Requirements for Nuclear Facility Applications		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 12: CSA N286.6-98 (R2003), Decommissioning Quality Assurance for Nuclear Power Plants.

Decommissioning Quality Assurance for Nuclear Power Plants		
Section and Title	**Description**	**Implementing Document(s)**
3 Basic Requirements		
3.8 Work Planning and Control	Decommissioning activities shall be identified, planned, sequenced, resourced, assigned, defined, controlled, and verified.	900-508120-MCP-001, *Design Planning*
3.10 Verification	Work requiring specific independent in-field inspection, to confirm that results meet requirements, shall be identified. The extent of inspection may vary depending upon the complexity of the work and the potential impact on safety.	900-508120-MCP-003, *Execution of Design Review and Verification*
3.14 Document Control	3.14.1 The identification, review, approval, issue, distribution, and revision of all documents shall be controlled. 3.14.2 Documents, including changes and revisions, shall be reviewed for adequacy and approved for release by authorized personnel. 3.14.3 The individuals or organizations responsible for preparing, revising, reviewing, approving, and issuing documents shall be identified. 3.14.4 Modifications to documents relating to items or services shall, prior to implementation, undergo the same reviews and approvals as the original documents. Such reviews and approvals shall be carried out by persons having access to pertinent background information and having adequate understanding of the requirements and intent of the original documents.	900-508120-MCP-002, *Production and Acceptance of Design Documents*

Decommissioning Quality Assurance for Nuclear Power Plants		
Section and Title	**Description**	**Implementing Document(s)**
	3.14.5 Documents, including changes and revisions, shall be distributed for use at the location where the prescribed activity is performed or where the document is required for reference. 3.14.6 Obsolete documents shall be identified as such and promptly removed from use. 3.14.7 Information that permits the identification of any changes and revisions to documents shall be maintained"	
3.15 Records	3.15.1 Essential records shall be identified, maintained, stored, and routinely inspected to ensure their preservation and protection from loss, deterioration, or destruction. Essential records are the records essential to decommissioning, including those records that are necessary to provide evidence that items, services, and activities meet specified requirements. 3.15.2 Essential records shall be complete, valid, legible, retrievable, and traceable to the items and activities to which they refer. 3.15.3 Retention periods for records shall be defined.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
5 Links to other Quality Assurance Standards		
5.3 Design	Design activities shall be performed in accordance with the requirements of CSA Standard CAN/CSA-N286.2.	900-508120-MCP-002, *Production and*

Decommissioning Quality Assurance for Nuclear Power Plants		
Section and Title	**Description**	**Implementing Document(s)**
		Acceptance of Design Documents WLD-01150-STD-001, *Whiteshell Laboratories Engineering Standards Index*

Table 13: CSA N299-16 series, Quality assurance program requirements for the supply of items and services for nuclear power plants.

Quality assurance program requirements for the supply of items and services for nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 14: SOR/86-304, Canada Occupational Health and Safety Regulations.

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 15: CSA N285.0-17, General requirements for pressure retaining systems and components in CANDU nuclear power plants.

General requirements for pressure retaining systems and components in CANDU nuclear power plants		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 16: CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.

Boiler, Pressure Vessel, and Pressure Piping Code		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 17: CSA B51-19, Boiler, Pressure Vessel, and Pressure Piping Code.

Boiler, Pressure Vessel, and Pressure Piping Code		
Section and Title	**Description**	**Implementing Document(s)**
All applicable sections	Included when applicable in review of codes and standards during design planning and design execution.	900-508120-MCP-001, *Design Planning* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

Table 18: Professional Engineers Act (Professional Engineers Ontario).

Professional Engineers Act (Professional Engineers Ontario)		
Section and Title	**Description**	**Implementing Document(s)**
When licences or certificates required Section 12	Licensing requirement (1) No person shall engage in the practice of professional engineering or hold himself, herself or itself out as engaging in the practice of professional engineering unless the person is the holder of a licence, a temporary licence, a provisional licence or a limited licence. Certificate of authorization (2) No person shall offer to the public or engage in the business of providing to the public services that are within the practice of professional engineering except under and in accordance with a certificate of authorization. Exceptions (3) Subsections (1) and (2) do not apply to prevent a person, (a) from doing an act that is within the practice of professional engineering in relation to machinery or equipment, other than equipment of a structural nature, for use in the facilities of the person's employer in the production of products by the person's employer; (b) from doing an act that is within the practice of professional engineering where a professional engineer or limited licence holder assumes responsibility for the services within the practice of	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Professional Engineers Act (Professional Engineers Ontario)		
Section and Title	**Description**	**Implementing Document(s)**
	professional engineering to which the act is related; [see the Act for additional exceptions]	
Corporation Section 13	A corporation that holds a certificate of authorization may provide services that are within the practice of professional engineering.	900-508120-PDD-001, *Design Authority and Design Engineering*

Table 19: The Engineering and Geoscientific Professions Act (Engineers Geoscientists Manitoba).

The Engineering and Geoscientific Professions Act (Engineers Geoscientists Manitoba)		
Section and Title	**Description**	**Implementing Document(s)**
Part 12 – Prohibitions, in concurrence with Part 14 - Exceptions	Prohibitions on practice 57 Except as otherwise provided in this Act, no person who is not a member, a holder of a certificate of authorization, a temporary licensee, or a specified scope of practice licensee shall (a) engage in the practice of professional engineering or the practice of professional geoscience within the province; or (b) act in such a manner as to lead any person to believe that he or she is authorized to fulfil the office of, or act as, a professional engineer or professional geoscientist within the province. Prohibition on contracting with corporations and partnerships 59 No person shall knowingly engage, employ or contract with any person,	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

The Engineering and Geoscientific Professions Act (Engineers Geoscientists Manitoba)		
Section and Title	**Description**	**Implementing Document(s)**
	corporation, partnership or other legal entity that does not hold a certificate of authorization for any work that requires the services of a professional engineer or professional geoscientist. 14 – Exceptions Activities that are not affected 66(1) Nothing in this Act applies to prevent (a) the performance of professional engineering work by a natural person who is employed or engaged under the immediate and direct personal supervision and guidance of a professional engineer who assumes all responsibility for the work; (b) the performance of professional engineering work by an engineering intern who is enrolled in a program of training authorized under this Act or the by-laws; (c) the performance of professional geoscience work by a natural person who is employed or engaged under the immediate and direct personal supervision and guidance of a professional geoscientist who assumes all responsibility for the work; (d) the performance of professional geoscience work by a geoscience intern who is enrolled in a program of training authorized under this Act or the by-laws;	

The Engineering and Geoscientific Professions Act (Engineers Geoscientists Manitoba)		
Section and Title	**Description**	**Implementing Document(s)**
	[for additional exceptions, see the Act]	

Table 20: Engineers Act (Ordre des ingénieurs du Québec).

Engineers Act (Ordre des ingénieurs du Québec)		
Section and Title	**Description**	**Implementing Document(s)**
DIVISION II PRACTICE OF ENGINEERING	1.1. The practice of engineering consists, regardless of life cycle phase of works, in engaging in scientific analysis, design, execution, alteration, operation or advisory activities applied to structures and materials as well as to processes and systems that extract, use, exchange, transform, transport or store energy, information or matter in order to produce a reliable, safe and durable environment. The practice of engineering also consists in coordinating the work of persons who participate in the carrying out of engineering works. Respect for the environment and for life, the protection of property, heritage preservation and economic efficiency are part of the practice of engineering to the extent that they are related to the engineer's professional activities. [See Section 2 and 3 of DIVISION II of the Act for a description of the professional activities in the practice of engineering which are reserved to engineers]	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Engineers Act (Ordre des ingénieurs du Québec)		
Section and Title	**Description**	**Implementing Document(s)**
DIVISION V PENAL PROVISIONS	22. No one who is not an engineer may (1) engage in a professional activity referred to in section 2; (2) assume the title of engineer alone or qualified; (3) use any title, designation or abbreviation which may lead to the belief that the person is authorized to practise the profession of engineer, or advertise himself as such; or (4) act as an engineer or in such a way as to lead to the belief that the person is authorized to act as such.	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Table 21: Engineering and Geoscience Professions Act (Association of Professional Engineers and Geoscientists of New Brunswick).

Engineering and Geoscience Professions Act (Association of Professional Engineers and Geoscientists of New Brunswick)		
Section and Title	**Description**	**Implementing Document(s)**
AUTHORIZED PRACTICE	**9** Only persons who are members of the Association, or licencees, or holders of certificates of authorization as provided in this Act or by-laws, shall be entitled: (a) to take and use the title or designation “Engineer”, “Professional Engineer”, “Eng.”, “P. Eng.”, “Geoscientist”, “Professional Geoscientist”, “Geo.”, or “P. Geo.”, or any addition to such title or designation or any abbreviation thereof, and, in the case of geoscientists, any similar titles or	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Engineering and Geoscience Professions Act (Association of Professional Engineers and Geoscientists of New Brunswick)		
Section and Title	**Description**	**Implementing Document(s)**
	designations referring to the subdisciplines of geoscience; or (b) to practise the Professions in or for application in New Brunswick.	
DEEMED PRACTICE	**10** A person is deemed to practise or offer to practise the Professions within the meaning or intent of this Act who: (a) practises the Professions; (b) by verbal claim, sign, advertisement, letterhead, card, or use of a title, or in any other way, represents or implies to be a professional engineer or professional geoscientist; (c) represents to be a member, licencee, or holder of a certification of authorization under this Act; or (d) holds out the ability to practise, or practises the Professions or performs any other service which is recognized as part of the Professions.	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
PUBLIC OFFENSES	**17**(1) Any person, other than a member, licencee, or a certificate of authorization holder who […] (d) engages in the practice of the Professions; commits an offence.	Accountability Statements 900-508120-MCP-005, *Assigning a Delegation of Design Authority* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

Engineering and Geoscience Professions Act (Association of Professional Engineers and Geoscientists of New Brunswick)		
Section and Title	**Description**	**Implementing Document(s)**
PUBLIC OFFENSES	**17**(3) No partnership, association of persons, or corporation shall (a) practise the Professions; […] unless the partnership, association of persons, or corporation is the holder of a valid certificate of authorization, and every member or manager of the partnership or association of persons, and every shareholder, director, officer or manager of a corporation who participates in a violation of this subsection commits an offence.	900-508120-PDD-001, *Design Authority and Design Engineering*

4. Requirements Applicability

Table 22: Requirements applicability across CNL sites.

	Site								
Requirements	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
SOCA	X	X	X	X	X	X	X	X	X
NRTEOL-LCH-01.00/2028	X								
NRTEDL-LCH-08.00/2024						X			
WFDL-LCH-W4-331.00/2034									X
WFDL-LCH-W4-342.00/2034			X						
WFDL-LCH-W4-332.03/2030				X					
LCH-WNSL-W1-2310.00/2032		X							
REGDOC-2.6.3	X					X			
CSA N286-12	X	X	X	X	X	X	X	X	X
CAN/CSA-ISO 9001	X	X	X	X	X	X	X	X	X
ASME NQA-1-2015	X	X	X	X	X	X	X	X	X
CSA N286.6-98 (R2003)						X			
CSA N299-16 series	X	X	X	X	X	X	X	X	X

	Site								
Requirements	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
SOR/86-304	X	X	X	X	X	X	X	X	X
CSA N285.0-17	X					X			
CSA B51-14						X			
CSA B51-19	X								
Professional Engineers Act	X	X	X	X	X	X	X	X	X
The Engineering and Geoscientific Professions Act	X	X	X	X	X	X	X	X	X
Engineers Act	X	X	X	X	X	X	X	X	X
Engineering and Geoscience Professions Act	X	X	X	X	X	X	X	X	X

5. Requirements Specifying Assessment Activities

There are no assessment activities for requirements.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Pressure Boundary REV 5.2

900-508140-PDD-001

Information Use

Approved by	Title	Date
Jason deRuiter	Pressure Boundary Specialist	2023/07/04

Effective Date: 2023/07/18
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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
5.2	2023/07/04	Issued as “Approved for Use”. “Review and Comment” not required. Minor revision to address CNSC staff comments (REG action REG-R-23-3385): • 5.1 and 5.2: replaced “CNSC designated inspection agency” with “the recognized and accepted inspection agency”.	M. Agnelli	A. Dash J. deRuiter	J. deRuiter
5.1	2023/04/26	Issued as “Approved for Use”. “Review and Comment” not required. Minor revision: • Added CSA N285.0-08 for WL; kept CSA N285.0-17 for CRL. • Added CSA B51-19 for CRL; kept CSA B51-14 for WL. • Section 6: moved “AI/ANI” to external interface; replaced “AI/ANI” by “AI/ANI from Authorized Inspection Agency”; added Pressure Boundary Functional Support Manager. • Updated references. • Minor editorial changes.	M. Agnelli	A. Dash J. deRuiter	J. deRuiter
5	2022/05/02	Issued as “Approved for Use”. “Review and Comment” not required. Minor revision: • Updated references. • Replaced WL-508140-QAM-001 by WL-508140-QAP-001. • Minor edits.	J. deRuiter	J. deRuiter	J. deRuiter
4	2021/06/09	Issued as “Approved for Use.	N. Dadhiala	J. deRuiter	J. deRuiter
4D1	2021/05/18	Issued for “Review and Comment”. Updated to include latest references.	N. Dadhiala	A. Coulas J. deRuiter	
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1D1	2018/08/29	Issued for “Review and Comment”. Minor editorial changes. Moved all definitions and acronyms to the Glossary of Controlled Terms and Acronyms. Removed Program Authority role. Added reference to Pressure Boundary Quality Assurance Plans in Section 5.1 and 5.2. Changed CRL 508140-QAM-001 to QAP. Revised 5.1 to reflect new LCH. Revised TSSA and ITSM interface details.	J. deRuiter	J. Afelski M. Bagshaw B. Bruneau A. Coulas D. Cram S. Deighton O. Dillenbeck Y. Dube D. Hill R. Latimer T. Long K. Lundie L. McGrath D. Meldrum R. Michaud S. Mistry S. Parrott S. Portman P. Pottelberg J. Slade S. White	
0	2017/01/04	Issued as “Approved for Use”.			K. Lundie
D1	2016/12/13	Issued for “Review and Comment”.		J. Afelski M. Bagshaw B. Bruneau S. Celovsky A. Coulas S. Deighton O. Dillenbeck D. Gerl D. Hill R. Latimer C. Lee L. Leung T. Long K. Lundie L. McGrath D. Meldrum R. Michaud S. Mistry B. Orbanski A. Sharma J. Slade A. Stewart	

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1. Scope and Applicability

The Pressure Boundary Program applies to design, procurement, fabrication, installation, examination, testing, repair, replacement, modification, construction, and maintenance of pressure retaining systems and components performed by Canadian Nuclear Laboratories (CNL) at the Chalk River Laboratories (CRL), Deep River facilities controlled by CRL, and Whiteshell Laboratories (WL).

The Sites, Facilities, and Buildings that fall under the auspices of the Pressure Boundary Program are federally regulated. As such, provincial legislation does not apply to activities conducted on pressure retaining systems and components at these locations. The Canadian Nuclear Safety Commission (CNSC) identifies applicable codes and standards through the licences issued to permit the conduct of licensed activities. At this time, the CNSC have included specific pressure boundary requirements in the site licences for both CRL and WL. To ensure compliance with these defined requirements, the Pressure Boundary Program has been implemented at each of these sites. The *CRL Nuclear Pressure Boundary Quality Assurance* plan [1], *CRL CSA B51 Pressure Boundary Quality Control Manual* [2], and the *WL Pressure Boundary Quality Assurance Plan* [3] detail the specific scope, as permitted by the Certificates of Authorization issued to each laboratory, and describe the controls, authority, and responsibilities applicable to each laboratory.

Specific programs have not been developed to support activities conducted on pressure retaining systems and components at any other location.

The Pressure Boundary Program does not include the design, fabrication, modification, or repair of Class 1, 1C, 2, 2C, 3, or 3C pressure vessels, or overpressure protection devices as classified in accordance with CSA N285.0 *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* [4] [5]. The program does not include qualification of material organizations or the qualification of unqualified source material. Qualified suppliers are to be contracted for specific scopes of work.

Any questions regarding the content or application of this document should be directed to the Functional Support Manager for Pressure Boundary as identified in *Functional Authorities* [6].

2. Purpose

The purpose of the Pressure Boundary Program is to assure that pressure-retaining systems and components are designed, constructed, and operated in full compliance with statutory and legislative requirements, while promoting and supporting performance excellence with a strong safety culture. The ultimate objective of the Pressure Boundary Program and its governing codes and standards is “no pressure boundary failures”.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [7] contains specific meanings for those words that require further clarification.

Definitions of terms used in nuclear applications follow the hierarchy below:

- *Licence Conditions Handbook for Chalk River Laboratories* (LCH for CRL) [8]
- *Licence Conditions Handbook for Whiteshell Laboratories* (LCH for WL) [9]
- *General requirements for pressure-retaining systems and components in CANDU nuclear power plants* (CSA N285.0) [4] [5]
- *Glossary*, Section III - Article NCA-9000, Boiler and Pressure Vessel Code (ASME NCA-9000) [10]
- *Definitions*, Section III - Article NCA-4120, Boiler and Pressure Vessel Code (ASME NCA-4120) [11]
- *Quality Assurance Requirements for Nuclear Facility Applications* (ASME NQA-1) [12]

Definitions of terms used in non-nuclear applications follow the hierarchy below:

- *LCH for CRL* [8]
- *LCH for WL* [9]
- *Boiler, pressure vessel, and pressure piping code* (CSA B51) [13] [14]
- ASME codes of construction (ASME B31) [15] [16] [17]

4. Roles and Responsibilities

4.1 Functional Support Manager

The Pressure Boundary Functional Support Manager is responsible for:

- Assessing the applicability of laws, statutes, regulations, guidelines, codes, and standards for the program.
- Implementing regulatory, legal, codes, and standards requirements applicable to the program at all CNL Canadian sites considering specific work environment and activities.
- Defining performance measures for CRL and WL sites.
- Developing and maintaining Quality Assurance Plans for CRL and WL sites.

4.2 Classifier

The Classifier role may be performed by the Designer or by the Owner of the system or component. The Classifier is responsible for:

- Determining the classification of systems and components.
- Obtaining regulatory acceptance of classifications.

4.3 Designer

The Designer is responsible for:

- Determining if design registration is required.
- Registering designs with the Authorized Inspection Agency (AIA).
- Completing reconciliation statement when required.

4.4 Buyer

The Buyer is responsible for:

- Processing requisitions for items and services.
- Confirming suppliers are qualified.
- Awarding purchase orders.

4.5 Shipper or Receiver

The Shipper or Receiver is responsible for:

- Controlling materials to ensure traceability and preservation.
- Ensuring materials and items requiring inspection are segregated.

4.6 Supplier or Manufacturer

The Supplier or Manufacturer is responsible for:

- Controlling materials to ensure traceability and preservation.
- Ensuring Quality Assurance (QA) accepted material is used in fabrication.

4.7 Welding Professional

The Welding Professional is responsible for:

- Preparing, certifying, and registering Welding Procedure Specifications and maintaining Procedure Qualification Records.

4.8 Welder

The Welder is responsible for:

- Controlling materials to ensure traceability and preservation.
- Ensuring QA accepted material is used and welding is performed in accordance with registered Welding Procedure Specifications.

4.9 Quality Control Inspector

The Quality Control Inspector is responsible for:

- Controlling materials to ensure traceability and preservation.
- Ensuring QA accepted material was used.
- Conducting inspections, including non-destructive examination and incoming inspection.
- Initiating non-conformance reports for items found not complying with the specified requirements.

4.10 Planner or Assessor

The Planner or Assessor is responsible for:

- Coordinating hold and witness point inspections with the Jurisdictional Liaison.
- Planning maintenance, fabrication, installation, and inspection activities.
- Preparing, reviewing, and controlling maintenance documentation such as route sheets and/or other process control documents.
- Initiating inspection requests for pressure boundary items including customer supplied material.
- Closing out completed maintenance documentation.
- Controlling fabrication and installation activities.
- Controlling materials to ensure traceability and preservation.

4.11 Jurisdictional Liaison

The Jurisdictional Liaison is responsible for:

- Coordinating Authorized Inspector (AI) / Authorized Nuclear Inspector (ANI) visits to site.
- Providing AI/ANI with documentation.

4.12 Installer

The Installer is responsible for:

- Controlling materials to ensure traceability and preservation.
- Ensuring QA accepted material is used and process control documents are adhered to.

4.13 Authorized Inspector / Authorized Nuclear Inspector

The AI/ANI represents the AIA at CNL sites. The AI/ANI is responsible for:

- Ensuring QA accepted material was used.
- Verifying material traceability.
- Verifying installations and fabrications meet specified requirements, and witnessing post-maintenance pressure tests.

4.14 Owner

At CNL, the duties of the Owner are assigned to the Chief Engineer (also known as the Design Authority). The Owner is responsible for:

- Executing the owner's duties for CNL sites as defined by Site Licence Conditions and applicable codes and standards related to the Pressure Boundary Function.
- Formally delegating review and documentation of the review of Design Reports.
- Documenting a pressure boundary quality assurance program.
- Obtaining written agreement with an AIA.

5. Functional Programs

DESIGN (Classifier, Designer)

- Engage Engineering Safety & Licensing to conduct a consequence of failure analysis
- Determine system classification
- Produce design documentation (reports, forms, drawings, specifications)
- Register design with the AIA

↓

PROCUREMENT (Buyer)

- Produce and release purchase order to qualified suppliers
- Maintain procurement records

↓

LOGISTICS, SHIPPING, RECEIVING (Shipper or Receiver)

- Receive materials or items, with Certificate of Compliance
- Identify and control materials
- Generate Receipt Travellers

↓

FABRICATION (Supplier, Manufacturer, Welder, Welding Professional)

- Fabricate traceable item
- Generate welding procedure specifications
- Generate process control documents such as manufacturing inspection and test plans
- Certify procedure qualification records

↓

INSPECTION (Quality Control Inspector, Jurisdictional Liaison, AI/ANI)

- Conduct incoming material inspections
- Generate the receiving inspection report
- Perform non-destructive examinations
- Witness in-service testing
- Perform in-process inspections
- Calibrate measuring and test equipment

↓

PLANNING (Planner, Assessor, Jurisdictional Liaison)

- Prepare process control documents such as route sheet or job cards.
- Select materials or components
- Produce data reports
- Schedule work, including periodic inspections and replacements
- Engage the AI/ANI: AI/ANI reviews route sheet for acceptance and identification for any hold, or witness, or verification points

↓

INSTALLATION (Installer, Jurisdictional Liaison, AI/ANI)

- Install item
- Generate maintenance record and data report
- Complete required tests and inspections

Figure 1: Pressure Boundary process.

5.1 Chalk River Laboratories

CRL operates under the *Nuclear Research and Test Establishment Operating Licence, Chalk River Laboratories* [18] issued by the CNSC. The licence states that CNL will implement and maintain a pressure boundary program. The licence is supported by the *LCH for CRL* [8].

The Pressure Boundary Program at CRL complies with the requirements of CSA N285.0 [5], which defines the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination, and inspection of pressure-retaining and containment systems, including their components and supports.

Where indicated by CSA N285.0 [5] and its applicable referenced publications, CNL has the following:

- Registered designs and procedures (by AIA).
- Inspections (by AIA).
- Documents describing the classification, registration, and reconciliation processes and the associated controls.

CNL also obtains AIA acceptance for implementation of the CRL's programs and procedures for:

- Calibration, repair, and maintenance of overpressure protection devices.
- Repair and maintenance of mechanical joints.
- Periodic inspection of boilers and pressure vessels designed according to CSA B51 [14].

Where CSA N285.0 [5] requires items to be submitted to CNSC for approval before implementation, CNL:

1. Documents the item in sufficient detail to ensure it is safe to proceed.
2. Submits the item to the AIA for assessment and acceptance, if required by CSA N285.0 [5] or its referenced publications.

CNL may implement the item and notifies CNSC staff if the AIA has given its acceptance.

CNL has in place a formal agreement with an AIA acceptable to the CNSC to provide services for the pressure boundaries of the nuclear facility as defined by CSA N285.0 [5] and its applicable referenced publications. The Technical Standard and Safety Authority (TSSA) is the Provincial Boiler & Pressure Vessel authority in Ontario and the recognized and accepted inspection agency to CRL site.

The *CRL Nuclear Pressure Boundary Quality Assurance* plan [1] and the *CRL CSA B51 Pressure Boundary Quality Control Manual* [2] presents the details of the pressure boundary quality assurance program implemented at CRL.

5.2 Whiteshell Laboratories

WL operates under the *Nuclear Research and Test Establishment Decommissioning Licence (NRTEDL), Whiteshell Laboratories* [19]. The licence states that CNL will implement and maintain a pressure boundary program. The licence is supported by the *LCH for WL* [9].

The LCH further defines and clarifies the requirements and allowances for the pressure boundary program at WL to design, manufacture, fabricate, procure, install, modify, repair, test, examine, inspect, or otherwise perform work related to vessels, boilers, systems, piping, fittings, parts, components, and supports according to the specifications in CSA N285.0 [4], CSA B51 [13], or other codes and standards approved or prescribed by the CNSC.

Where indicated by these standards, CNL obtains regulatory approvals for the following work:

- Registered designs.
- Accepted overpressure protection reports.
- Approval of applicable standards and code classification.
- Registered welding and brazing procedures.
- Qualified welders, welding operators, brazers, and examination personnel.
- Accepted quality assurance programs.
- Accepted plans and procedures (certificates of authorization).

WL classifies as Class 6 systems or sections of systems that contain tritium or other radioactive substances, if the consequence of failure limit of 20 mSv effective acute whole body dose is not exceeded. WL carries out the activities listed above in accordance with CSA B51 [13], or other codes and standards approved or prescribed by the CNSC, for pressure boundary systems and components that do not contain nuclear substances, do not adversely impact a nuclear safety system, or do not cause an unreasonable risk involving nuclear substances at WL.

Whiteshell Laboratories:

- Operates vessels, boilers, systems, piping, fittings, parts, components, and supports safely and keeps them in a safe condition.
- Complies with operating limits specified in certificates, orders, designs, overpressure protection reports, and applicable codes and standards.
- Has any certified boiler or vessel that is in operation or use, inspected and certified by an AI according to an accepted schedule.
- Inspects and performs material surveillance according to accepted schedules, plans, and procedures.
- Ensures that vessels, boilers, systems, piping, fittings, parts, components, and supports have markings as specified in the applicable standards.
- Keeps proper records of regulatory approvals and other documents required as set out in the *LCH for WL* [9] and the standards applicable to the work or equipment.

WL reports to the CNSC and to the Manitoba Department of Labour and Immigration when WL learns of any failure of a pressure boundary that has caused injury, death, or property damage. The Inspection and Technical Services Manitoba (ITSM) is the Provincial Boiler & Pressure

Vessel regulatory authority in Manitoba (*The Steam and Pressure Plants Act* [20]) and the recognized and accepted inspection agency to WL site and provides AIA services to WL. This requirement is in addition to any reporting requirements of the *Nuclear Safety and Control Act* [21] and its associated Regulations.

The *WL Pressure Boundary Quality Assurance Plan* [3] presents the details of the pressure boundary quality assurance program implemented at WL.

6. Interfaces

6.1 Internal Interfaces

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Lines of Business (Owners of system or component)	• Determines the classification of systems and components • Obtains regulatory acceptance of classifications • Determines if design registration is required • Provides concurrence to non-conformance dispositions	• Meetings, email, phone, change requests	• Designer
Design Engineering	• Registers designs with the AIA • Assesses the as-built configuration of systems and components and reconciles differences with the registered design	• Meetings, email, phone, change requests	• Designer
Procurement	• Processes requisitions • Confirms suppliers are qualified • Awards purchase orders	• Purchase Orders	• Buyer
Logistics	• Controls materials to ensure traceability and preservation • Ensures materials and items requiring inspection are segregated	• Receipt Traveller	• Warehouse Supervisor
Quality	• Incoming inspection • Non-destructive examination • In-service testing • Calibrating measuring and test equipment • Initiates non-conformance reports for items found not complying with the specified requirements • Coordinates AI/ANI visits to site • Provides AI/ANI with documentation	• Process control documents such as route sheets • Inspection Record • ImpAct	• Quality Control Inspector • Jurisdictional Liaison

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Fitness for Service	• Controls materials to ensure traceability and preservation • Ensures QA accepted material is used and work control documents are adhered to • Coordinates hold and witness point inspections with the Jurisdictional Liaison • Plans fabrication and installation activities • Prepares, reviews, and controls maintenance documentation such as route sheets or other process control documents • Initiates inspection requests for pressure boundary items including customer supplied material • Closes out completed maintenance documentation • Controls fabrication and installation activities	• Work control package, documentation, email	• Planner, Assessor, Installer
Quality Audit & Support	• Carries out audits to determine the adequacy and effectiveness of the pressure boundary quality assurance programs	• Audit plan • Audit report	• Pressure Boundary Functional Support Manager
Pressure Boundary Working Group	• Provides oversight to existing processes identified in the pressure boundary programs as required under CRL and WL's site licences	• Working group meetings	• Pressure Boundary Functional Support Manager
Manufacturing Services	• Controls materials to ensure traceability and preservation • Ensures QA accepted material is used in fabrication • Fabricates traceable item • Generates welding procedure specifications • Generates Manufacturing Inspection and Test Plans • Certifies Procedure Qualification Records	• Manufacturing Inspection and Test Plans • Work request	• Manufacturing Assessor or Planner • Welding Professional

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Canadian Standards Association (CSA) N285.0	• Information exchange and collaboration • Prepare and maintain CSA Nuclear Standards for pressure-retaining systems and components	• Nuclear Standards Steering Committee, Technical Committees	• General Manager, Engineering • Chief Engineer • Pressure Boundary Functional Support Manager
AI/ANI from Authorized Inspection Agency	• Ensures QA accepted material was used • Verifies material traceability • Witnesses post-maintenance pressure tests • Provides concurrence to non-conformance dispositions	• Inspection and witness testing • Email, phone • ImpAct	• Jurisdictional Liaison • Planner/Assessor • Pressure Boundary Functional Support Manager
Technical Standards and Safety Authority (TSSA)	• Jurisdictional requirements for pressure retaining systems within Ontario	• Procedure on Design Registration • Procedure on AIA Agreement • Audit plan • Audit report • Meetings, email, phone	• Pressure Boundary Functional Support Manager • Manager, Process, Mechanical & HVAC • CRL Jurisdictional Liaison
Inspection and Technical Services Manitoba (ITSM)	• Jurisdictional requirements for pressure retaining systems within Manitoba	• Procedure on Design Registration • Procedure on AIA Agreement • Audit plan • Audit report • Meetings, email, phone	• Pressure Boundary Functional Support Manager • Manager WL Engineering
CANDU Owners Group (COG)	• Information exchange and collaboration • Develop unified positions on generic pressure boundary issues	• Workshops, peer groups	• Pressure Boundary Functional Support Manager
Canadian Nuclear Safety Commission (CNSC)	• Unplanned event reporting • Compliance with licence	• Procedure on Reporting of Unplanned Events and Situations to the CNSC • Procedure on External audit	• Pressure Boundary Functional Support Manager

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Supplier Manufacturer Fabricator	• Procurement of Components and/or Services	• Purchase Order • Technical Specification • Technical Scope of Work	• Procurement

7. References

[1] *CRL Nuclear Pressure Boundary Quality Assurance*, CRL-508140-QAP-001, 51654825.

[2] *CRL CSA B51 Pressure Boundary Quality Control Manual,* CRL-508140-QAP-003, 50275773.

[3] *WL Pressure Boundary Quality Assurance Plan. Whiteshell Site Documentation. Pinawa, Manitoba, R0E 1L0*, WL-508140-QAP-001, 55257059.

[4] *General requirements for pressure-retaining systems and components in CANDU nuclear power plants / Material Standards for reactor components for CANDU nuclear power plants*, N285.0-08/N285.6 Series-08 (with no updates), Canadian Standards Association, June 2008.

[5] *General requirements for pressure-retaining systems and components in CANDU nuclear power plants / Material Standards for reactor components for CANDU nuclear power plants*, N285.0-17/N285.6 Series-17, Canadian Standards Association, July 2017.

[6] *Functional Authorities,* 900-514100-LST-001, 51965478.

[7] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions

[8] *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028*, Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14,2023.

[9] *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-08.00/2024*, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-HBK-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023.

[10] *Glossary*, ASME Boiler and Pressure Vessel Code, Section III - Article NCA-9000, American Society of Mechanical Engineers, 2015.

[11] *Definitions*, ASME Boiler and Pressure Vessel Code, Section III - Article NCA-4120, American Society of Mechanical Engineers, 2015.

[12] *Quality Assurance Requirements for Nuclear Facility Applications*, NQA-1-2015, American Society of Mechanical Engineers, February 20, 2015.

[13] *Boiler, pressure vessel, and pressure piping code*, CSA B51-14 (with no updates), Canadian Standards Association, January 2014.

[14] *Boiler, pressure vessel, and pressure piping code***,** CSA B51-19 (with no updates), Canadian Standards Association, March 2019.

[15] *Power Piping,* B31.1, American Society of Mechanical Engineers.

[16] *Process Piping,* B31.3, American Society of Mechanical Engineers.

[17] *Refrigeration Piping and Heat Transfer Components,* B31.5, American Society of Mechanical Engineers.

[18] Canadian Nuclear Safety Commission, *Nuclear Research and Test Establishment Operating Licence, Chalk River Laboratories*, Licence No. NRTEOL-01.00/2028, Expiry Date: 2028 March 31.

[19] Canadian Nuclear Safety Commission, *Nuclear Research and Test Establishment Decommissioning Licence, Whiteshell Laboratories,* Licence No. NRTEDL-W5-8.00/2024, Expiry Date: 2024 December 31.

[20] *The Steam and Pressure Plants Act (Manitoba)*, C.C.S.M. c. S210.

[21] *Nuclear Safety and Control Act*, S. C. 1997, c. 9.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Pressure Boundary REV 5.2

900-508140-PRD-001

Information Use

Approved by	Title	Date
Jason deRuiter	Pressure Boundary Specialist	2023/10/11

Effective Date:	2023/11/30
Expiry Date:	2026/10/10

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
5.2	2023/09/29	Issued as "Approved for Use." Minor Change Revision: corrected section 4, Table 13 to address CNSC comments in letter 145-NOCN-23-0041-L.	M. Agnelli	J. deRuiter S. Toelly	J. deRuiter
5.1	2023/07/25	Issued as "Approved for Use." Minor Changes Revision: • Updated to latest PRD template: removed former section 3, Definitions and Acronyms; added section 4. • Added comment on "specific provincial requirements" in section 1. • Moved NRTEOL-LCH-01.00/2028 to rev. 3: no changes in requirements. • Moved NRTEDL-W5-08.00/2024 to rev. 1: added CSA N285.0 row to Table 2. • Added N285.0-08 for WL; kept N285-17 for CRL; no change in requirements. • Added B51-19 for CRL; kept B51-14 for WL; no change in requirements. • Added list of guidance documents. • Added 900-508140-FID-001 to Table 1. • Collapsed Table 10 and 11 for B51 and referenced WL and CRL QAPs.	M. Agnelli	J. deRuiter	J. deRuiter
5.1D1	2023/05/08	Issued for "Review and Comment".	M. Agnelli	J. deRuiter S. Toelly	
5	2022/04/20	Issued as "Approved for Use." "Review and Comment" not required. Minor revision: • Rephrased scope and purpose sections according to latest PRD template. • Updated references. • Replaced WL-508140-QAM-001 by WL-508140-QAP-001.	J. deRuiter	J. deRuiter	J. deRuiter

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		• Minor edits.			
4	2021/06/09	Issued as “Approved for Use.	N. Dadhiala	J. deRuiter	J. deRuiter
4D1	2021/05/20	Issued for “Review and Comment”. Updated to include minor editorial changes and updated references.	N. Dadhiala	A. Coulas J. deRuiter	
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3D1	2020/09/11	Issued for “Review and Comment”. Updated to reflect transition from CSA N285.0-08 to CSA N285.0-17. Changes to clauses have been captured for CSA N285.0, as well as its applicable referenced publications.	N. Dadhiala	M. Bagshaw J. Bailey C. Ball C. Charbonneau A. Coulas D. Cram J. deRuiter S. Deighton Y. Dube D. Garrick L. McGrath D. Meldrum S. Parrott S. Portman J. Slade	
2	2019/09/20	Issued for “Approved for Use” No formal R & C required; Minor changes include updated references to implementing documents.	N. Dadhiala		J. deRuiter
1	2018/11/16	Issued as “Approved for Use.			J. deRuiter
1D1	2018/11/16	Issued for “Review and Comment”. Aligned Scope and Applicability, sections with 900-508140-PDD-001. Revised Purpose section and introduction to Section 4 to remove duplication. Revised Figure 1. Added TSSA Agreement to list of source requirement document. Replaced sub-section numbering by table caption as per latest template. Updated to latest version of the Licence Conditions Handbook for Chalk River Laboratories. Updated implementing documents.		J. Afelski M. Bagshaw B. Bruneau A. Coulas D. Cram S. Deighton O. Dillenbeck Y. Dube D. Hill R. Latimer T. Long K. Lundie L. McGrath D. Meldrum R. Michaud S. Mistry S. Parrott	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		Added requirements for assessment activities in Section 5. Removed source requirement documents from the reference section.		S. Portman P. Pottelberg J. Slade S. White	
0	2017/01/04	Issued as “Approved for Use.			K. Lundie
D1	2016/12/13	Issued for “Review and Comment”.		J. Afelski M. Bagshaw B. Bruneau S. Celovsky A. Coulas S. Deighton O. Dillenbeck D. Gerl D. Hill R. Latimer C. Lee L. Leung T. Long K. Lundie L. McGrath D. Meldrum R. Michaud S. Mistry B. Orbanski A. Sharma J. Slade A. Stewart	

Table of Contents

1. Scope and Applicability

This company-wide document applies to all activities unique to the Pressure Boundary Functional Support Area, performed at the Chalk River Laboratories (CRL), Deep River facilities controlled by CNL, and Whiteshell Laboratories (WL), by Canadian Nuclear Laboratories' employees, contractors, and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

The Sites, Facilities, and Buildings that fall under the auspices of the Pressure Boundary Function are federally regulated. As such, provincial legislation typically does not apply to activities conducted on pressure retaining systems and components at these locations. Where specific provincial requirements are implemented, these are identified in the site-specific Quality Assurance Plans, and accepted by the Jurisdictional Authority for the Province. The Canadian Nuclear Safety Commission (CNSC) identifies applicable codes and standards through the licences issued to permit the conduct of licensed activities. At this time, the CNSC have included specific Pressure Boundary requirements in the site licences for both CRL and WL. To ensure compliance with these defined requirements, the Pressure Boundary Function has been implemented at each of these sites.

2. Purpose

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment, and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

This section describes the requirements to ensure that the Pressure Boundary Function is planned, implemented, and maintained.

CSA standard N285.0 and its applicable referenced publications, as well as other codes and standards approved or prescribed by the CNSC, specify the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of, and other work related to, pressure-retaining systems, components, and supports over the service life of a Canada Deuterium Uranium (CANDU) nuclear power plant. Figure 1 presents the hierarchy and interrelation between these standards.

The following list presents the requirement source documents for Pressure Boundary.

- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028*, Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023. Table 1

- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-08.00/2024,* Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-LCH-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023. Table 2
- *Canada Labour Code*, R.S.C., 1985, c. L-2. Table 3
- *Canada Occupational Health and Safety Regulations*, SOR/86-304. Table 4
- *The Steam and Pressure Plants Act (Manitoba)*, C.C.S.M. c. S210. Table 5
- *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, N285.0-08 (with no updates), Canadian Standards Association, June 2008. Table 6
- *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, N285.0-17 (with no updates), Canadian Standards Association, July 2017. Table 7
- *ASME Boiler and Pressure Vessel Code*, American Society of Mechanical Engineers, 2015. Table 8
- *Quality Assurance Requirements for Nuclear Facility Applications,* NQA-1-2015, American Society of Mechanical Engineers, February 20, 2015. Table 9
- *Boiler, pressure vessel, and pressure piping code*, CSA B51-14 (with no updates), Canadian Standards Association, January 2014. Table 10
- *Boiler, pressure vessel, and pressure piping code*, CSA B51-19 (with no updates), Canadian Standards Association, March 2019. Table 11
- *Authorized Inspection Agency Services Agreement between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*, CRL-508140-141-000, 56842344. Table 12

The following list presents the guidance documents for Pressure Boundary not listed in the below tables.

- *Commentary on CSA N285.0-17, General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, N285.0.1-2018, Canadian Standards Association, August 2018.
- *Commentary on CSA N285.0-12, General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, N285.0.1-2016, Canadian Standards Association, November 2016.

Pressure Boundary work conducted at CRL and WL is controlled by various procedures, all of which are captured in the following quality assurance plans:

- *CRL Nuclear Pressure Boundary Quality Assurance*, CRL-508140-QAP-001, 51654825.
- *CRL CSA B51 Pressure Boundary Quality Control Manual*, CRL-508140-QAP-003, 50275773.
- *WL Pressure Boundary Quality Assurance Plan*, WL-508140-QAP-001, 55257059.

The quality assurance plans describe the controls, processes, special processes, test equipment, tools, and skills/certification of personnel required to meet the quality requirements. The quality assurance plans are used to ensure that all pressure boundary work is compliant with the requirements of *CSA N285.0, General Requirements for Pressure Retaining Systems and Components in CANDU Nuclear Power Plants* and/or *CSA B51, Boiler, Pressure Vessel, and Pressure Piping code* standards, including construction requirements for pressure boundary work at CNL**.**

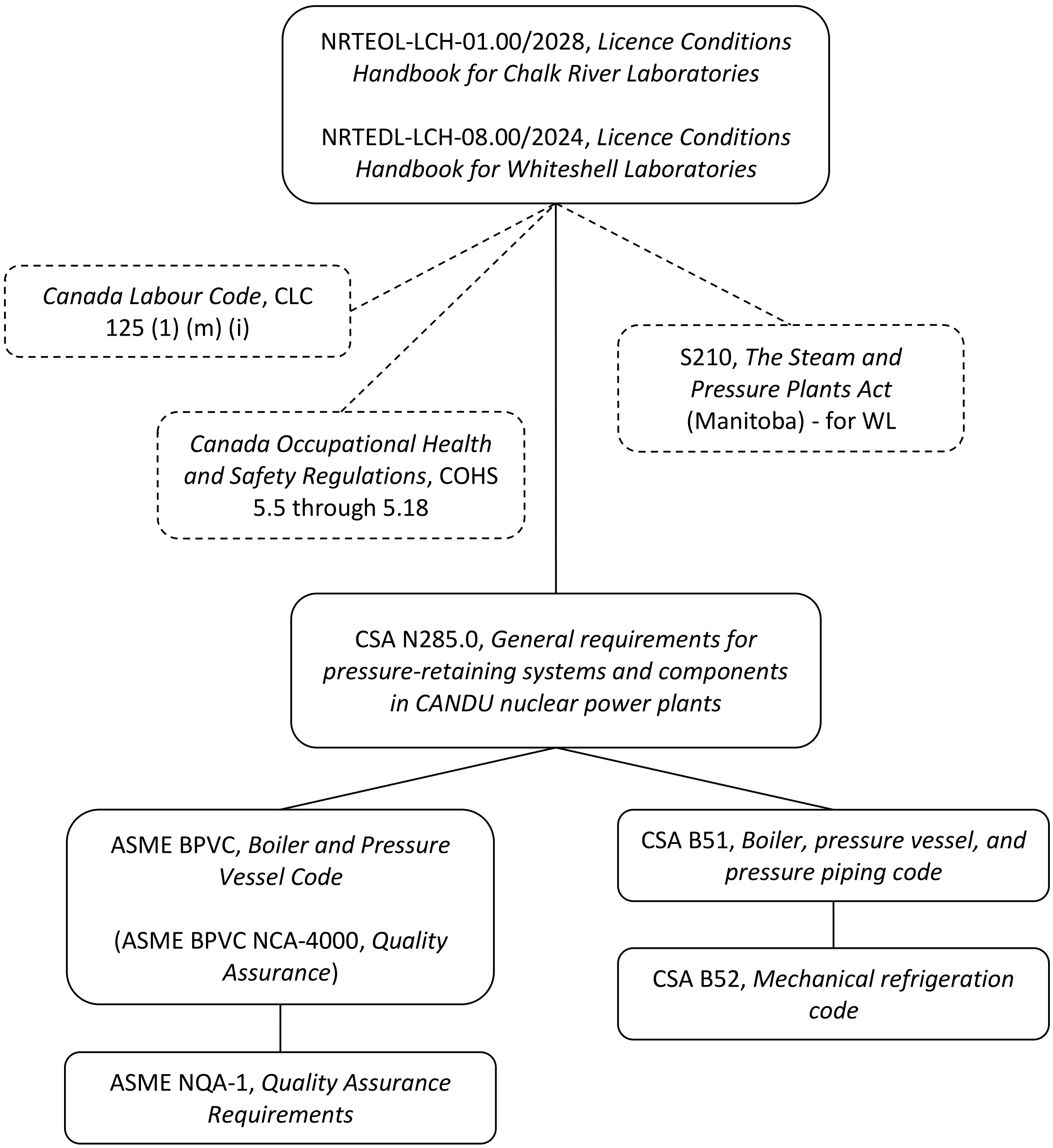

Figure 1: Requirements flowdown.

Table 1: NRTEOL-LCH-01.00/2028, Licence Condition Handbook for Chalk River Laboratories.

Licence Condition Handbook for Chalk River Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.2: Pressure Boundary Program and Authorized Inspection Agency	The licensee shall implement and maintain a pressure boundary program and shall have in place a formal agreement with an authorized inspection agency.	900-508140-PDD-001, *Pressure Boundary* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components* CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*
5.2: Pressure Boundary Program and Authorized Inspection Agency Compliance Verification Criteria	CSA N285.0, General requirements for pressure-retaining system and components in CANDU nuclear power plants, Revision 2017.	900-508140-PDD-001, *Pressure Boundary* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
5.2: Pressure Boundary Program and Authorized Inspection Agency Compliance Verification Criteria	<u>Pressure Boundary Program</u> Where CSA standard N285.0 requires items to be submitted to CNSC for approval before implementation, the licensee shall: (a) document the item in sufficient detail to ensure it is safe to proceed; and (b) submit the item to AIA for assessment and acceptance (if required by CSA standard N285.0 or its referenced publications). The licensee may implement that item and notify CNSC staff if the AIA has given its acceptance. Licensee documents describing the classification, registration and reconciliation processes and the associated controls are considered part of the pressure boundary program.	900-508140-PDD-001, *Pressure Boundary* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*

Licence Condition Handbook for Chalk River Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.2: Pressure Boundary Program and Authorized Inspection Agency Compliance Verification Criteria	Formal Agreement with an Authorized Inspection Agency The licensee shall have in place a formal agreement with an AIA acceptable to the CNSC to provide services for the pressure boundaries of the nuclear facility as defined by CSA standard N285.0 and its applicable referenced publications.	900-508140-PDD-001, *Pressure Boundary* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
5.2: Pressure Boundary Program and Authorized Inspection Agency Compliance Verification Criteria	Formal Agreement with an Authorized Inspection Agency The licensee shall always have a valid AIA agreement, and shall adhere to the following: a) The licensee shall arrange for the AIA inspectors to have access to all areas of the CRL's facilities and records, and to the facilities and records of the CRL's pressure boundary contractors and material organizations, as necessary for the purposes of performing inspections and other activities required by the standards; b) The licensee shall provide the inspectors of the AIA with: information, reasonable advance notice and time necessary to plan and perform inspections and other activities required by the standards; c) Where a variance or deviation from the standard exists, the licensee shall submit the proposed resolution to the AIA for evaluation; and d) Design registration services shall be provided by an AIA legally entitled under the applicable provincial boilers and pressure vessels acts and regulations to register designs in the province of installation.	900-508140-PDD-001, *Pressure Boundary* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
5.2: Pressure Boundary Program and Authorized Inspection Agency Compliance Verification Criteria	Formal Agreement with an Authorized Inspection Agency The licensee shall obtain AIA acceptance for implementation of the licensee's programs and procedures for: a) calibration, repair and maintenance of overpressure protection devices; b) repair and maintenance of mechanical joints; and c) periodic inspection of boilers and pressure vessels designed according to CSA standard B51.	CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*

Table 2: NRTEDL-LCH-08.00/2024, Licence Conditions Handbook for Whiteshell Laboratories.

Licence Conditions Handbook for Whiteshell Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.2 – Pressure Boundary Program	The licensee shall implement and maintain a Pressure Boundary program.	900-508140-PDD-001, *Pressure Boundary* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2: Pressure Boundary Program Compliance Verification Criteria	CSA N285.0, General requirements for pressure-retaining system and components in CANDU nuclear power plants, Revision 2008.	900-508140-PDD-001, *Pressure Boundary* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2 – Pressure Boundary Program Compliance Verification Criteria	a) Subject to (b) and (c) below, the licensee shall design, manufacture, fabricate, procure, install, modify, repair, test, examine, inspect, or otherwise perform work related to vessels, boilers, systems, piping, fittings, parts, components, and supports according to the specifications in CSA standards N285.0-08, B51-14 or other codes and standards approved or prescribed by the Commission. Where indicated by these standards, the licensee shall obtain the following regulatory approvals for this work: i) Registered designs; ii) Accepted overpressure protection reports; iii) Approval of applicable standards and code classification; iv) Registered welding and brazing procedures; v) Qualified welders, welding operators, brazers, and examination personnel; vi) Accepted quality assurance programs; and vii) Accepted plans and procedures (certificate(s) of authorization).	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2 – Pressure Boundary Program Compliance Verification Criteria	b) CNL may classify as Class 6 systems or sections of systems that contain tritium or other radioactive substances, if the consequence of failure limit of 20 mSv effective acute whole body dose is not exceeded.	WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems / Components*

Licence Conditions Handbook for Whiteshell Laboratories		
Section and Title	**Description**	**Implementing Document(s)**
5.2 – Pressure Boundary Program Compliance Verification Criteria	c) CNL shall carry out the activities listed in a) above in accordance with B51-14, or other codes and standards approved or prescribed by the Commission, for pressure boundary systems and components that do not contain nuclear substances, do not adversely impact a nuclear safety system, or do not cause an unreasonable risk involving nuclear substances at WL.	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2 – Pressure Boundary Program Compliance Verification Criteria	d) CNL shall operate vessels, boilers, systems, piping, fittings, parts, components, and supports safely and keep them in a safe condition. The licensee shall: i) follow accepted plans and procedures to test, maintain, or alter overpressure protection devices; ii) comply with operating limits specified in certificates, orders, designs, overpressure protection reports, and applicable codes and standards; iii) inspect and perform material surveillance according to accepted schedules, plans and procedures; iv) have any certified boiler or vessel that is in operation or use inspected and certified by an authorized inspector according to an accepted schedule; and v) ensure that vessels, boilers, systems, piping, fittings, parts, components and supports have markings, as specified in the applicable standards.	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2 – Pressure Boundary Program Compliance Verification Criteria	e) CNL shall keep proper records of regulatory approvals and other documents required as set out in a) through d), and the standards applicable to the work or equipment.	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
5.2 – Pressure Boundary Program Compliance Verification Criteria	f) In addition to any reporting requirements of the *Nuclear Safety and Control Act* and its associated Regulations, CNL shall report promptly to the Commission and to the Manitoba Department of Labour and Immigration when the licensee learns of any failure of a pressure boundary that has caused injury, death or property damage.	900-514300-MCP-006, *CNL Reporting to Regulatory Agencies*

Table 3: Canada Labour Code.

Canada Labour Code		
Section and Title	**Description**	**Implementing Document(s)**
125 (1) (m) (i)	125 (1) Without restricting the generality of section 124, every employer shall, in respect of every work place controlled by the employer and, in respect of every work activity carried out by an employee in a work place that is not controlled by the employer, to the extent that the employer controls the activity, (m) ensure that the use, operation and maintenance of the following are in accordance with prescribed standards: (i) boilers and pressure vessels,	900-508140-PDD-001, *Pressure Boundary*

Table 4: Canada Occupational Health and Safety Regulations.

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
Application		
Part V 5.2	This Part does not apply to: a) a heating boiler that has a wetted heating surface of 3 m^2 or less; b) a pressure vessel that has a capacity of 40 L or less; c) a pressure vessel that is installed for use at a pressure of one atmosphere of pressure or less; d) a pressure vessel that has an internal diameter of 152 mm or less; e) a pressure vessel that has an internal diameter of 610 mm or less and that is used to store hot water; f) a pressure vessel that has an internal diameter of 610 mm or less connected to a water pumping system and that contains compressed air which serves as a cushion; g) a hydropneumatic tank that has an internal diameter of 610 mm or less; h) an interprovincial or international pipeline; or i) a refrigeration plant that has a capacity of 18 kW or less.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components* WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems / Components*
Fabrication and Installation Standards		
Part V 5.3	Every boiler, pressure vessel and pressure piping system used in a work place shall, if feasible, meet the standards relating to design, construction, testing, stamping, nameplates, fabrication inspection and installation set out	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
	in clauses 4.15 to 4.18 and 5.1 to 9.1 of Part I of the Boiler Code.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
Part V 5.4	1. Every boiler and pressure vessel shall have at least one safety valve or other equivalent fitting to maintain pressure at or below the maximum allowable working pressure of the boiler or pressure vessel. 2. When two or more boilers or pressure vessels are connected and are used at a common operating pressure, they shall each be fitted with at least one safety valve or other equivalent fitting to maintain pressure at or below the maximum allowable working pressure of the boiler or pressure vessel that has the lowest maximum allowable working pressure.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
Use, Operation, Repair, Alteration, and Maintenance		
Part V 5.5	1. An employer shall ensure that a qualified person, charged with the operation of a boiler, is in attendance and readily available at all times while the boiler is in operation and other employees are normally present in the same building as a boiler. 2. The attendance referred to in subsection (1) is not required if a) the boiler is equipped with a fail-safe device and an automated warning device that will ensure the safe operation of the boiler and its shutdown if required, and that are installed in such a manner that they i) cannot be rendered inoperative, and ii) can be tested under operating conditions; and b) the boiler is rated below 2,000 kW in the case of a high pressure boiler, and below 3,000 kW in the case of a low pressure boiler, which includes a low pressure hot water boiler, a low pressure organic fluid boiler and a low pressure steam boiler. 3. When a boiler is shut down by a device referred to in paragraph (2)(a), the boiler shall not be restarted unless it has been examined by a qualified person and the cause of the shutdown rectified.	4172-508000-COP-003, *Powerhouse Operational Control*

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
Part V 5.6	Every boiler, pressure vessel and pressure piping system in use at a work place shall be operated, maintained and repaired only by a qualified person.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*
Part V 5.7	All repairs and welding of boilers, pressure vessels and pressure piping systems shall be carried out in accordance with the standards referred to in clauses 6.1, 7.1 and 8.1 of Part I of the Boiler Code.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* 172-508230-PRO-001*, CRL Site Infrastructure Work planning*
Part V 5.8	No person shall alter, interfere with or render inoperative any fitting attached to a boiler or pressure vessel except for the purpose of adjusting or testing the fitting.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
Part V 5.9	The factor of safety of a high pressure lap-seam riveted boiler, shall be increased by at least 0.1 each year after 20 years of use.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
Inspections		
Part V 5.10	1. No person shall use a boiler, pressure vessel or pressure piping system unless it has been inspected by an inspector in accordance with subsection (2) and it has been certified by the inspector as safe for its intended use as stated in the declaration referred to in subparagraph 5.18(2)(b)(v). 2. The inspector shall a) inspect every boiler, pressure vessel and pressure piping system i) after it is installed and before it is used for the first time, ii) after any welding, alteration or repair is carried out on it, and iii) in accordance with section 5.11, 5.12 or 5.16; and b) make a record of each inspection in accordance with section 5.18. 3. A person who operates, repairs or maintains a boiler, pressure vessel or pressure piping system or any part of it may not inspect the boiler, pressure vessel or pressure piping system for the purposes of subsection (2).	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*
Part V 5.11	1. Every high pressure boiler and every low pressure steam boiler in use at a work place shall be inspected a) externally, at least once each year; and b) Internally, at least once every two years. 2. Every low pressure hot water boiler and every unfired boiler in use at a work place shall be inspected a) externally, at least once every two years; and b) Internally, at least once every four years. 3. Every low pressure organic fluid boiler in use at a work place shall be inspected a) externally, at least once every two years; and b) internally, at least once every three years. 4. Every waste heat boiler in use at a work place shall be inspected a) externally, at least once every year; and b) internally, i) at least once every two years, or	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.* CRL-508140-PRO-003, *Pressure Vessel Management Process*

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
	ii) where ultrasonic thickness measurements are performed annually by an NDT technician, at least once every three years. 5. Pressure vessels, other than buried pressure vessels, that have a corrosion rate exceeding 0.1 mm of metal loss per year shall be inspected a) externally, at least once every year; and b) internally, i) at least once every two years, or ii) if ultrasonic thickness measurements are performed annually by an NDT technician on representative sections of the pressure vessel, at least once every three years. 6. Pressure vessels, other than buried pressure vessels, that have a corrosion not exceeding 0.1 mm of metal loss per year shall be inspected a) externally, at least once every year; and b) internally, i) at least once every four years, or ii) if ultrasonic thickness measurements are performed annually by an NDT technician on representative sections of the pressure vessel, at least once every six years. 7. Air receivers shall be inspected a) externally, at least once every year; and b) internally, at least once every five years. 8. If the known corrosion rate of a pressure vessel is zero, internal inspection is not necessary provided that complete external inspections, including nondestructive thickness measurements performed by an NDT technician, are made at least once every two years on the pressure vessel and the following conditions are met: a) the non-corrosive nature of the service conditions, including the effect of trace components, has been established by at least five continuous years of comparable service experience with the fluid being handled; b) the periodic external inspection indicates that the condition of the pressure vessel does not warrant any further investigation; c) the operating temperature and pressure of the pressure vessel does not exceed the lower limits	

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
	for the creep rupture range of the vessel metal; and d) the pressure vessel is protected against inadvertent contamination, and there is no evidence of contamination. 9. If a pressure vessel is used to store anhydrous ammonia, the internal inspection frequency referred to in paragraph (5)(b) may be replaced by an internal inspection conducted at least once every five years if, at the same time, a hydrostatic test at a pressure equal to one and one-half times the maximum allowable working pressure is conducted.	
Part V 5.12	Every boiler, pressure vessel and pressure piping system in use at a work place shall be inspected by an inspector more frequently than it is provided for in section 5.11, if it is necessary to ensure that the boiler, pressure vessel or pressure piping system is safe for its intended use.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*
Part V 5.15	If a pressure vessel that contains materials hazardous to human health or the environment is to be emptied before being inspected, it shall be emptied and inspected in a manner that does not pose a risk to human health or the environment.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and*

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
		Canadian Nuclear Laboratories Ltd.
Buried Pressure Vessels		
Part V 5.16	1. The installation of a buried pressure vessel shall meet the requirements set out in Appendix A to Part I of the Boiler Code. 2. Notice of the proposed backfilling shall be given to the Head of Compliance and Enforcement before backfilling is done over a pressure vessel. 3. If test plates are used as an indication of corrosion of a buried pressure vessel, the test plates and, subject to subsection (4), the pressure vessel shall be completely uncovered and inspected by an inspector at least once every three years. 4. If, on an inspection referred to in subsection (3), the test plates show no corrosion, the buried pressure vessel may be completely uncovered and inspected at intervals exceeding three years if the employer, immediately after the inspection, notifies the Head of Compliance and Enforcement in writing of the condition of the test plates and of the proposed inspection schedule for the pressure vessel. 5. Every buried pressure vessel shall be completely uncovered and inspected at least once every 15 years.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
Records and Reports		
Part V 5.17	The employer shall keep a record of every boiler, pressure vessel and pressure piping system to which this Part applies and that is under the employer's control.	900-508130-MCP-004, *Equipment Entity List Management* CRL-508230-PRO-707, *Asset Tagging and Equipment File Management*
Part V 5.18	1. A report of each inspection carried out under sections 5.10 to 5.16 shall be completed by the inspector who carried out the inspection. 2. Every report referred to in subsection (1) a) shall be signed by the inspector who carried out the inspection; and b) shall include i) the date of the inspection, ii) the identification and location of the boiler, pressure vessel or pressure piping system that was inspected,	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* CRL-508140-141-000, *Authorized Inspection Agency*

Canada Occupational Health and Safety Regulations		
Section and Title	**Description**	**Implementing Document(s)**
	iii) the maximum allowable working pressure and the maximum temperature at which the boiler or pressure vessel may be operated, iv) a declaration as to whether the boiler, pressure vessel or pressure piping system meets the standards prescribed by this Part, v) a declaration as to whether the boiler, pressure vessel or pressure piping system is safe for its intended use, vi) a list of any defects or deficiencies the inspector has observed in the condition or operating and maintenance practices of the boiler, pressure vessel or pressure piping system, and vii) any other observation that the inspector considers relevant to the safety of employees. 3. The employer shall keep readily available every record of inspection for the last two inspection periods and on the request of the work place committee or the health and safety representative, shall provide the work place committee or the health and safety representative with a copy.	*Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.* 900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*

Table 5: The Steam and Pressure Plants Act (Manitoba).

The Steam and Pressure Plants Act		
Section and Title	**Description**	**Implementing Document(s)**
RSM 1987, c.S210, Consolidated Regulation 108/87R	The Steam and Pressure Plants Act Steam and Pressure Plants Regulation	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan*

Table 6: CSA N285.0-08, General requirements for pressure retaining systems and components in CANDU nuclear power plants (Whiteshell).

CSA N285.0-08, General requirements for pressure retaining systems and components in CANDU nuclear power plants (Whiteshell)		
Section and Title	**Description**	**Implementing Document(s)**
Section 4 Effective Date for Standards	*Effective Date for Standards from Section 4.1 to 4.6*	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and*

CSA N285.0-08, General requirements for pressure retaining systems and components in CANDU nuclear power plants (Whiteshell)		
Section and Title	**Description**	**Implementing Document(s)**
		Design Registration of Pressure-Retaining Systems / Components
Section 5 Classification	*Classification Requirements from Section 5.1 to 5.4 and Annex A.*	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems / Components*
Section 6 Registration	Registration Requirements from 6.1.to 6.2 and Annex F	WL-508140-QAP-001, *WL Pressure Boundary Quality Assurance Plan* WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems / Components*

Table 7: CSA N285.0-17, General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories).

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
Section 4 Effective Date for Standards	*Effective Date for Standards from Section 4.1 to 4.6*	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Component*
5.1 General Requirements		
5.1.1	Unless otherwise stated in the Act, licence conditions, or regulatory documents, the licensee shall classify systems in accordance with Clause 5 of this Standard. See Figure 1 for guidance on the classification of process systems.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.1.2	The licensee shall classify pressure-retaining systems and sections of pressure-retaining systems having a design pressure greater than 103 kPag (15 psig) and storage tanks having a design pressure greater than or equal to atmospheric pressure.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
5.1.3	The licensee shall classify containment systems, sections of containment systems, and containment components that have a design pressure greater than 35 kPag (5 psig).	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.1.4	Components and supports assume the classification of the system of which they are a part. This Standard specifies requirements for components that are designated as one of the following: Classes 1, 1C, 2, 2C, 3, 3C, 4, 6, and Class Exempt that require registration. This Standard provides requirements for components designated with one of these classifications to ensure the structural integrity and quality of the individual items of the plant.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.1.5	Instrument lines assume the classification of the systems they are attached to except as noted in Clause 5.2.4.1.2.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.1.6	Radioactivity concentrations used for classification purposes shall be based on the expected equilibrium tritium concentration. Concentrations of other radionuclides may be disregarded where their energy- weighted activity concentration is less than 10% of that of the tritium content. Higher than normal concentrations of short duration shall be considered acceptable. For systems used only intermittently, the concentrations during operation shall be the basis for classification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.1.8	The classification approval form or the system classification list shall identify the ASME BPVC Code Cases that will be used in the design, fabrication, and installation of component(s) and supports. The alternative rules of Annex K may be used. When used, the alternative rule Clause number need not be included on the classification approval form or the system classification list but shall be recorded on the data report form.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2 Process Systems		
5.2.1	Systems and sections of systems, and systems connected thereto, that contain fluid that directly transports heat from nuclear fuel, and whose failure would cause a loss of coolant accident as defined in the safety report, shall be classified as Class 1.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
5.2.2	Sections of systems not classified as Class 1 that penetrate the containment structure and form part of the containment boundary shall be classified as Class 2 unless otherwise classified as permitted by Clause 5.3.1.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.3	Systems and sections of systems not classified as Class 1 or 2 and that contain radioactive substances with a tritium concentration exceeding 74 GBq/kg (2Ci/kg) shall be classified as Class 3.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.4.1.1	Systems and sections of systems that do not contain radioactive substances or that contain radioactive substances with a tritium concentration not exceeding 74 GBq/kg (2 Ci/kg) shall be classified as Class 6.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.4.1.2	Sections of systems and instrument lines that otherwise would be classified as Class 1, 2, or 3 and that contain only piping and components of nominal size equal to or smaller than NPS 3/4 may be classified as Class 6, except as follows: a) this Clause does not apply to vessels; and b) instrument lines NPS 3/4 and smaller connected to Class 1 or 2 systems or sections of systems associated with the control of systems whose function is to cool the fuel shall be the same class as the system to which they are attached.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.4.1.3	A system or a vessel that would otherwise be classified as Class 3 may be classified as Class 6, provided that the classification can be justified through a consequence of failure analysis that demonstrates in the event of a release the effective acute body dose received does not exceed 20 mSv.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.4.2.1	Systems and sections of systems that would otherwise be classified as Class 6 may be exempted from classification, provided that all of the following conditions are met: a) the system does not contain radionuclides or other nuclear substances that are present as a consequence of operation of a CANDU nuclear power plant; b) the system has no nuclear substances deliberately added, stored, or used; and	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	c) failure of the pressure boundary would not reduce the ability of a system to perform its design safety function. **Note:** Safety analysis, environmental qualification programs, or seismic qualification may be used to address the requirements of this Clause.	
5.2.4.2.2	Storage tanks that have a design pressure less than or equal to 103 kPag (15 psig) and would otherwise be classified as Class 6, as well as their related supports, shall be exempt from classification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.2.4.2.3	Systems and sections of systems that are exempt from classification shall be entered into the system classification list as Class Exempt.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3 Special Safety Systems		
5.3.1 Containment Systems and Components		
5.3.1.1	Components that form part of the containment boundary or containment isolation barriers shall be classified as Class 4, except as otherwise specified in Clauses 5.3.1.2 and 5.3.1.3. **Note:** Class 4 components refers to metallic containment components only.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3.1.2	Components that are part of a system that penetrates the containment structure and forms part of the containment boundary, unless otherwise classified as Class 1 or as permitted by Clause 5.3.1.3, shall be classified as Class 2.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3.1.3	Closed systems and sections of closed systems that penetrate the containment structure may be classified as Class 6, provided that all of the following are met: a) the design pressure of the closed system is greater than the design pressure of the containment boundary; b) the closed system is i) pressure tested regularly; or ii) operated at a pressure greater than the design pressure of the containment boundary and monitored for leaks; and c) other requirements for the system do not necessitate a higher classification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
5.3.1.4	Sections of pressure-suppression, pressure-reduction, pressure-relief, or containment auxiliary systems that do not form part of the containment boundary shall be classified in accordance with Clause 5.2.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3.2 Emergency Core Cooling Systems		
5.3.2.1	Emergency core cooling systems shall be classified as Class 1, except for those sections of the emergency core cooling systems that meet any one of the following requirements: a) during normal operation of the plant, are continuously pressurized at or above the operating pressure expected to occur after initiation of the emergency core cooling system and whose integrity is monitored continuously; b) are continuously pressurized during normal operation of the plant and are tested in accordance with a defined schedule at or above the system operating pressure expected to occur after the initiation of the emergency core cooling system; c) are pressurized only during testing of the system; or d) are pressurized only after the initiation of the long-term low pressure circulation stage of the emergency core cooling system and cannot normally be isolated for testing.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3.2.2	Sections of the emergency core cooling systems not classified as Class 1 shall be classified in accordance with Clause 5.2.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.3.3 Shutdown Systems		
5.3.3.1	Pressure-retaining sections of shutdown systems shall be classified as Class 1, except those pressure-retaining sections of the shutdown systems that meet any one of the following conditions: a) are normally at their maximum pressure and whose integrity is monitored continuously; b) are pressurized only during testing of the shutdown system; or c) a pressure boundary failure would not prevent the safe operation of the shutdown system.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
5.3.3.2	Sections of the shutdown system not classified as Class 1 shall be classified in accordance with Clause 5.2.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.4 Class 1C, 2C and 3C components	Components that would otherwise be classified as Class 1, 2, or 3, but to which the requirements of Annex E apply, shall be classified as Class 1C, 2C, or 3C, respectively.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.5 Adjoining Systems or Sections of Systems		
5.5.1	A system may have sections with different classifications, provided that the boundaries of such sections are designated on the system flowsheet. All items within the boundaries of a section shall have the same or equivalent classification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.5.2	Adjoining systems or sections that have different classifications shall be separated by a) a valve that is normally closed or closes automatically in the event of a failure; or b) a restriction that limits the flow between sections in the event of a failure, to ensure conditions are kept within the classification criteria for each section.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.5.3	The licensee shall ensure that the valve or restriction specified in Clause 5.5.2 is located in the section having the higher classification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.5.4	For process systems, no valve or restriction is required where the adjoining section contains only component(s) of nominal size equal to or smaller than NPS 3/4.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
5.5.5	Component(s) consisting of multiple compartments (e.g., heat exchangers) can have compartments with different classifications. The licensee shall include and account for the difference in service conditions between compartments of different classifications listed in the design specifications.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
6 Registration		
6.1 Designs to be Registered		
6.1.1 General Requirements		
6.1.1.1	The design of components, fittings, and supports that have been classified as Class 1, 1C, 2, 2C, 3, 3C, or 4 shall be registered. Annex B outlines procedures that are commonly used for registration and a sample statutory declaration form in Figure B.1.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.1.2	The design of component(s) that have been classified as Class 6 shall be registered in accordance with the requirements of CSA B51. Clause 6.2.2 specifies the Class 6 components and fittings that are exempt from registration.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.1.3	The design of systems and sections of systems that meet the requirements of Clause 5.2.4.2.1 shall be registered in accordance with CSA B51, except that the items listed in Clause 6.2.3.1 are exempt from registration.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.1.4	Regulatory approval of the classification shall be obtained before the design registration of a new piping system.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.1.5	The design of a component, fitting, or support shall be registered in accordance with Clauses 6.1.3 to 6.1.8.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.2 Subassemblies	The design of piping subassemblies shall not be registered separately but shall be included in the registration for the piping system.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.3 Small vessels	The design of vessels that have an internal diameter not exceeding 150 mm (6 in), or a capacity not exceeding 42.5 L (1.50 ft^3), shall be registered as Category H fittings. See Clause 6.1.6.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.4 Supports		
6.1.4.1	The design of all Class 1, 1C, 2, 2C, 3, 3C, or 4 supports, except standard supports that have been registered by the certificate holder, shall be registered.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
6.1.4.2	The design of supports for Class 1, 1C, 2, 2C, 3, 3C, or 4 shall be registered as follows: a) Supports shall be registered separately, except as permitted by Clause 6.1.4.3. b) The registration of components shall include any integral supports, except that integral supports that are attached in the field may be registered separately. c) Intervening elements shall not be registered, but design criteria and supporting evaluations shall be included in the design documentation of the support.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.4.3	All standard supports (as defined in Clause 7.5.1.2) that are of the same class may be included in a single application for registration, provided that copies of the appropriate standard drawings, including load capacity data sheets, accompany the application.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.4.4	The application for registration of supports shall include a) a list of documents submitted; b) a certified design specification* (see Clause 7.5 and Annex C), except where not required for standard supports; c) the general arrangements and applicable shop drawings necessary to provide evidence of conformance to this Standard (see Table 1); and d) a design report, load capacity data sheet, or design report summary that is certified when required by the ASME *BPVC*, Section III, NCA-3550. * The design specification for the support may be included in the design specification of the component.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.5 Pumps	Class 1, 1C, 2, 2C, 3, and 3C pumps shall be registered	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.6 Fittings	Standard* and non-standard fittings shall be designated as Category A to H, as follows: **A** - piping fittings that include couplings, tees, elbows, Ys, plugs, unions, nipples, pipe caps, and reducers;	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	B - flanges; **C** - line valves; **D** - expansion joints, flexible connections, and hose assemblies of all types; **E** - strainers, filters, separators, and steam traps; **F** - measuring devices that include pressure gauges, level gauges, sight glasses, level or pressure transmitters, and instruments; **G** - safety devices that include safety valves, relief valves, safety relief valves, and rupture disks; and **H** - pressure-retaining fittings that do not fall into Categories A to G. **A standard fitting is a fitting that complies with the ASME* BPVC *or another standard acceptable to the authorized inspection agency.*	
6.1.7 Instrument lines	Instrument lines shall be registered as part of the system, and the connection of instrument lines shall be indicated on the system flowsheets.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.8 Containment components	For registration of airlocks, bulkheads, and doors, a separate application for registration shall be made for each different type. For seal plates, flexible bellows, and containment penetration assemblies, a separate application for registration shall be made for each category or for each family of items.	Not Applicable – CANDU specific
6.1.9 Plant modifications	Modifications to a registered design during fabrication and that affect the boundary shall not be implemented until they have been accepted by the authorized inspection agency, except as permitted by Annex H.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.1.10 Design change after registration	The licensee shall retain records of approval by the authorized inspection agency of the updates of the registration for any design modification made after the original registration, except as permitted by Clause 14. The request to update the registration shall include the certified revisions or addenda to the design report and all referenced documents, whether or not they were revised.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
6.1.11 Welding and Brazing Procedures		
6.1.11.1	Prior to welding or brazing being performed inside Canada, unless otherwise permitted by this Standard, welding and brazing procedures for Class 1, 1C, 2, 2C, 3, 3C, and 4 components shall be qualified in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, and registered by the authorized inspection agency. For Class 6 components requiring registration, welding and brazing procedures shall be qualified and registered in accordance with CSA B51. The licensee shall retain records of the welding and brazing procedure registration by the authorized inspection agency.	CRL-508241-OP-001, *Qualifying Welding Procedure Specifications* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
6.1.11.2	Prior to welding or brazing being performed outside of Canada, the welding or brazing procedures shall be reviewed and accepted by the licensee. The licensee shall retain records of the acceptance.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
6.2 Registration Exemptions		
6.2.1 General	The licensee shall ensure that all systems or sections of systems that are exempt from registration are constructed to standards deemed by the licensee to be suitable for the service conditions.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.2.2 Class 6 Components and Fittings Exempt from Registration	Rotating or reciprocating mechanical devices, including pumps, compressors, turbines, generators, engines, and hydraulic or pneumatic cylinders where the primary design considerations or stresses, or both, are derived from the functional requirements of the device, are exempt from registration (see Clause 6.1.1.2). This includes piping internal to equipment or mounted upon equipment that carries fluid from one chamber to another on the same foundation.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
6.2.3 Items Exempt from Registration		
6.2.3.1	The following items are exempt from registration (see Clause 6.1.1.3): a) pressure-retaining systems that have a design pressure less than or equal to 103 kPag (15 psig) including their supports; b) containment systems that have a design pressure less than or equal to 35 kPag (5 psig) including their supports;	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

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	c) piping systems containing liquids not more hazardous than water, with a design pressure not exceeding 1.72 MPag (250 psig) and a design temperature not exceeding 65 °C (150 °F); d) hot water heating and chilled water cooling piping systems designed for pressures not exceeding 1.103 MPag (160 psig) and temperatures between –29 °C and 121 °C (-20 °F and 250 °F); e) hydraulic piping systems which drive hydraulic actuation devices (mechanical actuators, motors, cylinders, etc.) designed for temperatures not exceeding 65 °C (150 °F); f) oil piping systems designed for a temperature 28 °C (50 °F) lower than the flashpoint of the oil and a design pressure not exceeding 0.689 MPag (100 psig); g) compressed air piping systems that are outside containment and contain components NPS 3/4 or smaller; h) pressure-retaining enclosures for gas-filled high-voltage switchgear and control gear; i) stand-alone components and piping systems having a volume not exceeding 42.5 L (1.50 ft^3) and a design pressure not exceeding 4120 kPag (600 psig) and not containing a lethal substance (gas, vapour, or liquid); and j) refrigeration systems having a 125 kW and under prime mover nameplate rating covered by i) CSA C22.2 No. 63; ii) CSA C22.2 No. 92; iii) CSA C22.2 No. 117; iv) CSA C22.2 No. 120; v) CSA C22.2 No. 128; and vi) CSA C22.2 No. 236 when tested and certified by an approved testing laboratory.	
6.2.3.2	Storage tanks that meet the requirements of Clause 5.2.4.2.2, as well as their related supports, shall be exempt from registration.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

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7 Design		
7.1.1 Class 1	Class 1 components shall be designed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NB-3000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.2 Class 2	Class 2 components shall be designed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NC-3000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.3 Class 3	Class 3 components shall be designed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, ND-3000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.4 Classes 1C, 2C, and 3C	In addition to the requirements of Clause 7, Class 1C, 2C, and 3C components shall be designed to comply with the requirements of Annex E.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.5 Class 4	Class 4 components shall be designed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NE-3000. Design requirements for specific containment boundary components are provided in Annex F.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.6 Class 6 or Class Exempt	Class 6 or Class Exempt components, that are required to be registered, shall be designed to comply with the requirements of CSA B51.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

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7.1.7 Periodic inspection	Items shall be inspected periodically in accordance with CSA N285.4, N285.5, and N285.7 and shall be designed to allow access as required for such inspections.	NRU-508230-PRO-001, *Periodic Inspection*
7.1.8 Seismic requirements	When the system classification list or the design specification states that the effect of seismic loadings is to be considered, the licensee shall meet the system requirements of the CSA N289 series of Standards.	900-508120-MCP-003, *Execution of Design Review and Verification* 120-508120-OI-029, *Design for Earthquakes (Seismic Qualifications at CRL)*
7.1.9 Threaded fasteners with metallic inserts qualified by testing	Threaded fasteners and helical coil or other metallic inserts may be used for Class 1, 1C, 2, 2C, 3, 3C, and 4 components, provided that documents are available that give the results of the testing to destruction of representative quantities of full-size fastener/insert assemblies. The strength of such assemblies as shown in the test results shall be equal to or shall exceed the minimum specified strength of the fastener when threaded directly into the base material. The licensee shall retain records to demonstrate that the test report that qualifies each specific application was approved by the authorized inspection agency.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.1.10 Threaded fasteners with metallic inserts qualified by analysis	Threaded fasteners with helical coil or other metallic inserts for Class 1, 1C, 2, 2C, 3, 3C and 4 items shall satisfy the following: a) Class 1, 1C, 2, 2C, 3, 3C and 4 items shall be designed to comply with the corresponding requirements of the ASME BPVC, Section III, Division 1, NB-3000, NC-3000, ND-3000, NE-3000 and NF-3000. The helical coil or other metallic inserts shall be considered to be part of the female thread. b) For Class 1, 1C, 2, 2C and 4 items, the interface between the threaded fastener and the insert and the interface between the insert and the base material threaded hole shall meet the special stress limits for pure shear specified in ASME BPVC, Section III, Division 1, NB-3227.2 (a) for all axial loading experienced as a result of design loadings, test loadings or any service loadings except those for which Level D limits are designated. For axial loads induced by Level D service loadings the allowable shear stress requirements for bolted joints specified in ASME	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

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	BVPC, Section III, Appendix F, paragraph F-1335.2 (a) shall apply. c) For Class 3 and 3C items, the maximum allowable stress, S, for the helical coil or other metallic insert shall be larger than the maximum allowable stress for the tapped hole material. The engagement length between the helical coil, or other metallic insert, and both the tapped hole and the threaded fastener shall meet the minimum engagement length with the tapped hole as specified in ASME BPVC, Section III, Division 1, ND-3362 (b). d) For items having a combination of fasteners, with and without helical coil inserts, the design analysis shall consider the effect of potential stiffness differences between threaded fastener assemblies on load distribution and cyclic loading analysis.	
7.2 Plant design documents	The licensee shall ensure that the following documents are prepared and retained: a) system design documents for all systems that are required to comply with this Standard; b) a system classification list (see Clauses 5.1.7 and 7.3.3); and c) an overpressure protection report (see Clause 7.6.7), which may be a compilation of overpressure protection reports for different systems.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.3 System Design Documents		
7.3.1 System Records	For Class 1, 2, and 3 systems, the licensee shall retain records of the following: a) design requirements, shall consist of requirements for i) functionality; ii) performance; iii) safety, as well as regulatory requirements (e.g., pipe whip restraints), including applicable codes and standards and their effective dates; iv) seismic qualification; v) overpressure protection; vi) reliability and maintainability;	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*

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Section and Title	**Description**	**Implementing Document(s)**
	vii) configuration and interfacing (e.g., plant and equipment layout, space limits, clearances, and restraints); viii) environmental conditions; ix) fluid chemistry; x) materials; and xi) relevant special conditions or restrictions that influence the design (e.g., testing, commissioning, maintenance, and inspection requirements); b) conceptual design description, which consists of i) a functional and configurational description of the system; ii) schematic diagrams and/or general arrangement drawings; and iii) the classification of the system; c) loading categories, for which the designer shall consider all postulated service conditions for the system, including commissioning, scenarios, incidents, or events described and categorized according to the ASME *BPVC*, Section III, Division 1, NCA-2142, as follows: i) design loadings — as defined in the ASME *BPVC*, Section III, Division 1, NCA-2142; ii) Level A service loadings — Level A service conditions are those that are planned and occur frequently or routinely during normal operation. For process systems, this includes start-up, operation within the design power range (including full-power steady state), and controlled shutdown operations. For a safety system, this includes the system's designed operating mode after initiation by an abnormal plant condition and its normal standby condition; iii) Level B service loadings — Level B service conditions are any planned or unplanned deviations from Level A conditions anticipated to occur frequently enough that design shall include the capability to withstand the accumulated effect of these conditions without operational impairment;	

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	iv) Level C service loadings — Level C service conditions are unplanned but anticipated events. These conditions combined shall not result in more than 25 lifetime cycles, except that for seismic loadings the requirements of CSA CAN3-N289.3 shall be met. Design basis earthquakes shall be included in this level. The structural integrity of the system shall be preserved but local permanent deformation is acceptable*; **In this context, "acceptable" means from the safety point of view only.* v) Level D service loadings — Level D service conditions are unplanned but anticipated events that do not occur more than twice in the life of the system. The structural integrity of the system shall be preserved but gross deformation requiring shutdown for repair is acceptable; and **Note:** *As identified in the ASME BPVC, Section III, Division 1, NCA-2142, Level C and D events can require inspection, repair, or replacement of the damaged piping and items.* vi) test loadings (including testing of pressure relief devices); d) required loads, which are the loads that shall be taken into account in the design of the components for the system, shall include i) internal and external pressures; ii) impact loads, including rapidly changing or fluctuating pressures; iii) weight of the piping and components and normal contents under operating or test conditions, including pressure due to static and dynamic head of liquids; iv) superimposed loads, due to other components, operating equipment, insulation, shielding, corrosion/erosion-resistant linings, temporary maintenance flasks, and equipment; v) wind loads, snow loads, vibrations, and earthquake loads, when specified;	

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	vi) reactions of supporting lugs, rings, saddles, plinths, or other types of supports; vii) temperature effects; and viii) cyclic loads; e) load combinations, for which a load combination table shall be provided to indicate how loading data are to be combined for each of the service load conditions to be evaluated; f) acceptance criteria, which consist of the design, service, and test limits for each of the conditions listed in Item (c), for the materials employed, defined for stress limits, deformation limits, or alternative service limits as required by the ASME *BPVC*, Section III, Division 1, NCA-2142 and NCA-2143, except that for seismic loadings the acceptance criteria of CSA N289.3 shall apply; and g) flowsheets, design drawings, calculations, material requirements, and installation specifications for each system.	
7.3.2 System flowsheets	The licensee shall produce and retain a system flowsheet. The flowsheet shall show the schematic arrangement of all components in the system and shall contain the information listed below or reference the document where the information is to be found: a) design and operating pressures and temperatures; b) system fluids; c) system boundaries and, when more than one classification is specified, section boundaries; d) the containment boundary and containment penetrations; e) the seismic category and level boundaries; f) settings of pressure relief devices; g) the effective date or issue of applicable codes and standards for the design of the system; h) the test temperature and test pressure; and i) specifications for materials.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.3.3 System classification List	The system classification list shall identify all systems and their classification. The licensee shall include the following information for each item on the list:	900-508140-FID-001, *Classification and Design Registration of*

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Section and Title	**Description**	**Implementing Document(s)**
	a) system identification (title and reference number); b) a system flowsheet drawing number and revision number; c) system classification for each system; d) applicable codes and standards and their effective dates; e) the seismic level and category; f) reference to the classification approval form, where applicable; and g) the design pressure and temperature. When modifications are made to any system throughout the life of the plant, the system classification list shall be updated to reflect these changes. To ensure configuration control, the system classification list shall be updated no later than three years after the modification has been implemented.	*Pressure-Retaining Systems / Components*
7.4 Design Documents for Components and Non-Standard Fittings		
7.4.1 General requirements	A component and non-standard fitting that is not defined as part of a system shall meet the same requirements for design documentation as the component or a non-standard fitting that is part of a system.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.4.2 Design documents	For Class 1, 1C, 2, 2C, 3, 3C, and 4 components and non-standard fittings, the licensee shall have the following design documents: a) a component and/or non-standard fitting design specification certified by a registered engineer in accordance with the requirements of ASME *BPVC*, Section III, NCA-3250; b) a design report that meets the requirements of the ASME *BPVC*, Section III, NCA-3550, and is certified, when required by the ASME *BPVC*, Section III, Division 1, NCA-3550, by a registered engineer competent in the design field applicable to the component. The design report shall be submitted to the licensee or the licensee's designee for review and documentation of review in accordance with the ASME *BPVC*, Section III, NCA-3260;	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*

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	c) a record of the registration of the component and/or non-standard fitting design with the authorized inspection agency; and d) a record of the review of the certificate holder's drawings and documentation determining their compliance with the registered design documents. Annex C outlines the design documentation that is commonly used.	
7.4.3 Piping system design reports	The licensee shall retain records of the following: a) The design report for Class 1, 2, and 3 piping systems shall demonstrate that the design and service limits and other acceptance criteria are satisfied. The piping system design report(s) shall document the design and stress analysis of the Class 1, 2, and 3 piping systems. Each report shall include sufficient information to be able to regenerate the computer/analysis model on which the analysis is based. In addition, the licensee shall retain the design reports and all documentation of the loadings applied to adjacent components and supports. b) In the case of piping system connected to a component, the design report shall include confirmation that the reaction loads are within the allowable limits for the component. The piping system design report shall also include the support assessment. Annex C outlines the design documentation that is commonly used.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5 Supports for Class 1, 1C, 2, 2C, 3, 3C, and 4 Components		
7.5.1 General Requirements		
7..5.1.1	The licensee shall ensure that the following documents are prepared and retained: a) a review of the building structure and all structural elements in the support load path, as required by the ASME *BPVC*, Section III, NCA-3200; and b) a review of the jurisdictional boundaries between the component, attachments, intervening elements, component supports, and the building structure, that are consistent with	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*

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Section and Title	**Description**	**Implementing Document(s)**
	the boundary descriptions given in the ASME *BPVC*, Section III, Division 1, NF-1000. Supports for Class 1, 1C, 2, 2C, 3, 3C, and 4 components shall comply with the requirements of Clause 7.5., except where requirements specific to a support are given in Annex E.	
7.5.1.2	Supports or elements of supports, excluding intervening elements, shall be categorized as one of the types listed below: a) plate- and shell-type support — a support that is fabricated from plate and shell elements subjected to a biaxial stress field (e.g., pipe anchors, vessel skirts, saddles); b) linear-type support — a support that acts under a single component of direct stress or is subjected to shear stress (e.g., tension and compression struts, beams and columns subjected to uniaxial bending, trusses, frames, rings, arches, and cables); or c) standard support — a support that consists of one or more items usually referred to as “catalogue items” and is generally mass-produced (e.g., pipe hangers, snubbers).	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5.2 Specific Requirements		
7.5.2.1	The licensee shall retain objective evidence to demonstrate that integral attachments have been designed to comply with the design requirements for the component to which they are attached.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5.2.2	The licensee shall retain objective evidence to demonstrate that supports (intervening elements excepted) have been designed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NF-3000. The appropriate design rules shall be those rules consistent with the required class of the component on which the supports are installed.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5.2.3	The licensee shall retain objective evidence to demonstrate that for standard supports, a general arrangement drawing of the design and the	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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	certificate holder's load-capacity data sheets have been prepared.	CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5.2.4	The licensee shall retain objective evidence to demonstrate that by analysis or test, the intervening elements are capable of withstanding the loads imposed in supporting the component.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.5.2.5	For other than standard supports, the licensee shall retain a record of the following: a) a certified design specification; b) a design report that meets the requirements of the ASME *BPVC*, Section III, NCA-3550, and is certified, when required by the ASME *BPVC*, Section III, NCA-3550, by a registered engineer competent in the design field applicable to the support. The design report shall be submitted to the licensee or the licensee's designee for review and documentation of review in accordance with the ASME *BPVC*, Section III, NCA-3260; and c) a general arrangement drawing of the design.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.5.2.6	The licensee or agent shall append or reference in the piping system design report the design documents required for supports by the ASME *BPVC*, Section III, NCA-3550.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.6 Overpressure Protection		
7.6.1 General Requirements		
7.6.1.1	Overpressure protection of Class 1, 2, 3, and 4 components shall comply with the requirements of Clause 7.6 and the following articles from the ASME *BPVC*, Section III, Division 1: a) for Class 1 systems, NB-7000; b) for Class 2 systems, NC-7000; c) for Class 3 systems, ND-7000; and d) for Class 4 components, NE-7000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*
7.6.1.2	Overpressure protection of Class 6 piping and components shall comply with the applicable design documents of CSA B51.	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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7.6.1.3	When shutdown systems are part of an integrated overpressure protection system that is designed to protect the heat transport system with the reactor at power, the requirements of Clause 7.6.2 shall apply.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.1.4	Shutdown system action can make no contribution to overpressure protection in situations where the reactor is initially at zero power and remains at zero power. The requirements of Clause 7.6.2 do not apply to such situations.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.2 Heat Transport Systems		
7.6.2.1	Where there are two shutdown systems, each of the systems, along with any pressure-relief device, shall be capable of preventing failure of the heat transport system due to overpressure. The credit allowed for the action of overpressure-relief devices shall be in accordance with Clause 7.6.2.3(d) and (e), provided that the overpressure-relief devices comply with Clause 7.6.1.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.2.2	For qualification of the heat transport overpressure protection system, service limits for events leading to overpressure shall be as specified in Clause 7.3.1 and the ASME *BPVC*, Section III, NCA-2140. The service limits to be applied shall be determined in terms of frequency of an event and the operation of one shutdown system (see Table 2), and the applicable regulatory documents.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.2.3	The qualification of the heat transport system shall consider the following: a) For some events, control system action, including the reactor regulation system by itself, is capable of protecting the heat transport system from overpressure. However, credit for these actions shall not be counted in the overpressure assessment. b) The first trip parameter shall be credited if it is heat transport system high-pressure; otherwise, the second trip parameter of each shutdown system shall be credited. c) When only one trip parameter is available on the first shutdown system to trip and it is not high pressure, only the first trip parameter of the other shutdown system shall be credited (i.e., the service limits given for the first	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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	shutdown system in Table 2 shall be met by the first parameter of the other shutdown system). In a case where only one trip parameter is installed in the other shutdown system, this trip parameter may be credited, subjected to the regulatory authority's review and acceptance. d) When power-actuated pressure-relief valves are installed and are connected to instrumentation associated with one of the shutdown systems, these pressure-relief valves shall only be credited to overpressure protection for the heat transport system when it is assumed that the shutdown system in question trips. When the other shutdown system operates, qualification shall be performed with and without these pressure-relief valves functioning as designed. e) When pressure-relief devices are installed but are not connected to either shutdown system, the pressure-relief devices may be credited for overpressure protection purposes where either shutdown system operates, provided that each pressure-relief device is independent of any other (e.g., equipped with its own instrumentation and power supplies, etc.) so that no single failure would result in the disablement of more than one relief valve and its instrumentation is designed to the same safety standards used for shutdown system instrumentation.	
7.6.2.4	The licensee shall prepare a system-specific overpressure protection report that covers all postulated events with specified service limits up to and including Level C as specified in Table 2. Level D events may be reported in the station safety report, provided that they are cross-referenced in the overpressure protection report.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.3 Application		
7.6.3.1	Overpressure protection shall be provided for items that might be isolated from the overpressure protection provided for the system, including isolatable volumes within components and fittings (e.g., gate interspace of valves).	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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7.6.3.2	Pressure relief devices are not required for small isolatable volumes, for such lower-probability events as loss of coolant accidents (LOCAs), or for main feedwater line or main steam line breaks, provided that all of the following conditions are met: a) only piping shall be involved; b) piping shall meet the following requirements, as applicable: i) for Class 1 piping, the maximum primary membrane plus bending stress intensity shall not exceed the lesser of 3.0 *Sm* or 2.0 *Sy*, or the internal pressure shall not exceed twice the maximum allowable working pressure; and ii) for Class 2 and 3 piping, the maximum primary membrane plus bending stress shall not exceed the lesser of 3.0 *Sh* or 2.0 *Sy*, or the internal pressure shall not exceed twice the maximum allowable working pressure; c) the volume involved shall be less than 42.5 L (1.5 ft^3); d) the containment boundary integrity shall be maintained; e) there shall be no impairment of fuel cooling; f) compliance with Items (a) to (e) shall be demonstrated in the overpressure protection report; and g) piping shall be inspected, as necessary, after the event.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.3.3	Instruments and instrumentation shall be excluded from consideration as isolatable items.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.3.4	The effects of external pressure shall be considered on all components and fittings installed within the containment boundary.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.3.5	Pressure relief shall be provided wherever a component or fitting is not designed to withstand maximum external pressure conditions.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.3.6	Overpressure protection shall not be required for isolatable components that are vented, provided that venting that is capable of preventing overpressure is always available where the components are isolated.	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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7.6.4 Conditions		
7.6.4.1	The complete range of operating modes, as defined in the design specification, shall be considered when determining the overpressure protection required.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.4.2	When steady-state analysis does not adequately represent the system, the licensee shall perform transient analysis of the overpressure protection.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.5 Methods		
7.6.5.1	The licensee shall select an overpressure protection method with performance characteristics that are compatible with the design specification.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.5.2	Control system action may be used to reduce the requirement for overpressure protective action only to the extent that the frequency of occurrence of overpressure is reduced.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.5.3	For systems that require overpressure protection, where more than one relief path is available, key interlocked pairs of valves (where the key interlock prevents closure of more than one of the valves at any one time) may be used on the two paths, provided that the valves and piping systems are designed to ensure that overpressure protection for either of the paths meets the requirements for all operating conditions. The interlock key for each pair of valves shall be unique so that the key from any other key interlock will not fit, and shall be of a type that is not commonly available or easily reproduced. The licensee shall have no spare keys for key interlocks.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.6 Provisions		
7.6.6.1	Overpressure protection for a single failure event shall comply with the requirements of the ASME *BPVC*, Section III, Division 1 (see Clause 7.6.1.1 of this Standard).	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.6.2	A single device for the dual functions of control and overpressure protection shall not be used.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
7.6.6.3	The licensee shall ensure that pressure relief devices are designed, constructed, and installed in a manner that facilitates periodic testing.	900-508120-MCP-002, *Production and Acceptance of Design Documents*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
7.6.7 Overpressure protection report	The following requirements shall apply: a) The report shall cover all components classified as Class 1, 1C, 2, 2C, 3, 3C, or 4. The impact of other connected components of any class shall be considered in the overpressure protection report. The report shall describe the overpressure protection methods to be used and their adequacy in meeting the requirements of this Standard. Annex C outlines the design documentation that is commonly used. b) An individual overpressure protection report may be prepared for each system, or a single report may be prepared for the plant or sections of the plant. c) The final report for a system shall contain the following information: i) system identification: (1) system name and reference number; a Canadian Registration Number (CRN) for system and pressure relief devices (where known); (2) major function of the system; (3) reference system flowsheet and revision number; and (4) list of reference design documents; ii) system description: (1) brief written description; (2) identification of system fluids; and (3) identification of isolatable items; iii) overpressure protection methods: (1) description of method; (2) extent of system that is protected; (3) protection devices, including type, number, set pressure, blowdown, and capacity; and (4) testability of pressure relief devices; iv) overpressure protection description: (1) relieving capacity requirements (minimum and maximum); (2) type of fluid being discharged; (3) effect of variation in operating time; and	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components* CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	(4) inlet and discharge line characteristics; and v) isolatable items: (1) list of components and fittings; (2) overpressure protection method and description; (3) protection devices, including type, number, set pressure, blowdown, and capacity; and (4) method of testing.	
7.7 Reconciliation Statements for New Construction		
7.7 General requirements	The licensee shall retain records to demonstrate that any differences between the registered design and the as-built components have been evaluated and reconciled in accordance with Annex H. The licensee shall complete actions as specified in Annex H for any differences affecting the basis for classification or overpressure protection, and for reconciliation statements, design registration, and registration updates.	CRL-508140-PRO-004, *Certification of Design Documents for Nuclear Pressure Retaining Systems and Components* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.8 Instruments and Instrument Lines		
7.8.1 Instruments		
7.8.1.1	The design of sensing elements of instruments is outside the scope of this Standard, except that when an instrument is included in the design of a component, the system designer shall ensure that the pressure boundary of the sensing element is rated for the design conditions of the component.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.8.1.2	The licensee shall ensure that instruments that are included in the design of a piping system and that have an inlet larger than NPS 3/4 and a pressure boundary that is subject to flow shall meet all requirements associated with the class of the system.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.8.1.3	The pressure boundary portion of instruments in Class 1, 1C, 2, 2C, 3, 3C, or 4 components that have an inlet of NPS 3/4 or smaller shall be registered as a Category F fitting. The registration may be in accordance with the requirements of CSA B51. The	900-508120-MCP-002, *Production and Acceptance of Design Documents*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	licensee shall ensure that the following requirements are met: a) the design shall be such that the instrument is rated for the design conditions of the component; and b) the material for instruments to be welded to the components shall be compatible with the pressure boundary materials.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
7.8.2 Instrument lines	Instrument lines shall meet the following requirements: a) Class 1 instrument lines shall be designed in accordance with the ASME *BPVC*, Section III, Division 1, NB-3600. Class 2 instrument lines shall be designed in accordance with the ASME *BPVC*, Section III, Division 1, NC-3600. Class 3 instrument lines shall be designed in accordance with the ASME BPVC, Section III, Division 1, ND-3600. Class 6 instrument lines shall be designed in accordance with CSA B51; b) Instrument isolating valves shall meet the design requirements for the class of the piping system to which they are attached; and c) valves located downstream of the first isolating valve on Class 1, 2, or 3 instrument lines that have an inlet of NPS 3/4 or smaller shall be registered as a Category C fitting. The registration may be in accordance with the requirements of CSA B51.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
8 Materials		
8.1 General Requirements		
8.1.1 Material for Class 1 components	Material for components classified as Class 1 shall comply with the requirements of the ASME *BPVC*, Section III, Division 1, NB-2000, or the CSA N285.6 Series.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.1.2 Material for Class 2 components	Material for components classified as Class 2 shall comply with the requirements of the ASME *BPVC*, Section III, Division 1, NC-2000, or the CSA N285.6 Series.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
8.1.3 Material for Class 3 components	Material for components classified as Class 3 shall comply with the requirements of the ASME *BPVC*, Section III, Division 1, ND-2000, or the CSA N285.6 Series.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.1.4 Material for Class 1C, 2C, and 3C components	Materials for components classified as Class 1C, 2C, or 3C shall comply with the specific requirements given in Annex E of this Standard, CSA N285.6 Series, and as appropriate the requirements of the ASME *BPVC*, Section III, Division 1, NB-2000, NC-2000, or ND-2000, respectively.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.1.5 Material for Class 4 Components		
8.1.5.1 Metallic materials	Metallic materials for components classified as Class 4 shall comply with the ASME *BPVC*, Section III, Division 1, NE-2000, or the CSA N285.6 Series.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.1.5.2 Non-metallic materials	Non-metallic materials shall be qualified for the service conditions and the required service life. Both normal plant conditions and the environmental conditions during and following a postulated accident (e.g., pressure, temperature, humidity, radiation, expected service life) shall be considered. The qualification method (e.g., tests) shall be documented.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.1.6 Materials for Class 6 components	Materials for components classified as Class 6 or Class Exempt that are required to be registered shall be in accordance with the requirements of CSA B51.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.2 Identification	Material for components classified as Class 1, 1C, 2, 2C, 3, 3C, and 4 shall be identified in accordance with the ASME *BPVC*, Section III, NCA-3856.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
8.3 Supports		
8.3.1 Class 1, 1C, 2, 2C, 3, 3C, and 4 supports	Material used for Class 1, 1C, 2, 2C, 3, 3C, and 4 supports (intervening elements excepted) shall comply with the requirements of the ASME *BPVC*, Section III, Division 1, NF-2000, or the CSA N285.6 Series.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
8.3.2 Integral attachments	Material used for integral attachments shall be compatible with the material requirements for the component(s) to which the attachments are fastened.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
9 Fabrication & Installation		
9.1 General requirements	Fabrication and installation shall be carried out under a quality assurance program in accordance with Clause 10 and shall include preparation of the following documentation: a) fabrication and installation documents, instructions, and procedures that include verification; b) records to demonstrate the completion of all required tests, inspections, examinations, and treatments, including the qualification of the personnel and procedures used; c) records to demonstrate the acceptance of the inspection and test plan by the authorized inspector; d) permanent and non-permanent records for the applicable period of time (see Clause 12); and e) records showing actual stamping of the nameplate (e.g., a photocopy, photograph, or rubbing).	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2 Specific Requirements		
9.2.1 Class 1 components and non-standard fittings	The licensee shall have Class 1 components and non-standard fittings fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NB-4000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2.2 Class 2 components and non-standard fittings	The licensee shall have Class 2 components and non-standard fittings fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NC-4000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2.3 Class 3 components and non-standard fittings	The licensee shall have Class 3 components and non-standard fittings fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, ND-4000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2.4 Class 1C, 2C, and 3C components and non-standard fittings	The licensee shall have Class 1C, 2C, or 3C components and non-standard fittings fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NB-4000, NC-4000, or ND-4000, respectively, except where specific requirements are given in Annex E, in which case these components and non-standard fittings shall be fabricated and installed to these requirements.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2.5 Class 4 components and non-standard fittings	The licensee shall have components and non-standard fittings classified as Class 4 fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NE-4000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.2.6 Class 6 or Class Exempt components and fittings	The licensee shall have Class 6 or Class Exempt components and fittings that are required to be registered, fabricated and installed to comply with the requirements of CSA B51.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
9.2.7 Metallic Inserts	Helical coil or other threaded inserts shall be installed in accordance with the manufacturer's instructions and design requirements.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
9.3 Welding and Brazing		
9.3.1	The licensee shall retain records in accordance with Clause 12 to demonstrate that the welding or brazing procedure performed inside Canada on any Class 1, 1C, 2, 2C, 3, 3C, or 4 component meets the requirements of the ASME *BPVC*, Section III, Division 1, NB-, NC-, ND-, NE-, or NF-4300, and that the procedure has been registered with the authorized inspection agency, as required by Clause 6.1.11.1 of	CRL-508241-OP-001, *Qualifying Welding Procedure Specifications*

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Section and Title	**Description**	**Implementing Document(s)**
	this Standard. Annex G contains guidelines that may be used for in-service plugging by fusion welding of Class 1, 2, and 3 heat-exchanger tube or tubesheet holes with a one-inch maximum diameter.	
9.3.2	The licensee shall retain records in accordance with Clause 12 to demonstrate that the welding or brazing procedure performed outside Canada on any Class 1, 1C, 2, 2C, 3, 3C, or 4 component meets the requirements of the ASME *BPVC*, Section III, Division 1, NB-, NC-, ND-, NE-, or NF-4300.	900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
9.3.3	The licensee shall retain records in accordance with Clause 12 to demonstrate that, for welding or brazing performed on any Class 1, 1C, 2, 2C, 3, 3C, and 4 component, the welders, brazers, or welding operators are qualified for the process as required by the ASME *BPVC*, Section IX, and that they possess current, valid qualification documentation accepted or issued by the authorized inspection agency. Annex G of this Standard contains guidelines that may be used for in-service plugging by fusion welding of Class 1, 2, and 3 heat-exchanger tube or tubesheet holes with a one-inch maximum diameter.	CRL-508241-OP-002, *Required Qualifications for CRL Welders*
9.4 Support for Class 1, 1C, 2, 2C, 3, 3C, and 4 Components		
9.4.1	The licensee shall have supports fabricated and installed to comply with the requirements of the ASME *BPVC*, Section III, Division 1, NF-4000.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
9.4.2	The licensee shall have integral attachments fabricated and installed to comply with the fabrication and installation requirements for the component to which they are attached.	900-508120-PDD-001 and 900-508120-PRD-001, *Design Authority and Design Engineering* 900-508120-MCP-002, *Production and Acceptance of Design Documents*

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Section and Title	**Description**	**Implementing Document(s)**
		172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
10 General Requirements for Quality Assurance		
10.1 Applicability		
10..1.1	Class 1, 1C, 2, 2C, 3, 3C, 4 components and their supports shall be subject to the quality assurance requirements of Clause 10.	CRL-508140-QAP-001*, CRL Nuclear Pressure Boundary Quality Assurance*
10.1.2	Class 6 or Class Exempt components that are required to be registered shall be subject to the quality requirements of CSA B51.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
10.2 Construction of Class 1, 1C, 2, 2C, 3, 3C, and 4 components and their supports	Construction, or any limited scope of construction related activities, of Class 1, 1C, 2, 2C, 3, 3C, and 4 components and their supports shall be carried out under a quality assurance program that satisfies the requirements of ASME BPVC, Section III, Article NCA-4000.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.3 Repair, replacement, and modification of Class 1, 1C, 2, 2C, 3, 3C, and 4 components and their supports		
10.3.1	Repair, replacement, or modification of Class 1, 1C, 2, 2C, 3, 3C, and 4 components and their supports shall be carried out under a quality assurance (QA) program that satisfies the requirements of ASME BPVC, Section III, Article NCA-4000.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.3.2	A QA program that meets the requirements of NBBI NB23 may be used by the licensee for repair, replacement, and modification work not requiring registration updates when approved by the regulatory authority.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.4 Refurbishing of Class 1, 1C, 2, 2C, 3, 3C, and 4 items	Refurbishing activities shall be performed and controlled in accordance with a quality assurance program acceptable to the licensee.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.5 Servicing of Class 1, 2, and 3 pressure-relief valves	A QA program for servicing of Class 1, 2, and 3 pressure-relief valves shall be based on the NBBI NB23, Part 3, Section 1, with the following exceptions:	Not Applicable

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	a) a certificate of authorization or other method of acceptance issued by an authorized inspection agency (AIA) may be used instead of a National Board certificate of authorization; and b) National Board stamps are not required.	
10.6 Class 1, 1C, 2, 2C, 3, 3C, and 4 material	The manufacture or supply of materials (including welding consumables) for use in Class 1, 1C, 2, 2C, 3, 3C, or 4 components and their supports shall meet one of the following requirements: a) activities shall be carried out under a quality program that satisfies the requirements of the ASME BPVC, Section III, NCA-3800; or b) activities shall be carried out under a quality program that satisfies the requirements of CAN/CSA- ISO 9001, and the following additional requirements of the ASME BPVC, Section III: i) sources of material, source material, and services — NCA-3855.2; ii) identification marking, and material control — NCA-3856; iii) audits — NCA-3859.1(e); iv) certification requirements — NCA-3860; v) where utilization of unqualified source material is involved, the requirements of NCA-3855.5 shall also apply; vi) where welding repair is involved, the requirements of NCA-3857.3 shall also apply; and vii) scope and applicability — NCA-3851.2(a)(1), (2), (3), (5), and (6).	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.7 QA programs acceptable for use		
10.7.1	QA programs that are deemed to meet the requirements listed in Clauses 10.1, 10.2, 10.3, 10.4, 10.5, or 10.6 a), and any additional N285 scope requirements may be used when surveyed and conclusions are confirmed and recorded in writing by an AIA in Canada (this may be by issuance of a certificate).	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.7.2	ASME BPVC, Section III, NCA QA programs certified by ASME may be used.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*

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Section and Title	**Description**	**Implementing Document(s)**
10.7.3	The holder of a valid QA program (as described in Clause 10.7.1 or 10.7.2) and when included in its scope of activities, may evaluate and qualify a supplier to the requirements listed in Clause 10.6 b). This qualification is limited to the furnishing of source material, material or subcontracted services to the organization that performed the evaluation.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
10.7.4	A QA program for servicing pressure relief valves accredited by the National Board may be used.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-514200-PDD-001, *Quality*
11 Examination and Pressure Testing		
11.1 Examination requirements		
11.1.1	The licensee shall have documentation to demonstrate that Class 1 components have been examined in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, NB-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME *BPVC*, Section III, Division 1, NB-5000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001*, Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.2	The licensee shall have documentation to demonstrate that Class 2 components have been examined in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, NC-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME *BPVC*, Section III, Division 1, NC-5000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001*, Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.3	The licensee shall have documentation to demonstrate that Class 3 components have been examined in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, ND-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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	for repairs and replacements may be in accordance with a later edition of the ASME *BPVC*, Section III, Division 1, ND-5000.	900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.4	When specific examination requirements are given in Annex E, they shall apply in lieu of the requirements of Clause 11.1.	CW-505000-REQ-212, *Control of Special Processes*
11.1.5	The licensee shall have documentation to demonstrate that Class 4 components have been examined in accordance with the requirements of the ASME *BPVC*, Section III, Division I, NE-5000. For repairs and replacements to Class 4 component(s), the licensee shall have documentation to demonstrate that examination is in accordance with the requirements of the original design. For repairs and replacements, newer procedures and techniques may be used.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.6	The licensee shall have documentation to demonstrate that supports have been examined in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, NF-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME *BPVC*, Section III, Division 1, NF-5000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.7	The licensee shall have documentation to demonstrate that integral attachments have been examined in accordance with the examination requirements for the component to which they are attached.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components* CW-505000-REQ-212, *Control of Special Processes*

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Section and Title	**Description**	**Implementing Document(s)**
		CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.1.8	The licensee shall have documentation to demonstrate that for examinations performed on any pressure-retaining component, the persons performing the non-destructive examinations were, at the time of the examinations, qualified in accordance with Clause 11.3, and possessed current, valid qualification documentation.	900-514200-STD-006, *Requirements to Perform Non-Destructive Testing at CNL* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.2 Examination Methods		
11.2.1	The licensee shall have documentation to demonstrate that all non-destructive examination procedures performed on Class 1, 1C, 2, 2C, 3, 3C, and 4 components comply with Clause 11.1.	CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.2.2	The licensee shall have documentation to demonstrate that procedures for non-destructive examination on Class 1, 1C, 2, 2C, 3, 3C, and 4 components have been demonstrated to and accepted by the authorized inspection agency. For special applications, the licensee shall have documentation to demonstrate that methods of examination were agreeable to the regulatory authority. For special examinations carried out by organizations other than the licensee, the licensee shall have documentation to demonstrate that methods of examination were accepted by the licensee.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CW-505000-REQ-212, *Control of Special Processes*
11.3 Examination Personnel		
11.3.1	The licensee shall have documentation to demonstrate that persons performing non-destructive examinations on Class 1, 1C, 2, 2C, 3, 3C, and 4 pressure-retaining component(s) were, at the time of the examinations, qualified in accordance with the following standards: a) In Canada: i) radiography, ultrasonic, magnetic particle, liquid penetrant, and eddy current methods — CAN/CGSB-48.9712/ISO 9712; and ii) other methods — standards acceptable to the licensee and the authorized inspection agency; or	900-514200-STD-006, *Requirements to Perform Non-Destructive Testing at CNL*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	b) Outside Canada: all methods — standards acceptable to the licensee and the authorized inspection agency.	
11.3.2	Certification and re-certification of non-destructive examination personnel shall be in accordance with the requirements of the standards listed in Clause 11.3.1 and of the authorized inspection agency.	900-514200-STD-006, *Requirements to Perform Non-Destructive Testing at CNL*
11.3.3	The licensee shall have documentation of the persons who performed the non-destructive examination, the effective and expiry dates of their certification, and the level of their qualification.	900-514200-STD-006, *Requirements to Perform Non-Destructive Testing at CNL*
11.4 Pressure Testing of Components		
11.4.1	The licensee shall have documentation to demonstrate that all new components have been subjected to a pressure test in accordance with Clause 11.4.	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.2	A pneumatic pressure test may be used only when a hydrostatic pressure test is not practicable because of service conditions, and provided that precautions have been taken for the protection of personnel.	900-514200-MCP-026, Pressure Test Verification Procedure
11.4.3	The licensee shall retain the data report to demonstrate that a pressure test has been performed to the satisfaction of an inspector, who has countersigned the data report (See Table 1).	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.4	The licensee shall have documentation to demonstrate that Class 1 component(s) have been tested in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, NB-6000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
11.4.5	The licensee shall have documentation to demonstrate that Class 2 component(s) have been tested in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, NC-6000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.6	The licensee shall have documentation to demonstrate that Class 3 components have been tested in accordance with the requirements of the ASME *BPVC*, Section III, Division 1, ND-6000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.7	The licensee shall have documentation to demonstrate that in addition to the requirements of Clause 11.4.4, 11.4.5, and 11.4.6, component(s) classified as Classes 1C, 2C, and 3C have been tested in accordance with the requirements of Annex E.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.8	The licensee shall have documentation to demonstrate that components classified as Class 4 have been tested in accordance with the requirements of the ASME *BPVC*, Section III, Division I, NE-6000.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
11.4.9	The licensee shall have documentation to demonstrate that Class 6 components have been tested in accordance with the requirements of CSA B51.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
12 Documentation		
12.1 General	The licensee shall document all activities on components and their supports for which requirements are given in this Standard, and shall retain records as specified in Clause 12. Annex C outlines a system of design documentation that has been used in some facilities.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
12.2 Records, Identification, and Reports		
12.2.1	Records shall include permanent and non-permanent records. Records pertaining to Class 1, 1C, 2, 2C, 3, 3C, and 4 components and supports listed in Table 3 are classified as permanent. The licensee shall retain records of all registered items requiring data reports in accordance with Table 1, including their CRNs.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
12.2.2	Certified overpressure protection reports for Class 1, 2, and 3 systems and Class 4 components, where required by this Standard, are classified as permanent records.	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance
12.2.3	The certified material test report or the certificate of compliance for Class 1, 1C, 2, 2C, 3, 3C, and 4 materials are classified as permanent records. The certified material test report shall contain the product specification for the material and all records specified therein as well as the information required by the ASME *BPVC*, Section III, Division 1, NCA-3800.	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance 900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
12.2.4	The certificate holder shall assemble all permanent records listed in Table 3 for a given component or fitting into a history docket.	CRL-508140-QAP-001, CRL Nuclear Pressure Boundary Quality Assurance 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
12.2.5	The certificate holder other than the licensee shall forward the appropriate history docket to the licensee or to a designated agent upon completion of the component or fitting.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*
12.2.6	History docket for any component or fitting specified in Clause 12.2.4 shall be retained by the licensee until that that component or fitting is removed from service or the whole plant is decommissioned. Except for final radiographs designated by the licensee for CSA N285.4, CSA N285.5, and CSA N285.7 periodic inspection applications, radiographs shall remain in the history docket for 10 years after the in-service date. **Note:** Fabrication radiographs can be valuable in assessing flaws found as part of a fitness-for-service evaluation after a “beyond design” excursion or for a life extension evaluation. The licensee might want to designate certain radiographs for permanent retention for such purposes.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004*, Retention, Preservation and Disposition of Information Assets*
12.2.7	Non-permanent records consist of all those records not classified as permanent and that are required to verify compliance with this Standard.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-511300-STD-003, *Creation, Capture and Use of Information Assets* 900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
12.2.8	The certificate holder or licensee shall retain non-permanent records in accordance with the ASME BPVC, Section III, Table NCA-4134.17-2. Non-permanent records not covered by Table NCA-4134.17-2 shall be retained for a minimum period of five years.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-511300-STD-003, *Creation, Capture and Use of Information Assets*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		900-511300-STD-004, *Retention, Preservation and Disposition of Information Assets*
12.2.9	Partial shipments, or shipments other than to the licensee, shall be accompanied by documentation by the certificate holder sufficient to prove identification and acceptance. Duplicates of such documents shall be placed in the history docket.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-508120-MCP-003, *Execution of Design Review and Verification*
12.3 Identification		
12.3.1	Each Class 1, 1C, 2, 2C, 3, 3C, or 4 component (except a piping system), fitting*, part, piping subassembly, and support shall be identified by the certificate holder in accordance with the ASME *BPVC*, Section III, Division 1, NCA-8000, and all other applicable identification requirements of the ASME BPVC, Section III, Division 1, except an ASME code symbol stamp is not required for CSA N285.0 certificate holders. * Excluding Category A or B standard fittings (see Clause 6.1.6).	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.3.2	Identification shall be in a conspicuous location where it can be easily read. Duplicates may be used.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.3.3	When the size and configuration of a component does not permit the installation of a nameplate, identification shall be provided by a marking applied directly to the component or by other means acceptable to the authorized inspection agency.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.3.4	The nameplate shall be attached directly to the component or to a bracket attached to the component.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.3.5	The attachment shall not affect the integrity of the component.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.3.6	Class 6 component(s) shall be identified in accordance with the requirements of CSA B51.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.4 Data Report for Fabrication Activities and Report for Repair, Replacement, or Modification		
12.4.1 General Requirements		
12.4.1.1	The certificate holder shall complete and submit a data report for each component and for tubular products welded with filler metal in accordance with the requirements of Clause 12.4.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 900-514200-MCP-004*, Incoming Inspection*
12.4.1.2	Data reports shall be on forms of the type shown in Figures 3 to 8 and 12. Reports for repairs, replacements, or modifications shall be of the type shown in Figures 9 and 10. Variations of these forms may be used, provided that the applicable essential data and sign-off areas are included.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.1.3	The data report shall be signed by the certificate holder after all inspections, examinations, and tests required by this Standard have been completed. It shall then be countersigned by the inspector required by Table 1, who shall ensure that a) the shop is qualified for the work to be performed;	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*

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Section and Title	**Description**	**Implementing Document(s)**
	b) the design drawings are registered; c) the quality assurance program has been accepted as required by Clause 10; d) the welding procedures are registered; e) the welders and welding operators are qualified; f) non-destructive examination procedures are qualified; g) persons performing non-destructive examinations are qualified and certified; h) materials comply with requirements; i) he pressure boundary integrity dimensions are within drawing tolerances; j) the heat treatment operation has been performed in accordance with specified requirements; k) all required examinations and tests have been performed; l) work is in compliance with the quality assurance program; m) the pressure tests required by this Standard have been completed; and n) the reconciliation statements for differences between the registered designs and the as-built item(s) have been certified by the designer.	CRL-508140-141-000, *Authorized Inspection Agency Services Agreement Between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.*
12.4.1.4	When the data report required by Clause 12.4.1.3 cannot be issued because the design has not been finalized, and fabrication has proceeded on a piping system, piping subsystem, vessel, pump, support, or fitting under a provisional registration number, the item shall be accompanied by a partial data report that will define the status of the fabrication should the item be shipped to another certificate holder or to the nuclear power plant.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.1.5	The certificate holder other than the licensee shall submit completed original data reports to the licensee as part of the history docket, and shall submit a copy to the authorized inspection agency for vessels and piping systems.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.1.6	The certificate holder other than the licensee shall submit a completed data report, a certificate of conformance, or a certificate of compliance to the licensee as required by Table 1 for supports or	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	separately registered integral attachments. Supports of the same design may be covered by a single data report or certificate of conformance. Note: A data report or certificate of conformance is not required for non-welded supports that are furnished as material.	CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.1.8	The certificate holder shall complete and submit data report for Class 6 components in accordance with the requirements of CSA B51.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
12.4.1.9	The licensee shall have documentation to demonstrate that employees or agents designated as licensee's verifiers are qualified by training and experience in accordance with criteria that is deemed suitable by the licensee. The extent of the training program shall be based on trainee education, experience, and the type of product to be inspected and shall include instruction on the responsibilities of the licensee's verifier. Annex D provides sample training criteria for the qualification of a licensee's verifier. The licensee's verifier shall be independent of the organization whose work is being verified, and shall have no responsibility relating to cost control or expediting of delivery that might influence the responsibility for quality.	Not Applicable
12.4.1.10	The licensee shall maintain records of the qualified licensee's verifiers and have their duties and performance evaluated. Such records shall include an annual attestation of continued inspection proficiency based on experience and training. Figure D.2 provides a sample of an attestation of proficiency statement for a licensee's verifier. For licensee's verifiers not employed by the licensee, the evaluation of the duties and performance may be performed by outside agencies or by the licensee.	No Applicable
12.4.1.11	The monitoring of employees of the licensee shall be under the licensee's internal auditing program.	900-514200-MCP-002, *Quality Audits*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
12.4.2 Piping System Installations for Class 1, 1C, 2, 2C, 3, 3C, or 4		
12.4.2.1	The certificate holder shall complete a data report for each piping system, except that a group of piping systems having a common final pressure test may be included in a single data report.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.2.2	The certificate holder shall sign the data report only after final design registration has been obtained for the component(s) therein.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.3 Piping subassemblies for Class 1, 1C, 2, 2C, 3, 3C, or 4	The certificate holder shall complete a partial data report for each piping subassembly	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.4 Vessels for Class 1, 1C, 2, 2C, 3, 3C, or 4	The certificate holder shall complete a data report for each vessel.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.5 Modifications for Class 1, 1C, 2, 2C, 3, 3C, or 4	The certificate holder shall complete a data report for each modified component.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.6 Pressure Relief Devices for Class 1, 1C, 2, 2C, 3, 3C, or 4		
12.4.6.1	The certificate holder shall complete a data report for each pressure relief device.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.6.2	Pressure relief devices that are of the same design and size, have an inlet connection not larger than NPS 2, and do not exceed 25 in quantity may be included in a single data report. The certificate holder shall identify each device in the data report by an individual serial number.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.7 Pumps and Valves for Class 1, 1C, 2, 2C, 3, 3C, or 4		
12.4.7.1	The certificate holder shall complete a data report for each pump and valve having an inlet connection larger than NPS 4.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*

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Section and Title	**Description**	**Implementing Document(s)**
12.4.7.2	Pump and valves that are of the same design and size, have an inlet connection not larger than NPS 4, and that are released as one shipment not exceeding 25 in quantity may be included in a single data report. The certificate holder shall identify each pump and valve in the data report by an individual serial number.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.7.3	The data report shall be signed by the certificate holder after all inspections, examinations, and tests required by this Standard have been completed and countersigned by the inspector required by Table 1.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.8 Fittings for Class 1, 1C, 2, 2C, 3, 3C, or 4		
12.4.8.1	Fittings of the same design and size released as a single shipment may be included in a single data report, certified material test report (CMTR), or a certificate of compliance, as applicable.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.8.2	Fittings shall be identified by individual serial numbers listed in the data report or by a group identification mark.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
12.4.8.3	The data report shall be signed by the certificate holder after all inspections, examinations, and tests required by this Standard have been completed and countersigned by the inspector designated in Table 1.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
12.4.9 Parts for Class 1, 1C, 2, 2C, 3, 3C, or 4	A data report for a part shall be the same as that used for the component for which the part is to be used.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
13 In-Service Requirements		
13.1 General requirements	Components covered by this Standard shall be subject to inspections in accordance with CSA N285.4, CSA N285.5, and CSA N285.7.	NRU-508230-PRO-001, *Periodic Inspection*
13.2 Inaugural or baseline inspections	When the pressure boundary of a component that is subject to periodic inspection is repaired, replaced, or otherwise changed, it shall receive, before being put into service, an inaugural or baseline inspection as required by CSA N285.4, CSA-N285.5, and CSA N285.7.	NRU-508230-PRO-001, *Periodic Inspection*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
13.3 Class 1, 2, and 3 pressure relief devices	Testing programs of Class 1, 2, and 3 pressure relief devices shall meet the applicable requirements of the ASME OM Code, Appendix I, when those devices are required to protect systems or portions of systems that perform any of the following: a) shutting down a reactor to the safe shutdown condition; b) maintaining the safe shutdown condition; or c) mitigating the consequences of an accident. The licensee shall have documentation to demonstrate acceptance of the testing program by the regulatory authority. Class 6 pressure relief devices may be included in this program.	CRL-508140-QAP-002, *Repair or Service of Pressure Relief Valves to ASME Section VIII - Division 1 and CSA B51/B52 at Chalk River Laboratories*
13.4 Class 6 pressure relief devices	The licensee shall document that the inspection and testing of pressure relief devices in Class 6 systems and Class Exempt systems that require registration have been carried out in accordance with an approved program.	CRL-508140-QAP-002, *Repair or Service of Pressure Relief Valves to ASME Section VIII - Division 1 and CSA B51/B52 at Chalk River Laboratories*
14 Repairs, Replacements, and Modifications		
14.1 General	Clause 14 shall apply to all Class 1, 1C, 2, 2C, 3, 3C, 4, and 6 components and supports registered in accordance with Clause 6, unless otherwise specified.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
14.2 Repairs		
14.2.1	When repairs are made due to failure of an item or where an item does not comply with the requirements of this Standard, the licensee shall prepare a report on the failure or defect and submit it to the regulatory authority.	900-514300-MCP-006, *CNL Reporting to Regulatory Agencies*
14.2.2	The effective date used in the repair of an item for the design code of construction for the repaired item shall be the effective date for the original item or later.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components*
14.2.3	The licensee shall have documentation to demonstrate that the authorized inspector accepted the repair procedure before the repair was undertaken	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*

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Section and Title	**Description**	**Implementing Document(s)**
14.2.4	For repairs that result in a variation from the original design, but the item remains in compliance with the applicable codes and standards, the licensee shall have documentation to demonstrate that the authorized inspection agency accepted the design variation before the repair was undertaken.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.2.5	The licensee shall have documentation to demonstrate that the authorized inspector has been notified before commencing repairs that involve welding of the pressure boundary.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
14.2.6	Repairs carried out by the licensee on the pressure boundary that include welding shall comply with Clauses 6.1.11 and 9.3.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508241-OP-001, *Qualifying Welding Procedure Specifications*
14.2.7	Inspection, examination, and testing of repairs carried out by the licensee shall comply with Clauses 11 and 14.6.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
14.2.8	Documentation, in the form of both permanent and non-permanent records, shall be maintained by the licensee as required by Clause 12.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.2.9	The effective date for the standards covering materials, including welding and brazing consumables that are used in a repair shall be the effective date of the standard used in the design and construction of the component. However, if the licensee has demonstrated to the authorized inspector that a material manufactured to a more recent standard is functionally, chemically, and metallurgically compatible with the system or component, such a material may be used.	900-508140-FID-001, *Classification and Design Registration of Pressure Retaining Systems / Components* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
14.3 Replacement Items		
14.3.1	A replacement item may be purchased to the original design specification or to a different design	900-508140-FID-001, *Classification and Design Registration of*

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Section and Title	**Description**	**Implementing Document(s)**
	specification, provided that the design requirements for the original item are met. The effect on an existing components of the difference between the original item and the replacement item shall be reconciled with the original design reports. If these differences cannot be reconciled, updated design documentation shall be submitted to the authorized inspection agency in accordance with this Standard.	*Pressure-Retaining Systems / Components*
14.3.2	The classification of the replacement item shall be the same or a higher class than that required by the original design specification.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.3.3	For Class 1, 1C, 2, 2C, 3, 3C, and 4 items, the effective date for the design code of construction for the replacement item shall be the effective date for the original item or later.	900-508140-FID-001*, Classification and Design Registration of Pressure Retaining Systems / Components*
14.3.4	The replacement item shall be functionally, chemically, and metallurgically compatible with the components in which it is to be installed.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.3.5	The replacement item shall not have experienced any significant deterioration in storage that might adversely affect its structural integrity or operability.	900-505210-MCP-008*, Materials Management* CRL-508230-PRO-608, *Material Control for ASME Section III and Environmentally Qualified Work*
14.3.6	The licensee shall have documentation to demonstrate that the procedure for installing a replacement item was accepted by the authorized inspection agency before installation commenced.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.3.7	The licensee shall have documentation to demonstrate that the authorized inspector was notified before the installation of replacement items involving welding of the pressure boundary.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.3.8	Replacements carried out by the licensee on the pressure boundary that include welding shall comply with Clauses 6.1.11 and 9.3.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* CRL-508241-OP-001, *Qualifying Welding Procedure Specifications*
14.3.9	Replacement items that are the same as or similar to the ones being replaced and that meet the criteria of Clauses 14.3.1 to 14.3.8 shall be deemed acceptable for installation without further approval from the regulatory authority.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement* 900-508130-MCP-001, *Engineering Change Control*
14.3.10	When a replacement is made due to the failure of an item or when an item does not comply with the requirements of this Standard, the licensee shall prepare a report of the failure or defect and submit it to the regulatory authority.	900-514300-MCP-006, *CNL Reporting to Regulatory Agencies*
14.3.11	Examination and pressure testing of replacement items carried out by the licensee shall comply with Clauses 11 and 14.6.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*
14.3.12	Documentation, in the form of both permanent and non-permanent records, shall be maintained by the licensee as required by Clause 12. The licensee shall have documentation that traces the replacement item to its certified design specification and this documentation shall be available to the authorized inspection agency for review.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.3.13	Replacement items shall be purchased, shipped, handled, and stored in accordance with the licensee's instructions and procedures to prevent damage, deterioration, or loss. These procedures shall ensure that the necessary identification, traceability, and records are maintained by the licensee as specified by this Standard.	*900-505210-MCP-008, Materials Management* CRL-508230-PRO-608, *Material Control for ASME Section III and Environmentally Qualified Work*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.3.14	The licensee shall identify items with limited shelf life and shall implement procedures to control their storage. The licensee shall quarantine and dispose of items that cease to conform to the requirements of this Standard.	*900-505210-MCP-008, Materials Management* CRL-508230-PRO-608, *Material Control for ASME Section III and Environmentally Qualified Work*
14.3.15	Annex I defines an alternative process to qualify Category A to F replacement fittings manufactured without welding. The licensee shall obtain approval from the regulatory authority to apply this process.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
14.4 Refurbishing of Items		
14.4.1	The licensee shall retain a record of the item identification and date of refurbishment for each refurbished item or group of items, in accordance with Clause 12	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
14.4.2	Refurbishing activities are not subject to AIA involvement.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
14.5 Modifications		
14.5 Addition of a self-contained system		
14.5.1.1	A new self-contained Class 1, 2, 3, or 6 system shall comply with the requirements of this Standard.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.5.1.2	The effective dates for the standards that apply to the modification shall be the dates listed in Clause 2 or as otherwise agreed upon by the regulatory authority.	900-508140-FID-001*, Classification and Design Registration of Pressure Retaining Systems / Components*
14.5.2 Existing Components		
14.5.2.2	A modification to the pressure boundary of an existing component shall comply with the requirements of this Standard.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components* 900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.5.2.3	The effective dates for the standards that apply to the modification shall be the dates listed in Clause 2 or as otherwise agreed upon by the regulatory authority.	900-508140-FID-001*, Classification and Design Registration of Pressure Retaining Systems / Components*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.5.2.4	Licensees that have regulatory authority approval of their classification process shall obtain regulatory approval of the classification of the modification prior to the implementation of the modification when a) the modification changes the existing classification to a lower classification; or b) the modification involves penetration of the containment structure or a part of the containment boundary. Licensees not having regulatory authority approval of their classification process shall obtain regulatory approval of the classification of the modification prior to the implementation of the modification. The format of this submission may be an updated system classification list or a classification approval form, as specified in Clause 5.1.7.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.5.2.5	The licensee shall retain records to demonstrate that any differences between the following have been evaluated and reconciled in accordance with Annex H: a) the existing design and proposed modified design for existing components; or b) the registered or reconciled design of a modification and the as-built modification. The licensee shall complete actions as specified in Annex H for any differences affecting the basis for classification or overpressure protection and for reconciliation statements, design registration, and registration updates.	900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components*
14.5.2.6	The licensee shall have documentation to demonstrate that the procedure for the installation of modifications was accepted by the authorized inspection agency before installation commenced.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.5.2.7	The licensee shall have documentation to demonstrate that the examination and testing of modifications complies with Clause 11, except for pressure testing, which shall have documentation demonstrating compliance with Clause 14.6.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
		CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
14.5.2.8	Permanent records required by Clause 12.2.1 shall be included in the history docket.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
14.5.3 Temporary Modifications		
14.5.3.2	Temporary modifications shall comply with the requirements of Clauses 5.1.7 and 14.5.2 and Annex H, with the following exceptions: a) For recurring temporary modifications, the following shall be required only for the first occurrence of the modification: i) the classification approval (see Clauses 14.5.2.4 and H.2); ii) the overpressure protection report update (see Clause H.3); and iii) the registration update (see Clause H.4). b) For non-recurring temporary modifications, i) the registration need not be updated when the materials used in the temporary modification are different from those specified in the original design, provided that (1) the materials used for the temporary modification are evaluated to be equivalent to the original materials; and (2) all other requirements of Clause H.4 are met; ii) the overpressure protection shall be evaluated and documented but the overpressure protection report or calculations need not be updated; and iii) the system classification list need not be updated.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508140-FID-001, *Classification and Design Registration of Pressure-Retaining Systems / Components* 900-508130-MCP-001, *Engineering Change Control*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.6 Pressure Testing		
14.6.1 General Requirements		
14.6.1.1	For replacement items and items used in a piping system modification, the licensee shall have a pressure test performed in accordance with the requirements of the design and fabrication standards. The licensee may substitute the piping system pressure test for the item pressure test, provided that the requirements of the design standards are met.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.1.2	Where a modification consists of increasing the design pressure or temperature of a component, the licensee shall pressure test the component in accordance with the design and fabrication standard.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.1.3	When a new self-contained system is added, the licensee shall pressure test prior to operation in accordance with Clause 11.4.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.1.4	The licensee shall pressure test the tie-in joints involving welding or brazing of items in accordance with Clause 14.6.2 or 14.6.3, as applicable.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.1.5	After welding or brazing on a pressure-retaining boundary, the licensee shall perform a pressure test in accordance with	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	a) Clause 14.6.2 for Class 1, 1C, 2, 2C, 3, 3C, or 4 items; or b) Clause 14.6.2 or 14.6.3 for Class 6 items.	CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.1.6	The licensee shall take into account the fracture toughness of the ferritic materials all of the components of the piping system when determining the minimum metal temperature during pressure testing of the piping systems.	900-508120-MCP-002, *Production of Production and Acceptance of Design Documents*
14.6.2 Piping System Pressure Testing		
14.6.2.1	Where a pressure test is required by Clause 14.6.1, unless the welds or repairs are exempted by Clause 14.6.2.2, the piping system shall be filled with fluid and pressurized so that all welding or brazing repairs and tie-in welds are tested in accordance with Clause 14.6.2.	172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-002, *Pressure Boundary Mechanical Joint Replacement*
14.6.2.2	The following are exempt from the pressure test: a) seal welds; b) heat exchanger tube plugging and sleeving; c) piping system, pump, and valve welding, where the welded cavity does not exceed 50% of the pressure-boundary minimum design thickness in the repair location; d) pressure vessel welding, where the welded cavity does not exceed 10% of the minimum design wall thickness; e) component connections, piping systems, and associated valves that are NPS 1/2 and smaller; f) tube-to-tubesheet welds, where such welds are made on the cladding; g) capped drains and vents isolated from a piping system by a valve; and h) leakage collection lines (to the first isolation valve from the expected leakage site).	900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.6.2.3	Following a welded or brazed repair, replacement, or modification, the test pressure, temperature, and testing medium for a system pressure test shall	900-508120-MCP-002, *Production and Acceptance of Design Documents*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	comply with the requirements specified in the design specification of the piping system. The design specification shall be the one used for the original installation of that part of the piping system containing the item on which the repair, replacement, or modification was performed.	900-514200-MCP-026, Pressure Test Verification Procedure
14.6.2.4	The licensee shall perform a visual examination on the repaired areas, installation welds, or brazed joints to detect leakage at the pressure specified in the piping system design specification in effect at the time of the original installation. Areas requiring visual examination shall be accessible and free of any coating, insulation, or covering. Examination may be by direct visual means or may use visual aids (e.g., a mirror, telescope, borescope, or closed-circuit television).	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-025, *Visual Examination*
14.6.2.5	Where a piping system cannot be isolated to perform the pressure test, an operational pressure test in accordance with Clause 14.6.3 may be performed in lieu of the system pressure test, provided that the additional NDE of Clause 14.6.2.7 is carried out on welds that have not been tested in accordance with Clause 14.6.1.1. Where an operational pressure test is performed in lieu of the pressure test for Class 1, 1C, 2, 2C, 3, 3C, or 4 items, the exemptions of Clause 14.6.3.2 shall not apply.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, Pressure Test Verification Procedure
14.6.2.6	Where the replacement item or the area of the repair is isolatable within a portion of a piping system, only that portion shall require a pressure test.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, Pressure Test Verification Procedure
14.6.2.7	Where the licensee carries out pressure testing at a reduced pressure, as permitted by Clause 14.6.2.5, and in addition to those examinations required by Clause 11, the licensee shall perform the following: a) For butt welds of Class 1 or 1C component(s), the licensee shall perform an additional volumetric examination using a method different from the volumetric method required by the design and fabrication standards, in accordance with the ASME *BPVC*, Section III, Division 1, NB-5000. For other types of welds, the licensee shall perform a surface liquid penetrant (PT) or magnetic particle (MT) examination.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* 900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 900-514200-MCP-026, *Pressure Test Verification Procedure*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	b) For butt welds smaller than or equal to NPS 2-1/2 in Class 1 or 1C component(s) (excluding feeders), the licensee may perform the following in lieu of the second volumetric examination described in Item (a): i) for pipe sizes NPS 3/4 and smaller, a visual inspection of the root pass; or ii) for pipe sizes greater than NPS 3/4 and smaller than or equal to NPS 2-1/2, a visual inspection of the root and fill passes. Welds made in accordance with Item (b) shall be performed using gas tungsten arc welding (GTAW) only and welders shall be qualified on pipe coupons of the same diameter or a smaller diameter than the production pipe size being welded. c) For all welds of Class 2 or 2C component(s), the licensee shall perform a surface PT or MT examination. d) For butt welds of Class 3 or 3C components, the licensee shall perform a volumetric examination. For other types of welds, the licensee shall perform a surface PT or MT examination. The examinations outlined in Items (a) to (d) shall meet the applicable acceptance criteria of the design and fabrication standards. Examinations carried out to fulfill the requirements of the inaugural inspection for a periodic inspection program may be credited towards the requirements specified in this Clause.	
14.6.2.8	Any item within the pressure test boundary that the licensee considers unsuitable for exposure to the test pressure (e.g., instrumentation, pressure-relief devices) may be isolated, or removed prior to the application of pressure.	900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 900-514200-MCP-026, Pressure Test Verification Procedure
14.7.3 Operational Pressure Testing		
14.6.3.1	Where an operational pressure test is required by Clause 14.6.1 or 14.6.2, unless the welds or the repairs are exempted by Clause 14.6.3.2, the piping system shall be filled with the process fluid and pressurized using the process equipment so that all	900-514200-MCP-026, *Pressure Test Verification Procedure*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	welding or brazing repairs and tie-in welds are tested in accordance with Clause 14.6.3.	
14.6.3.2	The following are exempt from operational pressure tests: a) seal welds; b) heat exchanger tube plugging and sleeving; c) piping system, pump, and valve welding, where the repair weld does not penetrate the pressure boundary; d) pressure vessel welding, where the welded cavity does not exceed 33% of the minimum design wall thickness; e) component connections, piping system, and associated valves that are NPS 1 and smaller; f) tube-to-tubesheet welds; g) capped drains and vents isolated from the piping system by a valve; and h) leakage collection systems.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.6.3.3	The licensee shall perform a visual examination to detect leakage from repaired areas, installation welds, or brazed joints. This examination shall be performed after the piping system has been in operation for at least 10 min. Areas requiring visual examination shall be accessible and free of insulation. With prior agreement of the authorized inspection agency, for repaired areas, installation welds, or brazed joints that are insulated prior to the test, leakage detection shall be performed after the piping system has been in operation for at least 4 h. The surrounding area shall be examined for evidence of leakage. With prior agreement of the authorized inspection agency, repaired areas, installation welds or brazed joints that are inaccessible for examination may be examined using indirect methods to detect leakage.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-025, *Visual Examination*
14.6.3.4	When conducting an operational pressure test, the piping system pressure and temperature shall be determined by normal system instrumentation, test instrumentation, or through confirmation that the system is operating at its operating conditions. Records of the test shall be maintained in accordance with Clause 12.	900-514200-MCP-026, *Pressure Test Verification Procedure* 900-514200-QAP-001, *Calibration Program* 900-514200-MCP-013, *Calibration* 900-508230-MCP-002, *Preventive Maintenance*

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Section and Title	**Description**	**Implementing Document(s)**
		CRL-508230-PRO-609, *Route Sheet for ASME Section III Work*
14.6.3.5	Where the repaired areas, tie-in welds, or brazed joints of the installed item are isolatable within a portion of a piping system, only that portion shall require a pressure test.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.6.4 Alternative requirements for pressure testing	The alternative requirements for pressure testing specified in Clause 14.7 may be used in place of Clauses 14.6.1 to 14.6.3.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7 Alternative pressure testing of Class 1, 2, 3, and 6 systems after repairs, replacements, and modifications		
14.7.1 Requirements		
14.7.1.1 General		
14.7.1.1.1	As an alternative to the requirements of Clauses 14.6.1 to 14.6.3, Clause 14.7 may be used for the pressure testing of a repair, replacement, or modification to the pressure boundary of an existing Class 1, 2, 3, or 6 system.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* 900-508120-MCP-002, *Production and Acceptance of Design Documents* CRL-508230-PRO-609, *Route Sheet for ASME Section III Work* 172-508230-PRO-001, *CRL Site Infrastructure Work Planning Process* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.1.2	For replacement items and items used in a system modification, the licensee shall have documentation to demonstrate that the item has been pressure-tested in accordance with Clause 11.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.7.1.1.3	Where a modification to an existing system involves an increase of the design pressure or temperature of a system or component, the licensee shall have documentation to demonstrate that the system has been pressure-tested in accordance with Clause 11 using the revised design requirements.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.1.4	When a new self-contained system is added, the licensee shall have documentation to demonstrate that the system has been pressure-tested in accordance with Clause 11 prior to operation	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.1.5	The licensee shall have documentation to demonstrate that the tie-in joints involving welding or brazing of an item have been pressure-tested in accordance with Clauses 14.7.1.2 and 14.7.2.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.1.6	The licensee shall have documentation to demonstrate that repairs involving welding or brazing have been pressure-tested in accordance with Clauses 14.7.1.2 and 14.7.2.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.1.7	For Class 1, 2, and 3 systems, the following items are exempt from the system pressure test: a) seal welds; b) heat exchanger tube plugging and sleeving; c) piping, pump, and valve welding, where the welded cavity does not exceed 50% of the pressure- boundary minimum design thickness in the repair location; d) pressure vessel welding, where the welded cavity does not exceed 10% of the minimum design wall thickness; e) component connections, piping, and associated valves that are NPS 1/2 and smaller; f) tube-to-tube sheet welds, where such welds are made on the cladding; g) capped drains and vents isolated from a system by a valve; and h) leakage collection lines (to the first isolation valve from the expected leakage site).	900-508120-MCP-002, *Production and Acceptance of Design Documents*

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Section and Title	**Description**	**Implementing Document(s)**
14.1.1.1.8	For Class 6 systems, the following items are exempt from operational pressure tests: a) seal welds; b) heat exchanger tube plugging and sleeving; c) piping system, pump, and valve welding, where the repair weld does not penetrate the pressure boundary; d) pressure vessel welding, where the welded cavity does not exceed 33% of the minimum design wall thickness; e) component connections, piping system, and associated valves that are NPS 1 and smaller; f) tube-to-tube sheet joints involving welding or brazing; g) capped drains and vents isolated from the system by a valve; and h) leakage collection systems.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.7.1.2 Pressure-testing requirements for tie-in joints involving welding or brazing and repairs involving welding or brazing		
14.7.1.2.1	When pressure testing is performed in accordance with Clause 14.7.2.2, the licensee shall have documentation to demonstrate that tie-in joints involving welding or brazing or repairs involving welding or brazing of an item meet the requirements of Clauses 11.1 and 11.2.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.7.1.2.2	When operational pressure testing is performed in accordance with Clause 14.7.2.3, the licensee shall have documentation to demonstrate that the following requirements have been addressed: a) Tie-in joints involving welding or brazing or repairs involving welding or brazing of an item shall meet the requirements of Clauses 11.1 and 11.2. b) An engineering evaluation shall be performed on tie-in joints involving welding or brazing or repairs involving welding or brazing. The engineering evaluation shall postulate a flaw at the limit of the ability of the detection technique to be used. The analysis contained in the documentation shall demonstrate that the postulated flaw or any detected indication will not exceed an allowable flaw size within an inspection period as defined by the licensee.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
	c) The evaluation shall be accepted by the licensee. **Note:** An acceptable approach that may be used for determining allowable flaw size is to use ASME BPVC, Section XI, IWB-3600. Other approaches acceptable to the regulatory authority may be used.	
14.7.1.2.3	Parts and piping subassemblies used in the repair of a system shall be pressure-tested in accordance with Clause 14.7.2.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.1.3 Fuel Channel repair or replacement	The licensee shall have documentation to demonstrate that the repair or replacement of a fuel channel involving a new end fitting and/or pressure tube or complete replacement of the fuel channel assembly has been tested in accordance with Clause 14.7.2.2 and inspected for leaks in accordance with Clause 14.7.2.4 prior to, or as part of, returning to service.	Not Applicable
14.7.2 Pressure Testing		
14.7.2.1 General	The licensee shall take into account the fracture toughness of the ferritic materials in the system when determining the minimum metal temperature for pressure testing of systems containing ferritic steel components.	900-508120-MCP-002, *Production and Acceptance of Design Documents*
14.7.2.2 Pressure Testing		
14.7.2.2.1	For Class 1, 2, 3, and 6 systems, a pressure test at normal ambient temperature shall be conducted at not less than 1.1 times the lowest design pressure of any pressure-retaining item in the system.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.2.2.2	The requirements for measurement, maintenance of records, and conducting the pressure test shall be in accordance with Clause 11.4.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*

General requirements for pressure retaining systems and components in CANDU nuclear power plants (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
14.7.2.3 Operational Pressure Testing		
14.7.2.3.1	For Class 1, 2, 3, and 6 systems, an operational pressure test to check for leakage may be conducted in lieu of the pressure test specified in Clause 14.7.2.2, provided that the requirements of Clause 14.7.1.2 are met.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.2.3.2	The operational pressure test shall be conducted at normal operating pressure and temperature prior to, or as part of, returning to service.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-026, *Pressure Test Verification Procedure*
14.7.2.4 Inspection Requirements		
14.7.2.4.1	The licensee shall perform a visual inspection to detect leakage from joints involving welding or brazing or repairs involving welding or brazing that require pressure testing. This inspection shall be performed after the system has been operating at normal pressures and temperature for at least 10 min.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-025, *Visual Examination*
14.7.2.4.2	With prior agreement of the authorized inspection agency, joints involving welding or brazing or repairs involving welding or brazing that require pressure testing and are insulated prior to the pressure test shall be examined for leakage after the system has been in operation for at least 4 h. The surrounding area shall be inspected for evidence of leakage.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-025, *Visual Examination*
14.7.2.4.3	With prior agreement of the authorized inspection agency, joints involving welding or brazing or repairs involving welding or brazing that require pressure testing and are inaccessible for inspection may be examined using indirect methods to detect leakage.	900-508120-MCP-002, *Production and Acceptance of Design Documents* 900-514200-MCP-025, *Visual Examination*
15 Pressure Boundary Program Document		
15	The licensee shall have a pressure boundary program document(s) that indicates how the requirements of this Standard are addressed by the licensee’s processes and procedures for a nuclear facility. The pressure boundary program document shall be submitted to the regulatory authority. Annex J outlines a suggested format for this document.	900-508140-PRD-001, *Pressure Boundary*

Table 8: ASME Boiler and Pressure Vessel Code.

ASME Boiler and Pressure Vessel Code		
Section and Title	**Description**	**Implementing Document(s)**
4134.1 through 4134.18	ASME Boiler and Pressure Vessel Code, Section III, Subsection NCA, Quality Assurance	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*

Table 9: ASME Quality Assurance Requirements for Nuclear Facility Applications.

ASME Quality Assurance Requirements for Nuclear Facility Applications		
Section and Title	**Description**	**Implementing Document(s)**
Req’t 1-18	ASME NQA-1, Quality Assurance Requirements for Nuclear Facility Applications	CRL-508140-QAP-001*, CRL Nuclear Pressure Boundary Quality Assurance*

Table 10: CSA B51-14, Boiler, pressure vessel, and pressure piping code (Whiteshell).

Boiler, pressure vessel, and pressure piping code (Whiteshell)		
Section and Title	**Description**	**Implementing Document(s)**
PART 1 General Requirements for Boilers, Pressure Vessels, and Pressure Piping		
Section 4 to 13 and Annex F	CSA B51-14, *Boiler, pressure vessel, and pressure piping code*.	WL‑508140‑QAP‑001, *WL Pressure Boundary Quality Assurance Plan*

Table 11: CSA B51-19, Boiler, pressure vessel, and pressure piping code (Chalk River Laboratories).

Boiler, pressure vessel, and pressure piping code (Chalk River Laboratories)		
Section and Title	**Description**	**Implementing Document(s)**
PART 1 General Requirements for Boilers, Pressure Vessels, and Pressure Piping		
Section 4 to 13, Annex C and Annex F	CSA B51-14, *Boiler, pressure vessel, and pressure piping code*.	CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual* CRL-508140-QAP-002, *Repair or Service of Pressure Relief Valves to ASME Section VIII - Division 1 and CSA B51/B52 at Chalk River Laboratories*

Table 12: CRL-508140-141-000, Authorized Inspection Agency Services Agreement between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.

Authorized Inspection Agency Services Agreement between TSSA and CNL		
Section and Title	**Description**	**Implementing Document(s)**
Schedule A – Scope of Work		
3.5.2	[As it relates to discovered Non-Compliance.] The CUSTOMER will notify the AIA when the Non-Compliance is resolved.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*
3.5.5	When requested, the AIA will review proposed dispositions of deviations to code requirements for acceptability. The AIA shall advise the Customer of its recommendations. The Customer will seek CNSC acceptance of the Non-Compliance taking consideration of AIA recommendations.	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance*
4.0.1	The Customer will: a) Obtain prior approval of CNSC, to modify or cancel this Agreement with the AIA. b) Arrange for AIA inspectors to have access to all areas of the Customer's Facilities and records, and to the facilities and records of the Customer's pressure boundary contractors and material organizations, as necessary for the purpose of performing inspections and other activities required by the applicable codes, standards and regulations. c) Keep the AIA informed of the progress of the pressure boundary work plans and schedules to provide the AIA the necessary time to plan for inspections, verifications, and certifications or any other activities of the AIA as required by the Standards, and shall also provide reasonable advance notice to the AIA when the components and/or facilities will be ready for Inspection, audit or certification. d) Ensure all modifications and new fabrications are inspected by AIA when required by the standards. e) Obtain AIA approval of all non-destructive examination procedures for pressure boundary inspection prior to their use where required by the standards. f) Obtain AIA acceptance and certification of the inspection program and associated procedures for nuclear and conventional boilers and pressure vessels. g) Ensure, when requested by CNSC, the AIA representatives' participation as team members in pre-inspection activities, inspections and visits to verify the	CRL-508140-QAP-001, *CRL Nuclear Pressure Boundary Quality Assurance* CRL-508140-QAP-003, *CRL CSA B51 Pressure Boundary Quality Control Manual*

Authorized Inspection Agency Services Agreement between TSSA and CNL		
Section and Title	**Description**	**Implementing Document(s)**
	effectiveness of the pressure boundary quality assurance programs at the licensee's facility, h) Report pressure boundary Non-Compliances as required for the applicable CNSC licences, i) Where needed, seek a determination from the AIA regarding Non-Compliance to Codes and Standards prior to submission to CNSC for acceptance, j) Keep the AIA Informed when seeking clarifications from CNSC with respect to pressure boundary applications or Interpretations under the Customer’s licences, k) Inform the AIA of changes to the Customer’s Facilities' Licences that may affect this Agreement.	

4. Requirements Applicability

Table 13: Requirements applicability across CNL sites.

	Site								
Requirements	**Chalk River Laboratories**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**Ontario Unlicensed Offices**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Water Storage Facility**	**Gentilly-1 Waste Management Facility**
NRTEOL-LCH-01.00/2028	X								
NRTEDL-LCH-08.00/2024						X			
Canada Labour Code	X	X	X	X	X	X	X	X	X
COHS Regulations	X	X	X	X	X	X	X	X	X
The Steam and Pressure Plants Act						X			
CSA N285.0-08						X			
CSA N285.0-17	X								
ASME BPVC	X								
NQA-1-2015	X								
CSA B51-14						X			
CSA B51-19	X								
CRL-508140-141-000	X								

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment.

Table 14: Assessment activities for CRL-508140-141-000, Authorized Inspection Agency Services Agreement between Technical Standards and Safety Authority and Canadian Nuclear Laboratories Ltd.

Authorized Inspection Agency Services Agreement between TSSA and CNL			
Section and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
Schedule A – Scope of Work			
3.4.1	For all accessible CSA N285.0 Class 1, 2, 3 boilers and pressure vessels the AIA will perform the inspection and issue the certificate of inspection.	Annually	Performed by TSSA
3.4.1	For all other accessible boilers and pressure vessels, the Customer will maintain a separate arrangement with a second inspection agency to perform periodic inspections and issue Record of Inspection. For such boilers and pressure vessels, the AIA will only be required to confirm that they have been inspected and that a valid Record of Inspection has been issued.	Annually	Insurance company's inspectors
3.7.1	a) Currently the Customer has two pressure boundary programs, which require periodic auditing and renewal certification. This includes the following: • Chalk River Laboratories pressure boundary program • Repair/Services of Pressure Relief Valves to ASME Sections I, IV, VIII – Division 1 and CSA B51/B52 at CNL's Chalk River Laboratories	Every three years	Performed by TSSA

Table 15: Assessment activities for ASME Boiler and Pressure Vessel Code.

ASME Boiler and Pressure Vessel Code			
Section and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
Section III - Rules for Construction of Nuclear Facility Components **Subsection NCA - General Requirements for Division 1 and Division 2** **Article NCA-4000 - Quality Assurance Requirements**			
NCA-4134.18 Audits	m) The audit frequency shall be specified in the Certificate Holder’s Quality Assurance Manual. The Certificate Holder’s audit frequency shall be commensurate with his schedule of activities and shall be such that each ongoing Code activity is audited at least once annually.	Annually	Nuclear Oversight Audit

Table 16: Assessment activities for NRTEDL-LCH-0.8.00/2024, Licence Conditions Handbook for Whiteshell Laboratories.

Licence Conditions Handbook for Whiteshell Laboratories			
Section and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
5.2 – Pressure Boundary Program Compliance Verification Criteria	a) … Where indicated by these standards, the licensee shall obtain the following regulatory approvals for this work: (vi) accepted quality assurance programs.	Every 3 years	External ITSM Audit

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

eDoc # 7199364

Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems/Components REV 3.2

WLD-508140-PRO-001

Information Use

Approved by	Title	Date
Jason deRuiter	Pressure Boundary Specialist	2023/12/13

Effective Date: 2024/02/12
Expiry Date: 2028/12/11

Refer to ATOM for current version. Printed copies should not be considered current without first consulting ATOM.

Table of Contents

1. SCOPE

This procedure describes the requirements, responsibilities, and processes for the classification, registration, deviation submission, and reconciliation of pressure-retaining systems and components at the Whiteshell Laboratories (WL) site.

This procedure is applicable to both nuclear and non-nuclear pressure-retaining systems and components. WL Site does not have any Class 1, 1C, 2, 2C and 4 nuclear pressure boundary system as classified in Section 5 of CSA N285.0-17 with Update No.1[1] [1]. Class 3 and 3C are kept under this procedure for future flexibility. WL is not qualified to do any activities on nuclear pressure retaining system/ components per the WL Pressure Boundary Quality Assurance Manual [9].

2. PURPOSE

This procedure describes the processes followed to perform code classifications, design registrations, deviation submissions and reconciliations in compliance with CSA N285.0-17 with Update No.1 [1] and CSA B51-14[2] [2].

3. DEFINITIONS

3.1 Terms

Note: See CSA N285.0 [1], Section 3, for other applicable definitions and abbreviations.

Classification Approval Form (CAF)	A form to record the code class of a system or component, see WL-508140-FM-002, *Whiteshell Laboratories Classification Approval Form.* [3].
Classification States	• ***Exempt From Classification*** – A system and/or section of system that would otherwise be classified as Class 6 may be exempted from classification provided certain conditions are met. The applicable conditions are listed in Section 5.2.4.2.1 of CSA N285.0 [1]. • ***Not Requiring Classification*** – A system or component that does not require classification, as determined by the classification process in Section 6 (by completing WL-508140-FM-001, *Whiteshell Laboratories Code Classification Selection [4]*). • ***Not Classified*** – A system or component that has not been evaluated through the classification process.

[1] CSA N285.0-17 with Update No.1 will henceforth be referred to as CSA N285.0 [1] in this procedure.

[2] CSA B51-14 will henceforth be referred to as CSA B51 [2] in this procedure.

	• ***Classified*** – A system or component that has been evaluated through the classification process.
Classification Submission Package	Package for submission to the CNSC requesting code class approval (see Section 4.1.1).
Code Classification Selection (CCS) Form	A form that provides guidance to determine classification of a system or component.
Consequence of Failure (CoF)	A document which shows the dose that plant personnel and/or the public may receive as a result of failure of the system or component.
Facility Authority	The manager accountable to the Owner through the established line organization for the safe operation, maintenance and use of a facility in compliance with all applicable licences, permits, laws and regulations, policies and procedures.
Legacy Pressure Boundary System	An existing system that was constructed and in operation prior to 1996 January 01, that does not require registration.
Modification	A physical change to the system pressure boundary (excluding repair and replacement) or a change in the system design conditions affecting the pressure boundary (definition from CSA N285.0 [1], Section 14.5.2.1).
Nuclear Facility	As defined in the Nuclear Safety and Control Act (1997, c.9) and associated regulations.
Reconciliation Statement	A form which demonstrates that any difference between the registered design and the as-built system or components or fittings have been appropriately reviewed and reconciled.
Statutory Declaration Form	A form used for the registration of fittings with the ITSM (see Appendix H for a sample form).
System Classification List	A document that identifies all pressure-retaining systems in a facility/plant as well as their respective code classifications (see Section 4.1.3).
ATOM	CNL’s corporate document control and information management system.

3.2 Abbreviations

AI	Authorized Inspector
ASI	AECL Subject Index
CAF	Classification Approval Form
CNL	Canadian Nuclear Laboratories
CCS	Code Classification Selection Form
CNSC	Canadian Nuclear Safety Commission
CoF	Consequences of Failure
CRN	Canadian Registration Number
CSA	Canadian Standards Association
DRS	Design Registration Submission
MLI	Manitoba Labour & Immigration
ITSM	Inspection And Technical Services Manitoba
ML&EC	Manager WL Licensing and Environmental Compliance
NSQ	No Seismic Qualification
SCL	System Classification List
WL	Whiteshell Laboratories
WLE	Whiteshell Laboratories Engineering
WLR	Whiteshell Laboratories Records

4. REQUIREMENTS

4.1 Classification

a) CSA N285.0 [1] documents the various code classifications, describes how to determine the proper code class of a system/component (using Section 5 of CSA N285.0 [1]), and defines when a Consequence of Failure (CoF) is required.
b) Classification is typically performed on a system-by-system basis, which includes all of the components shown on the system flow sheet for the system; however, if required, a component may also be classified separately.
c) Approved classified systems or components being changed to a lower code classification require CNSC approval except when changing from Class 6 to “exempt from classification”.
d) CNSC approval and/or acceptance is not required prior to execution of further work by CNL for systems and components that satisfy the following:
   1) Classified as Class 6,
   2) Exempt from classification, or
   3) Do not require classification.

For all other systems and components, CNSC approval of the classification shall be obtained before registering the design.

4.1.1 Classification Submission Package

Whiteshell Laboratories Code Classification Selection (CCS) form [4] shall be used to select code classification; however, the CCS is not part of the classification submission package. The code classification submission package shall include the following:

- Cover letter to the CNSC (see Appendix E for sample),
- Classification Approval Form CAF [3],
- Consequence of Failure (CoF) statement (if required), and
- Flowsheet and/or component drawing (see Appendix G for a guideline on the information to be included in the drawing).

At WL only systems that contain nuclear substances, adversely impact a safety system or cause unreasonable risk involving nuclear substances require formal submission to the CNSC.

4.1.2 Consequence of Failure (CoF)

The code classification shall be based on Section 5 of CSA N285.0 [1] as well as the CoF statement, as required. The CoF may be directly written under Item 7 on the CAF [3], or it may be prepared as a separate document. In this case the document is to be listed under Item 7 and included in the Classification Submission Package.

4.1.3 System Classification List (SCL)

a) The SCL shall be updated throughout the life of WL site no later than 3 years after a modification has been implemented to comply with clause 7.3.3 of CSA N285.0 [1].
b) All systems, sections of systems, or components that undergo the classification process are entered on the SCL, including items determined to be “exempt from classification”, or “not requiring classification”. CSA N285.0 [1] (Clause 7.3.3) provides the required information for each system.
c) It is expected that there will be one SCL for each Nuclear Facility and one SCL for the rest of the WL site.

4.1.4 Use of an Item with Lower Classification than that Required by Code

CNSC approval is required if an item has a lower classification (For WL Class 3 highest, Class 6 lowest) than that required by the code. Such an approval process may be initiated during the request for classification approval. The justification for lower classification shall be provided on Item 4 of the CAF [3], or in a separate document. For example, such a justification may be based on low consequence of failure, previous operating experience, and/or unavailability of higher class component.

The SCL shall state the required code classification under the “Class” column, unless otherwise instructed by the CNSC.

4.1.5 Classification Exceptions

Systems or components that are not Class 3, 3C or 6 must also be included in the SCL. This includes the following:

a) Some Class 6 systems inside Nuclear Facilities can be "exempt from classification" based on Clause 5.2.4.2.1 of CSA N285.0 [1]. Include the justification for the classification exemption in the system description on the CCS [4], or on a separate page.
b) Systems and components may be deemed "not requiring classification", as determined using the CCS form [4].

4.1.6 Modifications to Classified Systems and Components

If a system or component is modified after the code class approval, a new Classification Submission Package must be approved by the CNSC prior to implementation of the modification if the following applies:

a) The modification changes the existing classification to a less stringent classification (except the change from Class 6 to "exempt from classification" or "not requiring classification").
b) The modification involves penetration of the containment structure or a part of the containment boundary (there are no reactor containment structures on the WL site).

After the new classification has been approved by the CNSC, this information shall be shown in the next revision of the SCL.

4.2 Design Registration

Nuclear systems, components and supports design documents submitted for registration shall be stamped and/or certified by a Professional Engineer as required by CSA N285.0 [1]. Final (or provisional) design registration shall be obtained before component fabrication or system installation has started. Final design registration must be obtained before the pressure test.

4.2.1 Repairs and Replacements for Classified System

Repairs and replacements to registered nuclear systems are carried out in accordance with CSA N285.0 [1] requirements.

Repairs and replacements to classified but unregistered systems (legacy pressure boundary systems) are performed according to the requirements of CSA N285.0 [1] and CSA B51 [2] for the approved classification [9], [10], [11]. Repairs and replacements to these systems do not require registration.

Repairs and replacements to systems exempt from classification and not requiring classification are performed to the requirements of CSA N285.0 [1], CSA B51 [2]and Manitoba Steam and Pressure Plant Act [8].

4.2.2 Design Registration Submission (DRS) Package

When a system is to be registered with the ITSM, a Design Registration Submission package shall be prepared that includes the following documentation:

a) A **Design Registration Submission** document. The document should be assembled using the CNL formal document template and WL-508140-FM-003, Whiteshell Laboratories Design Registration Submission Data Form [5].
b) **Approved CAF** [3] from the CNSC for Class 3, 3C and 6 systems (required before ITSM will begin registration process). Code Classification Selection (CCS) forms [4] are used for “exempt from classification” and “not requiring classification” systems or components.
c) A **cover letter** that clearly identifies the system name and building number, invoicing information, and the requirement to return two sets of stamped drawings and technical notes to the sender. A sample cover letter is included in Appendix C.
d) **Two copies of all drawings**, including reference drawings.
e) **Two copies of other documentation** required by code.
f) A **Statutory Declaration Form** (obtain latest version from ITSM website) notarized by a Commissioner of Oaths shall be included in registration submissions for all fitting designs.
g) **Piping Design Registration Application Form** required by ITSM.

4.2.3 Reconciliation of Design Changes after Construction for Classified Systems

Prior to pressure testing, any differences between the registered design and the as-built system or components must be reviewed and reconciled by WL Engineering and accepted by the Authorized (Nuclear) Inspector. This is achieved by the following:

a) Obtaining Design Engineering approval of all Field Change Requests during installation,
b) Completing one reconciliation statement to cover the scope of all field changes associated with the job and certified by a Professional Engineer for Class 3 and 3C systems/components.
c) Obtaining ITSM and CNSC acceptance of updated design documentation as required (Section 7.7 of CSA N285.0 [1] dictates classification, registration and submission requirements, depending on class of system and nature of differences), and
d) Submitting to the Authorized Inspector (as part of the associated installation route sheet or manufacturing inspection and test plan) the completed reconciliation statement, prior to pressure testing.

One form, WL-508140-FM-004, Whiteshell Laboratories Reconciliation Statement [6], is used to satisfy the requirements of CSA N285.0 [1], Figure H.1. For system modifications controlled by 900-508130-MCP-001, Engineering Change Control [7], an additional field verification activity is conducted by the Engineering and Operations Representatives during the post-construction field walk down.

4.3 Deviations from the Code for Classified System

ITSM and CNSC acceptance is required for all pressure boundary system and/or item designs that do not fully comply with the codes and standards mandated in the nuclear operating site licence. Such “code deviations” may be allowed for items which are not in full compliance with the Manitoba Steam and Pressure Plant Act [8] on a case-by-case basis.

Deviations apply to pressure boundary items that are registered, or registerable, with ITSM. The deviation shall not detrimentally affect the safe use of the system/component or the health or safety of any person. They are typically encountered for using a non-registered component in a registered system, or using a special system arrangement that is not permitted in CSA B51 [2] for a defined period of time. Code deviation requests may also be submitted for use of commercial grade items in pressure boundary systems.

4.3.1 Code Deviation Application

All deviations from the requirements of the applicable Codes and Standards shall be submitted by the Design Representative to the Provincial Regulator (ITSM) for acceptance. The code deviation application shall include the following:

a) Complete description of the item or process involved, including installation instructions,
b) Full description of the circumstances and reasons that require the deviation,
c) Assessment of every safety risk associated with the deviation, based on safety engineering principles and recognized industry standards,
d) Description of the measures that are proposed to make the installation equivalent in safety to the level of safety intended by the requirements in the regulation, standard, or code,
e) Signature of the applicant (the qualified individual, for example a Professional Engineer, who is knowledgeable in the design aspects and specifics of the installation.

On receiving ITSM acceptance, one copy of all related correspondence shall be forwarded to WL Records for filing in the appropriate Registration file.

4.3.2 Code Deviation Submission to CNSC (Classified Systems Only)

Once the ITSM has accepted the code deviation, CNSC acceptance is required prior to installation. The CNSC submission includes evidence of the ITSM acceptance of the deviation (e.g., letter from the ITSM as well as relevant drawing) and a cover letter addressed to the CNSC Project Officer responsible for Whiteshell Laboratories that satisfies the following:

a) Includes design job number, preparer’s contact information,
b) Copies to WL Records for filing and tracking.
c) Appendix J includes a sample letter to the CNSC that may be adapted for this application.

4.4 Code Effective Date

The design of new and modifications to existing pressure-retaining systems and components shall meet the requirements of CSA N285.0 [1], which is interpreted as the following:

a) Repairs and replacements to existing pressure-retaining systems and components shall meet the requirements of the latest applicable codes and standards unless there is a reason to maintain a code effective date for that system (allowances are further defined in CSA N285.0 [1], Section 4).
b) The design, fabrication and installation of new systems shall be to the editions of standards listed in CSA N285.0 [1].

Decision/reason for maintaining the code effective date for repairs and replacements shall be approved by the WL Engineering Manager and filed in the design job file.

Design of pressure-retaining systems and components issued for construction (release for construction drawings) require a reconciliation statement at the end of construction if the work is not started prior to next code revision or addenda that comes into effect to disposition the design code change.

The design of new and modifications to existing pressure-retaining systems and components issued for construction (release for construction drawings) require a new design review if the work is not started within 5 years of the approval date on the drawing.

5. RESPONSIBILITIES

5.1 WL Engineering Manager

The WL Engineering Manager is responsible for the following:

- Ensuring this procedure is approved in accordance with CNL’s quality program requirements
- Ensuring any required acceptances are obtained from the CNSC prior to releasing the procedure for use.
- Approving code effective date exceptions, as defined in Section 4.4.
- Reviewing/approving design documentation as required by this procedure.

The Manager, WL Engineering, may also fill the role of “Facility Authority” within the scope of this procedure (e.g., approving code variances as plant owner’s designee).

5.2 WLE Professional Engineer

The WLE Professional Engineer is responsible for the following:

- Reviewing/approving/stamping design documentation as required by this procedure.

5.3 Designer/Engineer/Preparer

The Design Engineering Staff, or designated preparer, is responsible for the following:

- Compiling the necessary design documentation and correspondence in accordance with this procedure and applicable codes and standards.
- Obtaining applicable internal and external reviews, approvals and acceptances.
- Updating the necessary design documentation as required at the end of the design job.
- Arranging for the SCL revision.

5.4 Facility Authority

- The Facility Authority for a nuclear facility is responsible for reviewing and approving documentation and correspondence as required by this procedure.

5.5 Safety and Licensing Operations Specialist

The designated individual is responsible for the following:

- Preparing the Consequence of Failure, including obtaining the associated reviews.

5.6 WL Records

WL records office along with WL Doc Control is responsible for assigning file numbers for ITSM correspondence as well as tracking and filing ITSM documentation required by this procedure.

5.7 WL Licensing Coordinator

The WL Licensing Coordinator along with Manager WL Licensing and End State are responsible for ensuring that CNSC correspondence required by this procedure is numbered, formatted, released and tracked, in accordance with applicable procedures and bulletins from Regulatory Affairs.

6. PROCESS

6.1 Classification

This section provides the instructions for activities pertaining to system classification. Refer to Section 4.1 for the associated documentation requirements.

Designer/Engineer/ Preparer

1. If classification is required, obtain a CCS [4] number from Document Control and identify any items that are likely "*exempt from classification*" or "*not requiring classification*".
2. Locate or prepare/update the system flowsheet and component drawings (see Appendix G for drawing information requirements).
3. As required, make a request to Safety and Licensing Operations Specialist to prepare a Consequence of Failure statement (not required for Class 1 systems) or other supporting safety/licensing information.

Safety & Licensing Operations Specialist	4. When asked, prepare Consequence of Failure (CoF) or other supporting safety/licensing information. The CoF is to be reviewed by the Facility Authority for the Nuclear Facility. 5. Send approved CoF to Designer/Engineer/Preparer.
Designer/Engineer/ Preparer	6. For systems, sections of systems, or components that are Class 3, 3C or 6 prepare the CAF [3] (see Appendix D). 7. Forward the CAF [3] and/or CCS [4] and the system flowsheet (or component drawings) to the WL Engineering Manager for review.
WL Engineering. Manager	8. Review and approve the CCS [4], and CAF [3] when applicable (see Appendix D for CAF [3] instructions).
Designer/Engineer/ Preparer	9. Implement any required actions including updating documentation when specific corrections, follow-up actions, or changes are required as a result of the review and comment process. 10. Obtain the “originator’s” written approval on the CAF [3] (see Appendix D for CAF [3] instructions). The originator’s name shall be Facility Authority for a Nuclear Facility or just the WL Engineering Manager for WL Site (or when no Facility Authority exists). 11. Ensure the CCS [4] and associated documentation is filed in ATOM. 12. For systems, sections of systems, and/or components that are Class 3 or 3C, prepare a classification submission package and cover letter and obtain necessary internal approvals in accordance with Section 4.1.1. 13. Provide the classification submission package to the Manager, Licensing, and End State for submission to the CNSC (see Section 6.5). 14. Upon receiving CNSC’s acceptance, ensure the Classification Submission Package and the CNSC-accepted CAF [3] are filed in ATOM. 15. In discussion with the WL Engineering Manager, arrange for the System Classification List (SCL) to be revised.

6.1.1 Modifications to Classified Systems or Components

If a modification to an existing system changes the approved code classification, as described in Section 4.1.6, then a new Classification Submission Package is required (follow instructions in Section 6.1).

6.2 Registration

Designer/Engineer/ Preparer

1. Determine whether the new system/component or modification to an existing system/component requires registration, using Appendix A as a guideline.

   Appendix B *provides principles for legacy pressure boundary systems that require registration of modifications*.

2. If registration is required, complete the steps in Section 6.2.1.

6.2.1 Design Registration Submission Package Preparation

Designer/Engineer/ Preparer

Section 4.2.2 defines the content requirements for DRS packages.

3. If a Design Registration Submission (DRS) for the item already exists, update the last DRS issued (if more than one DRS exists for an item, choose one DRS number).
4. If no DRS exists, obtain a new DRS number from Document Control
5. Obtain peer review of the complete DRS package, which includes the DRS document, design documents/drawings, reference/supporting drawings and documents, CAF/CCS, and the cover letter.

WL Engineering. Branch Manager

6. Review the DRS package and when satisfied, approve the DRS document.

Designer/Engineer/ Preparer

7. Deliver the registration package to WL Records (see Section 6.5) for submission to the ITSM and subsequent tracking.

6.2.2 Return and Distribution of ITSM Stamped Drawings and Documents

Designer/Engineer/ Preparer

8. On receipt of approved documents from the ITSM, revise drawing CRN block to include the CRN obtained from ITSM before uploading into VAULT.

6.3 Reconciliations

Designer/Engineer/ Preparer	9. Complete the appropriate form to be used for the reconciliation, as per Section 4.2.3. 10. Submit completed form to WL Engineering Professional Engineer for review and approval.
WLE Professional Engineer	11. Review and approve the reconciliation form.
Designer/Engineer/ Preparer	12. Submit approved reconciliation form to ITSM, following the instructions in Section 6.5 for corresponding with the ITSM.

6.3.1 Replacements and Repairs

See Section 4.2.1 for requirements pertaining to registration of repairs and replacements.

6.4 Code Deviation

See Section 4.3.1 for requirements pertaining to application for deviation approval.

Designer/Engineer/ Preparer	13. Prepare application for the ITSM requesting approval for the deviation. 14. Prepare additional information, as described in Section 4.3.1.
Designer/Engineer/ Preparer	15. Submit application for deviation package to WL Engineering Professional Engineer for review and signature. 16. Complete any necessary testing with the AI present to formally witness the test.
WLE Professional Engineer	17. Review and sign application for deviation package and supporting documentation, as described in Section 4.3.1.
Designer/Engineer/ Preparer	18. Submit application for the deviation to ITSM as per instructions for Design Registration Submission (Section 6.2.1).
Designer/Engineer/ Preparer	19. Upon receiving ITSM acceptance, prepare CNSC submission package, with the contents defined in Section 4.3.2. 20. Submit package to Manager, Licensing, and End State for transmittal to CNSC for acceptance as per Section 6.5.1.
CNSC	21. Review and accept/reject the deviation.
Designer/Engineer/ Preparer	22. Confirm responses are filed in ATOM.

Note: Any deviation implemented shall be reported to CNSC within 60 days of its installation.

6.5 Correspondence

6.5.1 CNSC Correspondence

The ML&EC coordinates with the Preparer and WL Engineering Manager to submit correspondence packages to the CNSC.

Designer/Engineer/ Preparer	23. Provide package, draft cover letter and Design job file number to the Manager, Licensing, and End State.
WL Licensing Coordinator	24. Obtain a correspondence file number from ATOM. Ensure that the letter is in the proper template and that the appropriate CNSC and CNL people are copied on the correspondence.
	25. Consult with Regulatory Affairs to have the letter and package reviewed prior to submission to the CNSC.
	26. Send the letter and package to the CNSC, file the correspondence in ATOM and forward copies to the Preparer.
	27. Arrange to associate the letter and package with the Design job file number in ATOM.
Designer/Engineer/ Preparer	Upon receiving the CNSC's response, provide the original copy to Manager, Licensing, and End State for filing in ATOM.

6.5.2 ITSM Correspondence

Designer/Engineer/ Preparer	28. Provide Design Registration Submission package to WL Records.
WL Records	29. Submit the complete registration package to the ITSM and maintain log of submitted and returned packages.
	30. Upon receipt of the returned registered package (should be one copy of the stamped drawings/documents), file the package in ATOM, associated with the Design job file number.
	31. Distribute as per the list provided by the Preparer, and mail one hard copy to the customer or the designated customer representative.
Designer/Engineer/ Preparer	32. If the documents/drawings are returned to the Designer/Engineer instead of WL Records, bring the documents/drawings to WL Records for initial processing.

7. REFERENCES

[1] *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*, CSA N285.0-17 Update No.1, CSA GROUP, December 2018.

[2] *Boiler, Pressure Vessel, and Pressure Piping Code*, CSA B51:14, CSA GROUP, 2017-07-12.

[3] *Classification Approval Form,* CRL-508140-FM-007, 53768330.

[4] *Whiteshell Laboratories Code Classification Selection*, WL-508140-FM-001, 53855110.

[5] *Whiteshell Laboratories Design Registration Submission Data Form*, WL-508140-FM-003, 54899814.

[6] *Whiteshell Laboratories Reconciliation Statement*, WL-508140-FM-004, 54900040.

[7] *Engineering Change Control,* 900-508130-MCP-001, 54327963.

[8] *Manitoba Steam and Pressure Plant Act*, Revised Statutes of Manitoba, C.C.S.M. c. S210 March 1987, Manitoba Gazette, Manitoba, Canada.

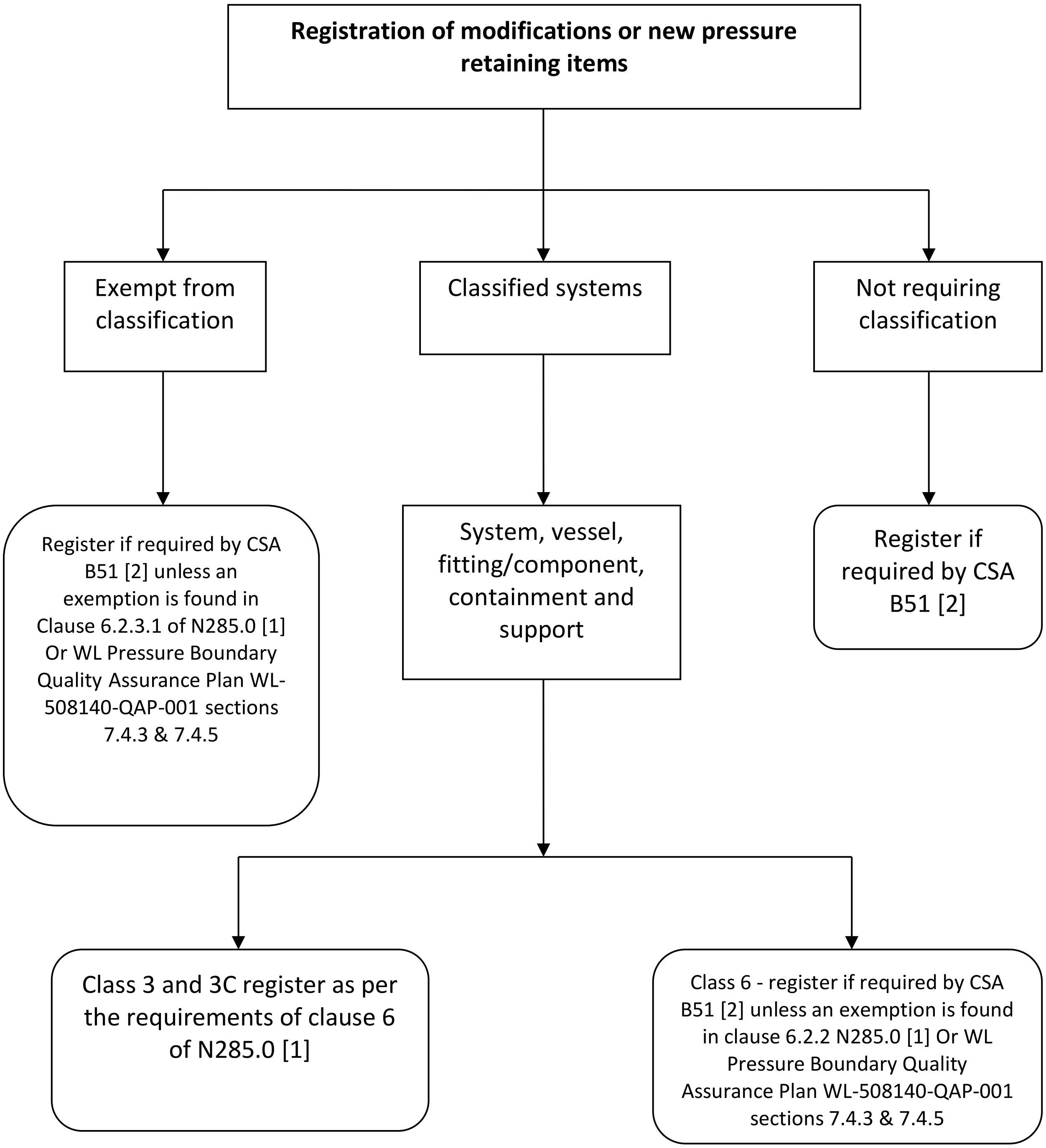
[9] *WL Pressure Boundary Quality Assurance Plan*, WL-508140-QAP-001, 55257059.

[10] *Licensing Package Documents,* WL-00521-LP-001, 16697206.

[11] WL Pressure Vessel and System Compliance document, TN-49W82-2, 16520268.

[12] *WL Legacy Pressure Boundary System List*, WL-508120-016-000-0001, 16819845.

Appendix A Registration Guidelines



Appendix B Legacy Pressure Boundary System Registration Principles

Definition:

Refers to piping systems constructed and operating prior to 1996 January 1 that do not require registration per agreement with the Provincial Regulator for CSA B51 (Manitoba Department of Labour), approved 1995 December 15. WL Legacy Pressure Boundary System List, WL-508120-016-000-0001 [12] contains the list of Legacy pressure boundary system. General Principles:

- Only modifications are registered per QAP requirements [9]
- The design registration of the modification must satisfy its classification.
  - The modification is classified as per Section 6.1.
- An analysis of the modification includes as much of the existing system as required to enable analysis of the modification.
- If a modification to a system does not require registration as per N285.0 [1]/CSA B51 [2]/ Manitoba Steam and Pressure Plant Act [8] then the modification to a legacy pressure boundary system would not require registration.

Appendix C ITSM Design Registration Submission Sample Cover Letter

Year, Month, Day   Ref. REA-XXXXX

XXXXXXXXXX
Inspection & Technical Services
508-401 York Avenue
Winnipeg, Manitoba
R3C 0P8
Email: TechnicalServices@gov.mb.ca

Dear XXXXX:

DESIGN REGISTRATION SUBMISSION Collection ID#-ASI#-DRS-XXX Rev X
Insert Title/System Name

Please find enclosed two (2) copies of the above referenced Design Registration Submission document. This system, [purpose of issue/background for issue]. The following documents are enclosed:

[Document No and Rev No]   [Document Title]

Following ITSM acceptance of the submission, please return two (2) approved drawing to WL Records (CNL). All DRS documents should be stamped as they are our official registration records subject to quality control.

For additional information or clarification, please contact the undersigned at (204)753-2311, Ext. 6XXXX or by e-mail at XXXX@CNL.ca.

Yours sincerely,

WL Design Engineer

Whiteshell Engineering
Whiteshell Laboratories,
Pinawa, Manitoba
R0E 1L0
Encl.

Appendix D Classification Approval Form (CAF) Instructions

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

CLASSIFICATION APPROVAL FORM

Page 1 of 2

CRL-508140-FM-007 REV 0

Reference: CRL-508140-PRO-002

File No.:

Reference Number:

		CAF	
Doc. Collection ID	Subject Index	Doc. Code	Serial No.

SECTION A – DESCRIPTION

1. Project/Province
2. Owner Designer
3. Identification of System or Component for which Classification Approval is sought

   System Name

   Component

   Classification Index No. (eg, USI)

   Drawing No. (General Assembly or Flowsheet)

   Code Cases
4. Proposed Design Classification
5. To be included in a periodic Inspection Program? Yes ☐ No ☐
6. Purpose and description of System or Component
7. Consequences of failure (only for other than N285.0 Class 1 categories)

SECTION B – SIGN OFFS AND APPROVALS

Note: Responses to Items 6 and 7 may be supplemented by attaching or referencing additional documentation

8. Prepared By: NAME SIGNATURE DATE
9. Reviewed By: NAME SIGNATURE DATE
10. Approved By: NAME SIGNATURE DATE

Appendix E CNSC Classification Submission Sample Letter

Year, Month, Day File #:

Name of CNSC Project Officer for Whiteshell Laboratories
Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
OTTAWA, Ontario K1P 5S9

Dear *Name of CNSC Project Officer for Whiteshell Laboratories*

CLASSIFICATION APPROVAL: (Add name of Facility and Building Number or equivalent description of subject item or system)

Please find enclosed, for the consideration of CNSC staff, a Classification Submission Package relating to the above noted system.

Following CNSC staff acceptance of the submitted package, please return the submitted classification approval form with signature block completed, as appropriate. For additional information or clarification with respect to this application, please call the undersigned at (204)753-2311, Ext. 6XXXX or contact by e-mail at XXXX@CNL.ca.

Yours sincerely,

XXXX XXXX
WL Design Engineer
Whiteshell Engineering
Whiteshell Laboratories,
Pinawa, Manitoba
R0E 1L0

cc:

(Follow most recent bulletin from Regulatory Affairs)

Appendix F System Classification List Information

Item	Action
Title	Enter the name of the system from the CAF.
Drawing Number	Enter the flow sheet/drawing number from the CAF.
Pressure (MPa(g))	Enter operating and design pressure in MPa(g) from the flow sheet.
Temperature (C)	Enter operating and design temperature in C from the flow sheet.
Working Fluid	Enter the fluid in the system from the flow sheet.
Class	Enter the CNSC approved code class from the CAF, or enter "*exempt from classification*", or "*not requiring classification*".
Reference	Enter the CoF number from the CAF.
Code Effective Date	Enter the design code and code effective date from the flow sheet.
CRN	Enter the Canadian Registration Number received from ITSM.
Seismic Qualification	Enter level and category from the flow sheet if seismic qualification is required; otherwise enter "no seismic qualification" (NSQ).
CNSC Acceptance	Enter the date of CNSC acceptance.

Appendix G System Flowsheet and Component Drawings

As per clause 7.3.2 of CSA N285.0 [1], the system Flowsheet shall show the schematic arrangement of all pressure-retaining components in the system and shall contain the information listed below or reference the document where the information is to be found:

a) Design and operating pressure and temperatures;
b) System fluids;
c) System boundaries and, when more than one classification is specified, section boundaries;
d) The containment boundary and containment penetrations;
e) The seismic category and level boundaries;
f) Settings of overpressure protection devices;
g) The effective date or issue of applicable codes and standards for the design of the system;
h) The test temperature and test pressure; and
i) Specifications for pressure-retaining piping materials.

Appendix H Example of Statutory Declaration Form, From CSA B51

STATUTORY DECLARATION
Registration of Fittings
Single or Multiple Fitting Designs within One Fitting Category
DÉCLARATION STATUTAIRE
Enregistrement d'accessoires
Conception unique ou multiple d'accessoires à l'intérieur d'une catégorie d'accessoires

(Show facsimile of logo or trademark, as it will appear on the fitting.)

(Apposer ici une reproduction du logo ou de sa marque de commerce tel qu'il figurera sur l'accessoire.)

I/Je, ______________________________
(Name & Position, e.g., President, Plant Manager, Chief Engineer/*Nom et position, ex: président, directeur d'usine, ingénieur en chef*)

of/de______________________________ located /*situé*
(Name of Manufacturer/*Nom du constructeur*)

at/à ______________________________
(Plant Address/*Adresse de l'usine*) (Telephone # /*numéro de téléphone*) (Email or Fax # /*courriel ou télécopieur*)

do solemnly declare for the fittings listed hereunder have dimensions, construction materials, pressure/temperature ratings, and identification markings that are in accordance with the herein named standards, as supported by the attached information.
déclare solennellement que les accessoires cités ci-dessous ont les dimensions, les matériaux, les pression/température de conception et le marquage conformes avec les codes mentionnés ci-dessous, tel que cité au présent document.

☐ comply with the requirements of ______________________________ , which specifies the dimensions,
(Title of recognized North American Standard)
construction materials, pressure/temperature ratings, and identification markings of the fittings.

conforme aux exigences du ______________________________ *, qui précise leurs dimensions,*
(Titre de la norme nord-américaine reconnue)
matériaux de fabrication, pression/température de conception et marquages des accessoires.

☐ are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with ______________________________ , as supported by the attached
(insert title of regulation, code , guideline, or other applicable document)
information, which specifies the dimensions, construction materials, pressure/temperature ratings (and the

basis for such ratings), and identification markings of the fittings

ne sont pas visés par une norme nord-américaine reconnue, mais conçus conformément à la ______________________________ *tel que le démontré par les*
(insérer le titre de la réglementation, du code, du guide ou autre document pertinent)
documents ci-joints qui précisent leurs dimensions, matériaux de fabrication, pression/température de conception (et les bases de ces valeurs) et marquages des accessoires.

I further declare that the manufacturing of these fittings is subject to a quality program that has been verified as described in the below Table as being suitable for the manufacturing of these fittings to the stated standard, regulation, code, guideline or other applicable document. The fittings covered by the declaration for which I seek registration are as provided in the Supplementary Sheet(s) attached.

De plus je déclare que la fabrication de ces accessoires est soumise à un programme qualité qui a été vérifié tel que décrit dans la table ci-dessous et reconnu conforme pour la fabrication de ces accessoires tel que stipulé dans les standard(s), réglementation(s), code(s) , guide(s) et autre documents applicables. Les accessoires couverts par cette déclaration pour laquelle je demande l'enregistrement sont tels que décrits sur le(s) page(s) ci-jointe(s).

Quality Program Verification and Manufacturing Sites /
Vérification des Programmes Qualité des lieux de fabrication

A copy of the Quality Certificate from each manufacturing site must be included
Une copie du certificat qualité pour chaque adresse de fabrication doit être incluse.

Item # / # d'item	Product Description, Model or Series / *Description du produit, modèle ou série*	Quality Program / *Programme qualité*	Scope of Certification / *Portée de la certification*	Expiry Date / *Date d'expiration*	Verifying Organization / *Organisme d'accréditation*	Location(s) Plant name and address / *Site(s) Nom de l'usine et adresse*
1.						
2.						

In support of this application, the following information, calculations, and/or test data are attached:
Pour supporter cette demande, les renseignements, calculs et/ou rapports d'essais suivants sont joints:

____

______________________________ (Signature of Declarer / *Signature du demandeur*)
______________________________ (Date)

Declared before me at / *J'atteste que cette déclaration a été signée devant moi* ____________________ in the / *à* ____________________ of / *de* ____________________

this / *le* ______________________ day of / *jour de* ____________________ (Month/*Mois*), ____________________ (Year/*Année*).

Name (please print) / *Nom (caractères d'imprimerie)* ______________________________

Signature ______________________________

Commissioner of Oaths in and for / *Commissaire à l'assermentation à et pour* ______________________ My commission expires on / *Ma commission expire le* ____________________

For regulatory authority use only / *Réservé à l'organisme de réglementation*

To the best of my knowledge and belief, this application meets the requirements of the Act and CSA Standard B51, Part 1, Clause 4.2, and is accepted for registration in Category ____________.

Au meilleur de ma connaissance et de mes croyances, cette demande satisfait aux exigences de la réglementation et du CSA B51, Partie 1, article 4.2, et est acceptée pour l'enregistrement dans la catégorie ____________.

CRN / NEC: ______________________________

Date registered / *Date d'enregistrement* ____________________ Expiry Date / *Date d'expiration* ____________________

Signature ______________________________

(For the Chief Inspector of ______________________)
(*Pour l'autorité réglementaire de* ______________________)

(Registration Stamp)
(*Sceau d'enregistrement*)

Appendix I CNSC Deviation Application Sample Letter

Year, Month, Day File #:

Name of CNSC Project Officer for Whiteshell Laboratories
Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
OTTAWA, Ontario K1P 5S9

Dear *Name of CNSC Project Officer for Whiteshell Laboratories*:

DEVIATION APPROVAL:
(CNL Design Job# xxxxx)

We submit the following deviation application and supporting information that has received approval by the Authorized Inspection Agency for your acceptance.

When satisfied with the application, please provide an acceptance letter for the deviation request. For additional information or clarification, please contact the undersigned, at (204)753-2311, Ext. 6XXXX or by e-mail at XXXX@CNL.ca.

Yours sincerely,

XXXX XXXX
WL Design Engineer
Whiteshell Engineering

Whiteshell Laboratories,
Pinawa, Manitoba
R0E 1L0

cc:

Appendix J Sample Letter to CNSC for Implementation of Non-Conformance or Deviation

Year, Month, Day File #:

Name of CNSC Project Officer for Whiteshell Laboratories
Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
OTTAWA, Ontario K1P 5S9

Dear *Name of CNSC Project Officer for WhiteshellLaboratories*:

Implementation Notice of Non-conformance or Deviation:
(CNL Design Job# xxxxx)

The following is notification of the non-conformance or deviation implementation, which occurred within the last 60 days.

For additional information or clarification, please contact the undersigned, at (204)753-2311 Ext. 6XXXX or by e-mail at XXXX@CNL.ca.

Yours sincerely,

XXXX XXXX
WL Design Engineer

Whiteshell Engineering
Whiteshell Laboratories,
Pinawa, Manitoba
R0E 1L0

cc:

Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
D1	2012/12/21	Issued for review and comment. This document was prepared by a contractor (D. W. Patterson) under the guidance of Biji Jose.	B. Jose	B. Orbanski A. Caron Z. Melnyk P. Henschell D. Lemire C. Van Drunen R. McCamis	
0		Issued as "Approved for Use"	B. Jose	P. Henschell	A. Caron (Accepted by) C. Van Drunen
1	2015/03/23	Issued as "Approved for Use" Minor updates: Updated document to new CNL template Updated document to include comments from CNSC letter (E-doc: 444004, File no: 37-20-15-0) Minor changes Appendix B and Section 5.1	K. Malek	J. Betteridge	A. Caron (Accepted by) K. Lundie
2	2015/12/15	Issued as "Approved for Use" Minor Updates: Four new Whiteshell form added WL-508140-FM-001, Whiteshell Laboratories Code Classification Selection. WL-508140-FM-002, Whiteshell Laboratories Classification Approval Form. WL-508140-FM-003, Whiteshell Laboratories Design Registration Submission Data Form. WL-508140-FM-004, *Whiteshell Laboratories Reconciliation Statement* Appendix D updated with the new form 4.1(d) added and/or acceptance for clarity Minor modification to section 4.2.1 for clarification Added reference "g" in section 4.2.2 Updated 4.3 title for clarification Merged 5.7 & 5.8 (WL Licensing Coordinator) as the duties are similar	K. Malek	L. Wojciechowski B. Orbanski	A. Caron (Accepted by) K. Lundie

		Updated 6.5.1 to reflect changes in 5.8 Updated Appendix B for clarification regarding registration Updated Job title throughout Changed throughout from ITSM approval to ITSM acceptance to align with provincial requirements			
3	2018/01/16	Issued as “Approved for Use” Minor Revisions: Changed security identifier from AECL – OFFICIAL USE ONLY to OFFICIAL USE ONLY. Refrence 7 - Updated with new procedure number. Updated Appendix D with new CNL form. Removed CNSC staff appoval requirement prior to release of this document for use.	K. Malek	M.Enns L. Wojciechowski	S. Parrott
3.1	2023/10/03	Issued as “Approved for Use”. “Review and Comment” not required. Minor Revisions: Updated CSA N285.0 for code effective.	M. Agnelli	B. Jose	J. deRuiter
3.2	2023/12/06	Issued as “Approved for Use”. Review and Comment not required. Minor Revision: Revised to specify CSA N285.0-17 with Update No.1, instead of simply N285.0-17, to address CNSC comment (REG-23-6602).	M. Agnelli	B. Jose	J. deRuiter

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Manitoba
Inspection & Technical Services
Certificate of Authority
Q.A.# : MB-21-014
Signature: Peter Petik
Approval Date: Aug 10, 2021
Expiry Date: August 10, 2024

QUALITY PLAN

WL PRESSURE BOUNDARY QUALITY ASSURANCE PLAN.

WHITESHELL SITE DOCUMENTATION. PINAWA, MANITOBA, R0E 1L0

WL-508140-QAP-001

Revision 0

Prepared by: 2021/08/05
Jose Biji, Mechanical Engineer — Date

Reviewed by: 2021/08/05
Mike Enns, Acting Manager, WL Engineering — Date

Approved by: 2021/08/05
Allan Caron, Director, WL ESH&Q — Date

Accepted by: 2021/08/05
Jason DeRuiter, Pressure Boundary Functional Support Manager — Date

Type te

Accepted by: 2021/08/05
Peter Petik, Authorized Inspector, OFC ITS — Date

Effective date: 2021/08/11

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

REVISION HISTORY

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
0	2021/02/11	Issued as "Approved for Use".	B. Jose	M. Enns	A. Caron J. DeRuiter P. Petik
D1	2021/02/02	Issued for "Review and Comment" Minor changes include: • Cancels and Supersedes WL-508140-QAM-001 • Section 2 Authority and Responsibilty revised to capture organizational changes and changes in responsibilities • Section 7.4.5.1.2 Fitting Exceptions revised and icluded new exceptions for ITS bullettin OFC ITSM 18-001 • Deleted item #4 under section 18.4 on inspection of pressure retaining components for the RD14M Facility.	B. Jose	K. Chrusch M. Enns K. Malek J. DeRuiter L. Wojciechowski K. Alarie	

DETAILED REVISION TABLE

Section	Title	Rev#	Date
	Document Cover Page and Document Approval Signature Page	0	August 03, 2021
	Revision History	0	August 03, 2021
i	Detailed Revision Table	0	August 03, 2021
Ii	Management Commitment and Certification	0	August 03, 2021
iii to viii	Table of Contents	0	August 03, 2021
1	Manual Scope	0	August 03, 2021
2	Authority & Responsibility	0	August 03, 2021
3	Organization	0	August 03, 2021
4	Abbreviations, Definitions and References	0	August 03, 2021
5	Manual Revision and Control	0	August 03, 2021
6	Drawings, Design Calculations & Specification Control	0	August 03, 2021
7	Design Registration	0	August 03, 2021
8	Material Control	0	August 03, 2021
9	Examination & Inspection Program	0	August 03, 2021
10	Correction of Non-conformances	0	August 03, 2021
11	Alteration and Repair	0	August 03, 2021
12	Welding/Brazing Control	0	August 03, 2021
13	Nondestructive Examination	0	August 03, 2021
14	Heat Treatment	0	August 03, 2021
15	Calibration of Measuring and Test Equipment	0	August 03, 2021
16	Records Retention	0	August 03, 2021
17	Control of Pressure Relief Valves	0	August 03, 2021
18	Regulatory Authority	0	August 03, 2021
19	Sample Forms	0	August 03, 2021

Accepted By: ______________________

Date: 2021/08/05

Jason deRuiter, CNL Pressure Boundary Authority Designate

Accepted By: ______________________

Date: August 10, 2021

Authorized Inspector -Inspection & Technical Services.

STATEMENT OF POLICY AND AUTHORITY

The provisions of this document, and the management system enabling documents specified herein, are mandatory and are implemented for pressure boundary activities in the facilities at the Whiteshell Laboratories (WL) site, as defined in Section 1 scope. The management and personnel of WL are committed to implementing and maintaining this Quality Assurance (QA) Program and associated procedures in the facilities.

This document describes the WL Quality Control Program for the manufacture, design, construction, examination, installation, repair, alteration/modification, replacement, and inspection of pressure retaining components (boilers, pressure vessels, fittings, and piping systems) as detailed in the scope herein. All repairs or alterations carried out by WL shall meet the requirements of the National Board Inspection Code, CSA B51, CSA B52, ASME BPV codes, sec I/Sec IV/Sec VIII, ASME B31.1/31.3/31.9 piping standards and Inspection & Technical Services (ITS) as applicable.

The Program described in this document, is supplementary to 900-514200-PDD-001, Quality Assurance and structured as per Appendix 10 of The American Society of Mechanical Engineers (ASME) Section VIII, Division 1.

Any disagreement in the implementation of this written document shall be referred for resolution to the higher authority (as applicable) as identified below, without negating Canadian Standards Association (CSA) B51, CSA B52, Applicable ASME Codes , NBIC, The Manitoba Steam and Pressure Plants Act, Chapter S210 and this Manual's requirements.

TITLE	NAME	SIGNATURE	DATE
WL Closure Project General Manager Deputy GM	John Gilbert		2021-08-05
WL Design Authority & Director, WL ESH&Q	Allan Caron		2021-08-05
WL Pressure Boundary Manager & Acting Manager, WL Engineering	Mike Enns		2021-08-05
Pressure Boundary Functional Support Manager	Jason DeRuiter		2021-08-05

TABLE OF CONTENTS

SECTION **PAGE**

1. QUALITY CONTROL PROGRAM SCOPE

This Quality Assurance Plan (QAP) document describes the Quality Control Program at Whiteshell Laboratories (WL), Pinawa for the manufacture, design, construction, examination, installation, repair, alteration/modification, replacement in the shop and field, and inspection of boilers, pressure vessels, and piping systems that must meet requirements of Statutes and Regulations of the Province of Manitoba. Applicable codes for this quality control programs are

- CSA Standard B51 - Boiler, Pressure Vessel and Pressure Piping Code
- CSA Standard B52 - Mechanical Refrigeration Code
- ASME Boiler and Pressure Vessel Code - Section I, Section IV, and Section VIII
- ASME B31.1 - Power Piping
- ASME B31.3 - Process Piping
- ASME B31.9 - Building Services Piping
- The Manitoba Steam and Pressure Plants Act, Chapter S210
- National Board Inspection Code –NBIC

This QAP is prepared as per the requirements of ASME BPVC VIII DIV 1, mandatory appendix 10, Quality control system. A cross reference table is included in Appendix A of this QAP outlines how this document meets the requirement of ASME BPVC VIII DIV 1, mandatory appendix 10.

This Quality Control Program does not cover any activities on Class 1, 1C, 2, 2C, 3, 3C, and 4 nuclear pressure retaining systems or components as classified in CSA N285.

For systems that are exempt from registration the Engineer of Record shall determine the applicable requirements from this manual that shall be applied to the work.

2. AUTHORITY AND RESPONSIBILITY

2.1 Scope

This section is applicable to employees at WL involved in this CSA B51 Quality Control Program.

2.2 Purpose

The purpose of this Section is to define the authority and responsibility of personnel involved in this Quality Control Program.

2.3 Authority

1. The overall responsibility for development and implementation of the Pressure Boundary Program and this QAP is with the Canadian Nuclear Laboratories (CNL) Pressure Boundary Functional Support Manager. He/she has the authority and is provided with the organizational freedom to ensure that all activities covered under the scope of this manual carried out by WL shall meet the requirements of the Provincial Regulatory Authority as applicable.
2. The WL Pressure Boundary Manager (WL Engineering Manager), as delegated by the Pressure Boundary Functional Support Manager, has the authority to enforce the requirements of this Quality Program.

3. The WL Pressure Boundary Subject Matter Expert (SME) is delegated to act on behalf of the WL Pressure Boundary Manager and has the authority to enforce the implementation of the requirements of the Quality Control Program described in this Quality Control Manual, Design and Construction of Pressure Retaining Components and Systems to CSA Standard B51. The WL Pressure Boundary SME has the authority to stop work on, or the operation of, any pressure retaining vessel, component, or system not in compliance with the requirements of the Quality Control Program or with the applicable Code and/or Regulatory requirements.
4. The Quality Control Representative (QCR) has the authority and organizational freedom to stop work not in compliance with requirements of this Quality Program.

2.4 Responsibilities

It is the responsibility of all WL employees to comply with the requirements, policies, and procedures contained and referenced in this Manual.

2.4.1 WL Engineering Branch

The WL Engineering Branch is responsible for the design, alteration and repair of pressurized components and systems to meet the applicable codes and provincial regulations.

2.4.2 WL Work Control Department

The WL Work Control Department is responsible for the fabrication, construction, maintenance and testing of pressurized components and systems in accordance with applicable codes and provincial regulations.

2.4.3 Customer Representatives

The Customer Representative is the interface within or between WL and an off-site organization. The Design Representative, QCR, Purchasing Agent or Requisitioner can all function as the Customer Representative.

2.4.4 Design Representatives

Personnel from WL Engineering or designates are responsible for the performance of the duties of the "Design Representative" in this Quality Control Program. The Design Representative reports to the WL Engineering Manager.

2.4.5 WL Engineering Manager

The WL Engineering Manager has overall responsibility for providing design and engineering services to the site, and is also responsible for ensuring that requirements of this Quality Control Program are applied within WL Engineering. The WL Engineering Manager reports to the Senior Project Manager, Engineering.

2.4.6 Facility Authority/ Landlord

The Facility Authorities and Landlords are accountable through the line organization for health, safety and environmental protection of Nuclear and Non-Nuclear facilities respectively. Facility Authorities and Landlords are listed in the Whiteshell Laboratories Procedure WL-508200-PRO-212 [1], Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories.

2.4.7 Instrumentation Group

Personnel from The WL Work Control Instrumentation group are responsible for the performance of the duties of the "Instrumentation Group" in this Quality Program. The Lead Hand of the Instrumentation Group is responsible for ensuring that requirements of this Quality Control Program are applied within the Instrumentation Group, WL Work Control.

2.4.8 Job Contact

The WL Work Control Trades Supervisor or Trades Leadhand or Trades Foreman is responsible for the performance of the duties of the "Job Contact" in this Quality Program. The Job Contact reports to the Manager, WL Work Control, who reports to the Senior Project Manager, Engineering.

2.4.9 Work Control Manager

The Work Control Manager has been delegated the responsibility for ensuring that WL Work Control personnel conform to this Quality Assurance Plan (QAP). The Work Control Manager is also responsible for determining Relief Valve (RV) servicing frequencies, and conducting an annual records review of RVs to verify proficiency and compliance with this QAP. The Preventative Maintenance coordinator, with approval from the Manager, WL Work Control, selects the personnel from WL Work Control to carry out this task. The Work Control Manager reports to the Senior Project Manager, Engineering.

2.4.10 WL Preventative Maintenance Coordinator

The Preventative Maintenance Coordinator is responsible for updating the Relief Valve Servicing Due Dates into the CMMS.

The Preventative Maintenance Coordinator shall issue the Scheduled Maintenance Request/Service Request, generated by the CMMS for each pressure vessel/RV as the scheduled Servicing Due Date is reached.

2.4.11 WL Procurement Group

Contracts Officers from WL Procurement are responsible for the performance of the duties of "Purchasing" in this Quality Program. The WL Procurement Manager reports to the Director of WL Business Operations.

2.4.12 WL Pressure Boundary Manager

The WL Pressure Boundary Manager (WL Engineering Manager) is responsible for the overall management of the WL pressure boundary program, ensuring the organization has a valid Certificate of Authorization issued by the Inspection and Technical Services (ITS) for the scope of work being performed and maintaining a list of controlled manual holders.

2.4.13 WL Pressure Boundary Subject Matter Expert

The WL Pressure Boundary SME is responsible for developing, implementing, and maintaining the Quality Control Program for the design registration, construction, alteration, repair, examination, and inspection of pressure retaining components and systems which must meet the requirements of the Steam and Pressure Plant Act, Chapter S210, of the Continuing Statutes of Manitoba.

The WL Pressure Boundary SME is responsible for the preparation, revision, distribution and implementation of this QAP. The WL Pressure Boundary SME provides pressure boundary-related advice to the WL Pressure

Boundary Manager. The WL Pressure Boundary SME shall be a member of the WL Engineering Branch and have the appropriate qualifications deemed acceptable by the WL Engineering Manager. The WL Pressure Boundary SME shall be designated by the WL Pressure Boundary Manager.

2.4.14 Quality Assurance Specialist

The QA Specialist is responsible for assisting the Managers from various WL departments in developing, implementing and periodically updating their quality programs. The QA Specialist, when requested, monitors the effectiveness and adequacy of the Program, reports findings to the Branch Managers, ensures corrective actions are conducted and become incorporated into the Program.

2.4.15 Quality Control Representative

The Quality Assurance/Quality Control (QA/QC) Representative from the WL Licensing and Quality Management Branch are responsible for performance of the duties of the “Quality Control Representative” in this quality program. The QCR is responsible for ensuring all specified examinations and inspections are completed. The QCR has the responsibility and organizational freedom to identify quality related problems, stop work not in compliance with specified requirements, and to recommend and verify corrective actions that do not contravene the QC program and/or Code requirements. The QCR also controls nonconforming material or components until a solution has been established. The QCR will report functionally to the WL Pressure Boundary SME and consult with the Quality Assurance Specialist on QA matters.

2.4.16 Site Authority

The Head of the WL Closure Project is the WL Site Licence Holder with oversight responsibility for activities that impact the requirements and conditions defined by the WL Licence Condition Handbook, NRTEDL-LCH-08.00/2024 [2]. Facilities at WL are also under the management authority of the Head of the WL Closure Project.

2.4.17 Stores

Stores personnel are responsible for performance of the duties of “Stores” in this Quality Program. Stores personnel report to the Section Head, Property & Material Management, who reports to the Director of Business Operations.

2.4.18 Records

The WL Records is responsible for performing the duties of “Records” in this Quality Program. The WL Records staff report to the Manager, WL Licensing and Quality Management. WL Records staff are responsible for ensuring records and reports used within this program are retrievable and stored.

3. ORGANIZATION

3.1 Scope

This Section describes the organizations involved in this Quality Control Program and their interface relationship at the time of revising this QAP.

3.2 Purpose

The purpose of this Section is to define the organizational structure applicable to this Quality Control Program. Figure 1 illustrates the organizational structure.

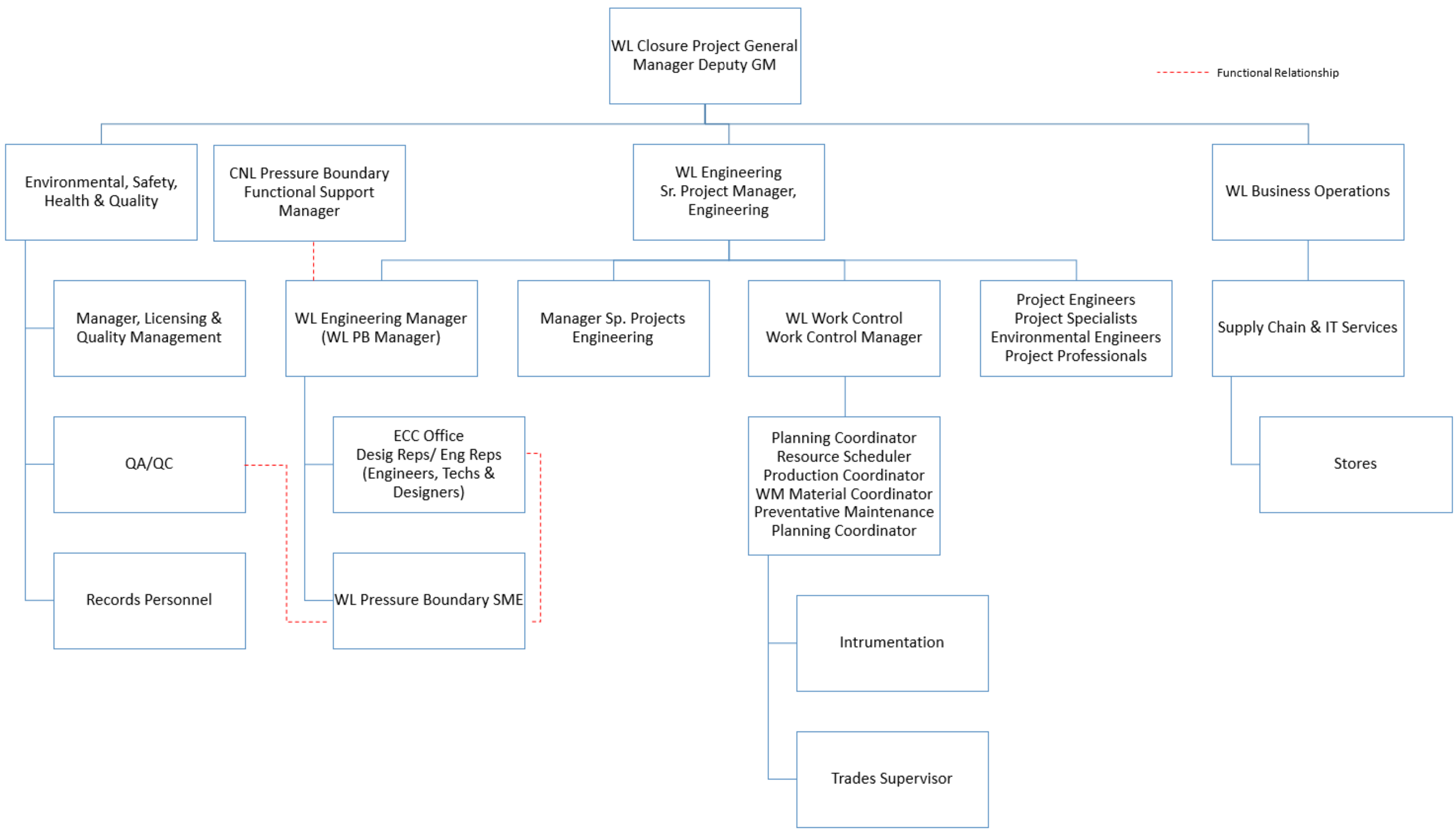


Figure 1 – WL Organizational Structure

4. ABBREVIATIONS, DEFINITIONS AND REFERENCES

4.1 Scope

This Section identifies abbreviations and definitions used at Whiteshell Laboratories for the design, construction, material control, installation, modification, and quality control and inspection activities of pressure retaining components and systems.

4.2 General

In addition to the following abbreviations and definitions, definitions described in other sections of this Plan, as well as in CNL's list of Acronyms and Abbreviations, and in CSA Standard B51, shall also apply.

4.3 Abbreviations

AECL	Atomic Energy of Canada Limited
AI	Authorized Inspector appointed by the Manitoba Labour and Immigration
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BPS	Brazing Procedure Specification
CMMS	Computerized Maintenance Management System
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories,
CRN	Canadian Registration Number
CSA	Canadian Standards Association
D&WM	Decommissioning and Waste Management
EDRMS	Electronic Document and Records Management System
ImpAct	Improvement Action
IRR	Inspection Request/Report
ITP	Inspection & Test Plan
ITS	Inspection & Technical Services
M&T	Measuring & Test
MAWP	Maximum Allowable Working Pressure
MITP	Manufacturing Inspection & Test Plan
MLI	Manitoba Labour and Immigration

MP&WM	Maintenance Planning & Work Management
NCR	Non-conformance Report
NDE	Non-Destructive Examination
NDT	Non-Destructive Testing
NIST	National Institute of Standards & Technology
NRC	National Research Council
PITP	Piping Inspection & Test Plan
PQR	Procedure Qualification Record
QA	Quality Assurance
QAM	Quality Assurance Manual
QC	Quality Control
QCR	Quality Control Representative
QOI	Quality Operating Instruction
QPS	Quality Program Selection
RV	Relief Valve
SIF	Supplementary Information Form
SME	Subject Matter Expert
WL	Whiteshell Laboratories
WMC	Work Management Coordinator
WPS	Welding Procedure Specification

4.4 Definitions

Act	The Steam and Pressure Plants Act, Province of Manitoba
Alteration	Any change in the item described on the original Manufacturer's Data Report which requires a change of design calculations or otherwise affects the pressure containing capability of the boiler or pressure vessel. Non-physical changes such as an increase in the maximum allowable working pressure (MAWP) (internal or external) or design temperature of a boiler or pressure vessel are also considered alterations, as are reductions, e.g., in minimum temperature, such that additional mechanical tests are required, shall also be considered an alteration.
Authorized Inspector	An Inspector authorized by the Regulatory Authority to perform inspections required under the Act.

Bill of Materials	A list of materials and fittings to be used in the construction of a pressure retaining system.
BPS	Brazing Procedure Specification; it identifies acceptable ranges of variables to be followed when brazing with a specific process, and is intended to provide direction to the brazer.
Calibration recall	A system for indicating in advance the next calibration due date for each piece of measuring and test equipment requiring calibration.
Calibration interval	The maximum allowable elapsed time between calibrations of a piece of measuring and test equipment which requires periodic calibration.
Code	The latest edition of CSA Standards B51 and B52 and their referenced Codes, e.g., ASME Section VIII Division 1 and ASME B31 Standards, as applicable.
Code Material	Material which must comply with requirements of ASME, ASTM, ANSI, or other applicable referenced Codes.
Component	An item, such as a vessel, boiler, heat exchanger, or a fitting manufactured at WL to meet Code requirements.
Construction	The activities of erection, installation, fabrication, assembly, alteration, and repair of items at the facility or plant.
Customer	For the purpose of this Manual, the term “customer” means purchaser of a product or service provided by WL.
Design	Includes calculations, analyses, drawings, and specifications to ensure the design meets Code and Regulatory requirements.
Design Documentation	Records of the design preparation, including design input, design output, engineering calculations and analyses, etc.
Design Input	Requirements, information, and data, e.g., performance and functional requirements, applicable Codes and standards, safety and environmental conditions, customer’s, Regulatory Authority’s , contractual, and other design group’s or discipline’s requirements to be used as a design basis for design work.
Design Output	May include drawings, specifications, technical notes, etc.
Fittings	An appurtenance attached to a boiler, pressure vessel, or piping, including such items as valves, gauges, and controlling devices, and which may include other pressure retaining components installed in a piping system within the scope of the Act.
Item	Item may be a component, part, fitting, or material.

Material	Item that conforms to a specification permitted by the Code or that is in the as- supplied condition.
Measuring and test equipment	A device used to measure, gauge, test, or otherwise examine items to determine their compliance with specifications.
Non-conformance	A deficiency in characteristic, documentation, system or procedure which renders an item or service unacceptable or indeterminate, or not meeting specified requirements.
Non-conformance Report (NCR)	A standardized form that is filled out when documenting a non-conformance.
Nonconforming Material	Materials, items or components deviating from specified requirements.
Piping System	Piping system as covered by this Manual applies to all piping and pressure retaining parts of piping manufactured in accordance with the Code. Piping includes pipes, fittings, flanges, and relief devices.
Registered Professional Engineer	A person who is licensed to practice under the "Engineering and Geoscientific Professions Act of Manitoba". The Engineer shall be qualified to assume responsibility for the engineering content of the design work done under his/her direction.
PQR	Procedure Qualification Record; it lists the actual conditions under which a test specimen was made and the results of tests performed on the specimen to qualify the process.
Purchase Request	The form used to initiate the purchase of goods and services
Purchase Document	Means any purchase order attachment such as specifications, drawings, or customer supplied documents.
Reference measurement standard	An instrument or device used in a calibration system as a primary standard or reference, its accuracy traceable to the National Institute of Standards and Technology (NIST), or to the National Research Council of Canada (NRC).
Registration File	File in records for pressure retaining components containing design registration, CRN etc.

Regulatory Authority	The body responsible for administering and enforcing the Act governing the design, fabrication, installation, repair, and alteration of boilers, pressure vessels, fittings and piping. In the Province of Manitoba, the Regulatory Authority is: Inspection and Technical Services, Municipal Relations 500-401 York Avenue Winnipeg, Manitoba R3C 0P8, Telephone (204)-945-3373
Reject	An item rejected for a CSA B51 application. Depending on the nature of the rejection it may be returned to the Supplier or dispositioned for use with non-CSA B51 jobs.
Repair	Processing a nonconforming item so it can function reliably and safely although the item still does not conform to the originally specified requirements. Note: for pressure-retaining components or systems, specifically, repair as defined in CSA B51 is to “restore a boiler or pressure vessel to a safe and satisfactory working condition”.
Request for Quotation	The form used to request quotation on goods and services.
Rework	Reprocessing a nonconforming item to conform to meet specified requirements. “Rework” to pressure retaining components or systems includes the correction of defects in weld/braze material, identified non-destructively during construction of the pressure retaining component or system. A rework procedure will be required if the original weld/braze procedure specification cannot be used.
Scrap	Designates material or items which cannot be used for their originally intended purpose.
Servicing Due Date	The date an RV must be withdrawn from its operating environment for servicing.
Servicing Frequency	The period of time for which the calibration of the set pressure of an RV is valid.
Transfer measurement standard	An instrument or device in a calibration system used to transfer measurements from the reference measurement standard to a lower echelon “working standard”, or directly to the measuring or test equipment being calibrated
Use-As-Is	An item not meeting specified requirements but still capable of performing satisfactorily without affecting fit, form, or function, can be “Used-As-Is”.
Working Standard	An instrument or device used in a calibration system to transfer measurements directly to the measuring and test equipment. Calibration of working standards is traceable to national standards via transfer measurement standards.

WPS	Welding Procedure Specification; identifies acceptable ranges of variables to be followed when welding with a specific process, and is intended to provide direction to the welder.

5. MANUAL REVISION AND CONTROL

5.1 Scope

This section describes the revision control of this Quality Control Plan including forms.

5.2 Quality Assurance Plan Revisions

The WL Pressure Boundary SME is responsible for preparation, revision, and distribution of the QAP, as well as for the review of applicable Codes and Standards and other internal or external changes affecting the Quality Program. This includes any process changes, organizational changes and any site license conditions affecting the Program. Once updated, the revised QAP is then submitted by the WL Pressure Boundary SME to the Inspection & Technical Services (ITS) for review and acceptance.

The WL Pressure Boundary SME reviews any new revision or addenda of the Codes and Standards, referenced in the QAP, within six months of their issue and incorporates any relevant changes in the QAP and the Program, the cycle followed for incorporation of the revisions in the QAP is as detailed in this Section. Formal revision of the QAP is done every 5 years.

Significant revisions are itemized in the Revision History associated with this document. Minor editorial changes and corrections that do not change the intent or meaning will not be marked. Only the most recent revision shall be indicated. Editorial type changes and corrections are not indicated. Revisions to any of the forms will be reflected in the Sample Forms in Section 20.

5.3 Quality Assurance Plan Control

The Pressure Boundary SME and WL Pressure Boundary Manage (WL Engineering Manager) are responsible for the development and implementation of the Pressure Boundary Program and this QAP.

After a review by the appropriate personnel, the QAP is approved by the WL Pressure Boundary Manager. Then, the QAP needs to be accepted by the CNL Pressure Boundary Functional Support Manager. Once accepted, the QAP is sent by the Pressure Boundary SME for acceptance to the Authorized Inspector of the Inspection & Technical Services (ITS). After their acceptance, the QAP shall be submitted to the CNSC as far in advance of planned implementation as practicable, but not less than 30 days prior to planned implementation. The QAP is then implemented at WL. Authorized Inspector's acceptance is indicated by his/her signature with date on the cover page.

The controlled document is approved and issued for use via a transmittal sheet through the Electronic Document and Records Management System (EDRMS) and the published revision is to be considered the official version of the QAP.

Uncontrolled copies of the QAP may be distributed (internally or externally) on request or for audit purposes. These are strictly for information purpose only.

5.4 Quality Assurance Plan Training

Training requirements for the WL Pressure Boundary quality program are prescribed in WL Training Plan WL-508140-TPL-001 [3]. This training plan identifies the training required by position within the organization to perform work on pressurized systems and to administer this quality program. It identifies who must be trained on the contents of this QAP, and other position specific training as identified by line management for each position.

6. DRAWINGS, DESIGN CALCULATIONS, AND SPECIFICATION CONTROL

6.1 Scope

This Section of the QAP applies to the design of pressure retaining components and systems that must meet requirements of CSA Standard B51.

6.2 Purpose

To describe the activities performed by the Design Representative when processing a design, to ensure that:

1. The latest technical data and correct design input are used in the preparation of design documentation and design output to assure Code compliance;
2. The latest and authorized design output documents are used for construction, installation and examination and testing purposes, and
3. Design documentation and design changes are controlled systematically.

6.3 Responsibilities

1. The Design Representative is responsible for performing design activities in conformance to applicable WL Engineering Design procedures. The Design Representative shall also ensure that the design is complete, current, and adequate to achieve the design objectives and comply with applicable regulatory, jurisdictional, and Code requirements. The design Representative is responsible for preparing construction drawings and obsolete drawings after decommissioning as per the WL Engineering Drawing Office Manual WLD-01150-MAN-001 [35].
2. The Registered Professional Engineer who applies his/her Seal to a design document has responsibility for the engineering content of the document and/or design.

6.4 Procedure

6.4.1 General Requirements

Procedures outlining the design process from receipt of a customer request through the close out phase of a design job shall conform to 900-508120-PRD-001 [4], Design Authority & Design Engineering and WLD-511300-PRO-002 [5], Construction Document & Record Control.

6.4.2 Design and Construction Criteria

1. Pressure retaining vessels, components, piping system and sub-assemblies shall meet requirements of CSA Standard B51, this Quality Control Program/Manual, and the applicable Code as specified below:
   a. Pressure vessels and boilers shall be designed and constructed in accordance with Section I, Section

IV, or Section VIII, Division 1 or 2, of the ASME Boiler and Pressure Vessel Code, as appropriate.

b. Pressure piping systems, sub-assemblies and portions thereof, shall be designed and constructed in accordance with the applicable ASME B31 Piping Code.

2. When service conditions, such as pressure and temperature, of an existing installation require re-evaluation, the review of the new service conditions must be performed by the Design Representative to determine the impact of these new conditions on design, construction, examination, and inspection.
3. For pressure vessels and boilers, the Design Representative shall summarize the design, material, examination, testing, and Code requirements on the drawings using a Pressure Vessel Specification Table (See Section 20 for a typical example).
4. The Registered Professional Engineer shall approve a design by applying his/her Seal to the design documents and ensure that every technical detail required for successful completion of the project, including parts list (with QA requirement), welding instructions, construction standards, examination, testing, quality control and code requirements are included.
5. When registration of the design is required with the Regulatory Authority, no Fabrication shall commence unless design registration is complete or prior approval has been received from the Authorized Inspector.

6.4.3 Deviations from the Code

1. All deviations from the requirements of the applicable codes and Standards shall be submitted by the Design Representative to the Regulatory Authority for approval.
2. One copy of all related correspondence shall be forwarded to WL Records staff for filing in the appropriate Registration File.

6.4.4 Release of Design Output

Procedures for releasing approved design output shall conform to applicable procedures listed in WLD-508120-GDI-001 [6], WL Engineering Governing Documentation Index and 900-508120-GDl-001 [7], Governing Documentation Index Design Authority & Design Engineering.

6.4.5 Design by External Suppliers

1. For pressure vessels and systems designed off-site, the Design Representative shall specify all applicable regulatory, design, and documentation requirements.
2. Supplier-generated designs for pressure retaining components or vessels from an external supplier may be reviewed by the Design Representative. Designs found not to be in compliance with the Code or Design Representative's requirements shall be returned to the Supplier for amendments/corrections prior to the start of any manufacturing activities.

6.4.6 Design or Manufacture for External Customers

For pressure retaining components or systems to be designed or manufactured for external customers, a representative from the Branch supplying the component or service shall contact the Design Representative and a QCR so that competent persons can be assigned to review any engineering documents/specifications submitted by an external customer, prior to any detailed design or construction, for adequacy and Code conformance. Customer documents found not to be in compliance with the Code shall be returned to the customer for amendment prior to the start of design or manufacturing activities. Design, construction or repair of such components and systems shall be performed in accordance with this Quality Program.

6.4.7 Change Control

1. The method used to control changes to approved engineering documents shall meet applicable requirements as specified in Engineering Change Control, 900-508130-MCP-001 [8].
2. A change in design may be initiated as the result of a proposed modification or alteration in the original design or existing pressure component/system, or due to a repair to be performed during manufacturing, construction or service of the component/system.
3. The Design Representative shall submit the revised design to the Regulatory Authority for prior approval/registration using the procedure described in Section 7 of this QAP. Revised Design documents may be issued for use only after obtaining approval from the Regulatory Authority.

7. DESIGN REGISTRATION

7.1 Scope

This section of the QAP applies to registration of designs of pressure retaining components and systems with the Regulatory Authority.

7.2 Purpose

To outline the procedures to follow and to define responsibilities when design registration is required for pressure retaining components or systems which must meet requirements of CSA Standard B51 and/or the Regulatory Authority.

7.3 Responsibilities

7.3.1 Design

1. The Design Representative is responsible for registration of the design of pressure retaining components and piping systems at WL. The design is registered in accordance with requirements of the applicable Code and/or Regulatory Authority.
2. WL Records staff is responsible for:
   a. Retaining the registered design and related documents, and
   b. Preparing and retaining the Registration File as outlined in Section 16.

7.4 Procedure

7.4.1 General

The design, construction, repair, alteration, and operation of pressure retaining systems and components are subject to the provisions of the Steam and Pressure Plants Act of Manitoba, and other applicable provincial regulations.

7.4.2 Design Registration

1. Where registration is required, the design of pressure vessels, boilers, piping or components to be manufactured in accordance with the Code shall be submitted to the Regulatory Authority for approval and registration in accordance with the requirements of the Regulatory Authority.
2. When a design is found defective by the Regulatory Authority in any detail, the Design Representative shall revise it to the satisfaction of the Regulatory Authority and re submit it for registration.
3. When the Regulatory Authority has approved the design and assigned it a Canadian Registration Number (CRN), a stamped copy of the design documents shall be returned to WL Engineering.
4. As standard procedure, a "Hold Point" shall be designated on ITP/MITP's for the Authorized Inspector to witness pressure testing of components and systems. A copy of the applicable ITP/MITP shall be forwarded to the Regulatory Authority for approval only when specifically requested by the Regulatory Authority. The Regulatory Authority may designate Hold Points on the ITP/MITP for additional activities to be verified or inspected by the Authorized Inspector.
5. Upon receipt of the registered and approved design from the Regulatory Authority, the Design documents shall be filed in the appropriate Registration File by WL Records staff.

7.4.3 Registration of Existing Piping Systems

Existing piping systems, which fall under CSA B51 requirements and were constructed and operating prior to 1996 January 01, will not require registration.

7.4.4 Design Registration for Alteration and Repairs

Unless permitted in Section 7.4.5.2 changes to registered pressure retaining components and systems which require alteration of the design shall require approval or re registration by the Regulatory Authority. Details for procedures to follow for alteration and repair are included in Section 11, Alteration and Repair.

7.4.5 Systems Exempt from Design Registration

By prior agreement with OFC, ITS, several specific systems at WL do not require CSA B51 design registration as per agreements contained in TN-49W82-2 [9], WL Pressure Vessel and System Compliance. Several system at WL are also exempt from registration due to CSA N285 Annex F clause. General descriptions of these systems are given below.

7.4.5.1 System Exemptions

1. Experimental facilities tubing systems which will otherwise be constructed to the applicable requirements of this Quality Control Program.
2. Experimental "Black Box" sections or components that do not fall within the scope of CSA B51. As examples, this would include items such as non-code materials evaluations or components that are designed for destructive failure evaluations.
3. Water, or water and glycol heating system pressures not exceeding 1.103 MPa (160 psig) and temperatures not exceeding 120°C (250°F). These systems shall otherwise be constructed to the applicable requirements of this Quality Program.
4. Compressed air systems up to and including ¾" diameter tubing connected together by means other

than welding or brazing. These systems shall otherwise be constructed to the applicable requirements of this Quality Program.

5. Pneumatic control systems, including control systems for experimental loops and facilities, as well as on heating, ventilation and air conditioning systems.
6. Systems will be registered on a loop or facility basis, as opposed to an individual system basis.

7.4.5.1.1 System Exemptions Based on CSA N285.0-08

1. Systems containing liquids not more hazardous than water, with a design pressure not exceeding 1.72 MPag (250 psig) and a design temperature not exceeding 65 C (150 F).
2. Chilled water cooling system pressures not exceeding 1.103 MPa (160 psig) and temperatures higher than -29^{o} C (-20^{o} F). These systems shall otherwise be constructed to the applicable requirements of this Quality Program

7.4.5.1.2 Fitting Exemptions

1. Exemption from Registration Requirements for Categories A, B, C and G category Fittings as per Safety Bulletin OFC ITSM 18-001 [10].
   a. Piping components complying with the standards and specifications listed in ASME B31 Pressure Piping Codes, as identified in Category A, B and C below:
      - **Category A**- Pipe fittings, including couplings, tees, elbows, wyes, plugs, unions, nipples, pipe caps, and reducers complying with a standard listed in Table 126.1 of ASME B31.1, Table 326.1 of ASME B31.3, Table 526.1 of ASME B31.5, or Table 926.1 of ASME B31.9
      - **Category B**- Flanges complying with a standard listed in Table 126.1 of ASME B31.1, Table 326.1 of ASME B31.3, Table 526.1 of ASME B31.5, or Table 926.1 of ASME B31.9
      - **Category C**- Valves complying with a standard listed in Table 126.1 of ASME B31.1, Table 326.1 of ASME B31.3, Table 526.1 of ASME B31.5, or Table 926.1 of ASME B31.9

   b. Certified pressure relief devices complying with ASME Boiler and Pressure Vessel Codes, as identified in Category G below:
      - **Category G**- Pressure-relief devices marked with an ASME or NB stamp.

   c. CGA fittings for pressure regulator applications.

7.4.5.2 Minor In-Service Repairs and/or Alterations to Piping Systems

Minor Modifications are defined as:

> “small piping changes only (re-routing or adding lines, addition/replacement of valves and other equipment, addition or replacement of instrumentation, addition or replacement of pumps, etc.)”

Minor in service repairs and/or alterations to piping systems do not require individual approval by the Regulatory Authority, provided the following conditions are met:

1. The design of such modifications/alterations is reviewed by the Design Representative to ensure Code compliance.
2. Minor repairs and alterations are performed in accordance with the applicable requirements of this Quality Program.

7.4.5.3 Exemptions Listed By the Inspection & Technical Services

ITS lists systems that do not require registration, specifically piping systems under 17 ft^3 in volume. Design and construction of systems under 17 ft^3 in volume are to be performed in accordance with the applicable requirements of this Quality Program.

See the Inspection and Technical Services website [11] for the latest information and requirements for systems under 17 ft^3.

8. MATERIAL CONTROL

8.1 Scope

This Section of the QAP applies to the procurement, receipt, storage, and handling of material used for fabrication, alteration and repair of boilers, pressure vessels, fittings, or piping systems which must meet requirements of CSA Standard B51.

8.2 Purpose

To document standard procedures followed for procurement, receipt, storage, and handling of Code materials.

8.3 Procedure

8.3.1 General Requirements

Requirements for procurement and control of material to be used for general construction of components are specified in WL Operating Procedure WL-508238-OP-003 [12], Obtaining and Controlling Material. The same requirements, as may be modified in the following Sections, shall be followed for control of material used for the construction of pressure retaining components and systems.

8.3.2 Material Requirements

1. The Design Representative is responsible for producing a Bill of Materials and Technical Specifications for material or fittings to be used in the construction of pressure retaining components or systems. Specifications for material shall include all applicable quality program, examination and inspection, dimensional and identification, documentation, and regulatory requirements.
2. Material selected and specified by the Design Representative shall be limited to those permitted by the applicable Codes mentioned in this QAP. The Bill of Materials shall specify the applicable ASME or ASTM Standard or Specification for the material.
3. Where required (See Section 7.4.5.1.2 for Fitting Exemptions) only pressure retaining components and fittings with a Canadian Registration Number (CRN) from the Province of Manitoba, or the Regulatory Authority in the Province of installation shall be used for construction of piping systems.
4. In the case where a Canadian Registration Number (CRN) number for Manitoba is required and not available then the Design Representative shall prepare and submit an application for exemption to Regulatory Authority. The application should include the CRN for any other Province/Territories in Canada if available, description of component and system it is being used on.
5. The Design Representative must approve any deviations from the Bill of Materials before such material is used.

6. Material Test Reports, traceable to the material and meeting requirements of the specification, shall be provided when required by applicable ASME Codes.

8.3.3 Procurement

8.3.3.1 General Procedure

General requirements for control of material procurement are defined in WL Operating Procedure WL-508238-OP-003 [12], Obtaining and Controlling Material. The procedure covers the following points:

1. Requisitioning of WL Stores Stock material,
2. Procurement of Non-Stores Stock material,
3. Responsibilities and
4. Material Control.

8.3.3.2 Stores Stock Material

Stores are responsible for re-ordering stock material. An automated procurement system generates the orders either directly or through blanket order contracts set up by the WL Purchasing Group. The Supply Chain Program Requirements Document, 900-505210-PRD-001 [13] and all applicable procurement procedures shall be followed. When required Quality Program Selection (QPS) Form [14], Supplementary Information Form (SIF) [15] and revisions to same, are either prepared or reviewed by the Design Representative.

8.3.4 Receiving Inspection

1. When material is delivered, it shall be received and handled by Stores.
2. Stores shall assign a traceability receipt number to the order received. They shall then raise a Quality Control Work Request (QCWR) identified with the same traceability receipt number, and forward it, along with a copy of the Receipt Traveler, to WL Quality Control to initiate receiving inspection of the material.
3. The QCR shall assign an additional traceability Inspection Request Report (IRR) number to the order, and perform receiving inspection to requirements of the Purchase Order, and in accordance with WL-508244-OP-003 [13], General Procedure for Receiving Inspection.
4. The QCR shall verify documentation, including Material Test Reports and Certificate of Compliance, and identification and markings on materials. The QCR shall perform any other inspection required by the Purchase Order or referenced Code Specification.
5. The QCR shall indicate acceptable material by affixing an Accept tag and/or QA Accepted label to the material, and/or container. The receipt number and the IRR number and where applicable the heat number shall be marked on the QA Accepted Tag.

8.3.5 Nonconforming Material

Nonconforming material shall be dealt with as described in Section 10 of this QAP.

8.3.6 Storage of Material

Following acceptance by Receiving Inspection, code material purchased for a specific job shall be stored in a designated storage area, or shall be released to direct control of the Job Contact, Planning Coordinator or Foreman in accordance with the WL Operating Procedure WL-508238-OP-003 [12], Obtaining and Controlling Material. Code material purchased for in-field stock shall be traceable, properly identified.

8.3.7 Inspection Records

The QCR shall maintain a listing of Inspection Request Reports and Material Test Reports pertaining to receiving inspection of material and fittings in accordance with WL Operating Procedure WL-508244-OP-003 [13], General Procedure for Receiving Inspection.

8.3.8 Material Control during Construction

Material to be used during construction of pressure retaining components and systems shall be identified and controlled in accordance with WL Operating Procedure WL-508238-OP-003[16], Obtaining and Controlling Material.

9. EXAMINATION AND INSPECTION PROGRAM

9.1 Scope

This Section of the QAP applies to the examination and inspection program and work planning process associated with the manufacture, installation, repair, replacement, and modifications of pressure retaining components in the shop and the field to the requirements of CSA B51.

9.2 Purpose

To describe the procedures used to ensure that examinations, inspections, and tests of pressure retaining components and systems are performed to the requirements of the applicable Codes and Standards.

9.3 Responsibilities

1. The Design Representative shall specify the extent and acceptance criteria for examination and inspection required on pressure retaining components and systems.
2. When required the QCR is responsible for the preparation of an Inspection and Test Plan (ITP) for the job. He/she shall ensure that the ITP describes all examinations and tests required by design documents and customer documents, when applicable. The Work Control Manager and QA Specialist shall review all revisions of ITP and approve the ITP prior to release to the field.
3. The Design representative is responsible for submitting the ITP to the Authorized Inspector when required.
4. The Job Contact or delegate is responsible for the construction of pressure retaining components and systems per design requirements. He/she shall ensure compliance with requirements of this Quality Control Program.
5. The QCR is responsible for performing examinations and tests specified in design documents and the ITP, and for reporting acceptance or rejection of tests.

9.4 Procedure

9.4.1 Construction Activities

General procedures for inspection and testing during construction activities are described in various procedures for Quality Control. These procedures are supplemented by requirements in the following paragraphs for Inspection and Test Plans, pressure testing, non-destructive testing, and initial service testing.

9.4.2 Inspection and Test Plans

1. Construction operations, examinations, and inspections are planned prior to the start of work and the results of examinations are documented. These actions are normally accomplished through the issue of an ITP for a job on a registered system. Preparation of ITP is done using Operating Procedure WL-508238-OP-001 [16], Preparation of Inspection & Test Plans.
2. The approved ITP and applicable drawings are stored into the Red file (WLD-511300-PRO-002 [5], Construction Documents & Record Control). Under control of the Job Contact, the Red file follows the work through the construction, examination, and inspection operations. Final ITP signoff to be done by Work Control Manager, QCR & Job Contact.
3. The Regulatory Authority may enter “Hold Point” on the ITP or drawing (See Section 7 Design Registration). Construction shall not proceed past such points without Authorized Inspector (AI) approval.
4. The Job Contact or Work Control Manager shall notify the QCR when the component or system is ready for AI “Hold Point” inspection or pressure testing. The QCR shall ensure the component or system is ready for “Hold Point” inspection prior to notifying the AI, and shall be present during the inspection.
5. The Design Representative and/or QCR shall notify the AI at least 48 hours in advance for “Hold Point” inspection or pressure testing.
6. Where required by code or for registered systems, pressure testing of repaired or altered components and systems shall be witnessed and accepted by the QCR and test records shall be maintained for AI verification. When required, the AI will witness pressure testing of repaired pressure vessels.

9.4.3 Non-Destructive Testing

Procedures for non-destructive testing of pressure retaining components and systems are referenced in Section 13 Non-Destructive Examination, in this QAP.

9.4.4 Pressure Testing

9.4.4.1 Hydrostatic Testing

Hydrostatic Testing shall be performed in accordance to the requirements provided in the applicable codes:

- ASME B31.1
- ASME B31.3
- ASME B31.9
- ASME Section I
- ASME Section IV

- ASME Section VIII, Division 1
- NFC

A dial indication pressure gauge shall be directly connected in an upright position to the component (preferably at the highest point). If the indicating gauge is not readily visible to the operator controlling the pressure being applied, an additional indicating gauge shall be provided that is visible to the operator throughout the duration of the test. Gauges used in testing shall be graduated over a range not less than 1 ½ or more than 4 times the test pressure. All test gauges shall be calibrated by qualified personnel against a standard dead weight tester, a calibrated master gauge, or a mercury column at least once every three months (or before testing when gauges are not in regular use). The calibration of the test gauge shall be traceable to the National Institute of Standards and Technology or to the National Research Council of Canada.

Suitable precautions shall be taken during testing to minimize the possibility of injury to personnel. These precautions shall include:

1. Pressurized equipment shall not be left unattended during testing,
2. Pressurized components shall be properly vented of all air and gases,
3. No heat shall be applied to pressurized components during testing,
4. Testing shall not be done in direct sunlight,
5. Isolation of the testing equipment from testing personnel (by distance, barriers, testing pit, etc.) shall be established by the Design Representative, and incorporated during testing and
6. Warning signs shall be posted at the exclusion zone and shall remain in position for the duration of the test.

Where required by the applicable codes listed above or for registered systems, a Hydrostatic Test Report shall be completed by the QCR and retained as a Quality Record (See Section 20, Sample Forms List). When required, the AI will be notified prior to pressure testing by the QCR.

9.4.4.2 Pneumatic Testing

Pneumatic Testing shall be performed in accordance to the requirements provided in the applicable codes:

- ASME B31.1
- ASME B31.3
- ASME B31.9
- ASME Section VIII, Division I

A dial-indicating pressure gauge shall be directly connected in an upright position to the component (preferably at the highest point). If the indicating gauge is not readily visible to the operator controlling the pressure being applied, an additional indicating gauge shall be provided that is visible to the operator throughout the duration of the test. Gauges used in testing shall be graduated over a range not less than 1 ½ or more than 4 times the test pressure. All test gauges shall be calibrated by qualified personnel against a standard dead weight tester, a calibrated master gauge, or a mercury column at least once every three months (or before testing when gauges are not in regular use). The calibration of the test gauge shall be traceable to the National Institute of Standards and Technology or to the National Research Council of Canada.

Suitable precautions shall be taken during testing to minimize the possibility of injury to personnel. These precautions shall include:

- Isolation of the testing equipment from testing personnel (by distance, barriers, testing pit, etc.) shall be established by the Design Representative, and incorporated during testing,
- Warning signs shall be posted at the exclusion zone and shall remain in position for the duration of the test,
- Testing shall not be done in direct sunlight,
- The application of pressure during the test shall be as outlined in the applicable Code,
- Pressurized equipment shall not be left unattended during testing,
- No heat shall be applied to pressurized components during testing and
- The test equipment must allow for a controlled release of pressure upon completion of testing.

Where required by the applicable codes listed above or for registered systems, a Pneumatic Test Report shall be completed by the QCR and retained as a Quality Record (See Section 20, Sample Forms List). When required, the AI will be notified prior to pressure testing by the QCR.

All pneumatic testing must be performed using a written procedure that is acceptable to the Authorized Inspector.

9.4.4.3 Initial Service Testing

Initial Service Testing shall be performed in accordance to the requirements provided in the applicable codes:

- ASME B31.1
- ASME B31.3
- ASME B31.9
- NFC

A dial-indication pressure gauge is not required for initial service testing. The QCR must be assured that the system is at normal operating pressure.

Where the applicable codes listed above allow, an initial service may be completed in lieu of a hydrostatic or pneumatic test. Where required by the applicable codes or for registered systems, the initial service test shall be recorded on a Hydrostatic/Pneumatic Test Report form by the QCR and retained as Quality Record. (See Section 20, Sample Forms List).

9.4.5 Inspection Stamps

1. Two styles of inspection stamps are in use, in both the acceptance and rejection form. These are rubber sets for marking on paper, and metal blunt-nosed low-stress sets. The procedure for controlling inspection stamps is described in Operating Procedure WL-508244-OP-010 [17], Managing Quality Control Stamps at Whiteshell Laboratories.
2. Each QCR who performs non-destructive examination shall be assigned a set of stamps.

9.4.6 Pressure Vessel Name Plate

1. A Name Plate (See Section 20) shall be attached to all registered pressure vessels constructed.

Appropriate Name-plate data shall be provided to the Job Contact by the Design Representative. The Job Contact shall enter the data and affix the Name Plate to the vessel.

2. Name Plate data shall be verified by the QCR.

10. CORRECTION OF NON-CONFORMANCES

10.1 Scope

1. This section covers material not conforming to specification, policy, procedures or design requirements. It establishes the responsibilities of personnel engaged in the detection, identification, segregation, and disposition of nonconforming material.
2. This section applies to material and work performed on material from receipt of the order to completion of work. This section also applies to work carried out on material returned by the customer.

10.2 Purpose

To provide control of items from the time of identification of the non-conformance until the non-conformance has been resolved; to provide assurance that the specifications and design requirements are met and nonconformities are fully investigated, properly dispositioned, and recorded.

10.3 Procedure

10.3.1 General Requirements

Requirements for control of non-conformances for construction of any components are specified in WL Operating Procedure WL-508238-OP-005 [18], Control of Non-conformances. This procedure covers non-conformances detected during receiving inspection, in process, and final inspection.

1. Nonconforming material is identified by a “HOLD” tag (optional for “Rework” items). Rejected or scrapped material is identified by a “REJECT” tag and/or reject stamp. Only a QCR is allowed to authorize the removal of either a “REJECT” or “HOLD” tag.
2. The QCR controls quarantine areas for storage of nonconforming items. When conditions such as size or contamination risk exist, segregation by means of a “HOLD” Tag may be used in lieu of storage in the quarantine area.
3. General rules for distribution and dispositioning of Non-conformance Reports (NCR) are addressed in WL Operating Procedure WL-508238-OP-005 [18], Control of Non-conformances
4. The Branch responsible for performing the repair is responsible for preparing repair instructions. Repair instructions may also be suggested by other functional groups. In any case, repair instructions shall be included as part of the disposition on the NCR, or as a separate attachment to the NCR. The Work Control Manager or Design Representative shall approve the repair procedure.
5. The Design representative is responsible to ensure the inspector is notified for concurrence (where Authorized Inspector involvement is required)

10.4 Record Management

Upon completion of the non-conformance, the QCR enters the NCR information into Improvement Action (ImpAct). The purpose is to document any non-conformances as outlined in 900-514000-MCP-004 [19], Improvement Action (Impact) Corrective Action Program. The entry of this data provides an electronic record of the NCR and allows trending of the non-conformances. When this step is completed the QCR forwards the completed NCR to WL Records for archival.

11. ALTERATION AND REPAIR

11.1 Scope

This section applies to alteration or repair of pressure retaining components and systems which must meet requirements of CSA Standard B51.

11.2 Purpose

To provide a documented system for the control of alterations or repairs of pressure retaining components and systems, and to provide assurance to the Regulatory Authority that the alteration or repair is performed in a safe manner in compliance with CSA B51 requirements.

11.3 Procedure

1. Unless stated otherwise, other requirements of this QAP, for example, Material Control, Design Calculations, Change Control, etc., shall apply equally to Alteration and Repair procedures.
2. Alteration or repair shall not be performed without the approval of a Design Representative.
3. Any change to the original registered design initiated due to alteration or repair shall be approved by and registered with the Regulatory Authority in accordance with change control procedures, (See Section 6 of this QAP).
4. Pressure Vessels and Boilers:
    a. When an alteration or repair is to be performed on a pressure vessel or boiler, the Design Representative shall complete the Alteration or Repair Record Form, Pressure Vessels (See Section 20, Sample Forms List). The Design Representative shall submit the form to the Regulatory Authority for approval prior to its execution.
5. Pressure Piping:
    a. With the exception of Section 11.3.2, for alteration or repair to registered pressure piping systems, the Design Representative shall complete the Alteration or Repair Record Form, Piping Systems (See Section 20 Sample Forms List). When required by the AI, the Design Representative shall obtain approval from the Regulatory Authority prior to its execution.
6. Pressure Fittings:
    a. With the exception of Section 11.3.2, for alteration or repair to registered pressure fittings, the Design Representative shall complete the Alteration or Repair Record Form, Fittings (See Section 20 Sample Forms List). When required by the AI, the Design Representative shall obtain approval from the Regulatory Authority prior to its execution.
7. The Design Representative shall maintain a record of alteration or repair for future reference by the

Regulatory Authority.

8. An Inspection and Test Plan (Traveler) is required to be developed and presented to the Authorized Inspector for review and designation of hold points prior to the commencement of work.
9. The Design Representative is responsible the hydrostatic testing of a repair or alteration and shall be performed in accordance with the requirements contained within the NBIC.
10. Authorized Inspector is to be notified in advance of any pressure testing to be performed.

11.3.1 Weld/Braze Repairs

1. Refer also to Section 12 - Welding/Brazing Control for more specific weld/braze repair requirements.
2. For weld/braze repairs, the Work Control Manager shall, when required, prepare and qualify appropriate repair and welding/brazing procedures with the Regulatory Authority. Approval by the Design Representative for such procedures is required prior to submission to the Regulatory Authority.
3. As a minimum requirement, weld/braze repair shall be subjected to the same non-destructive examination as the original weld/brazed joint. Examination and test records of repairs shall be maintained for AI verification.

11.3.2 Minor In - Service and/or Alteration to Piping Systems

Minor Modifications are defined as:

“small piping changes only (rerouting or adding lines, addition/replacement of valves and other equipment, addition or replacement of instrumentation, addition or replacement of pumps, etc.). No work will be undertaken involving repairs or alteration to registered boilers or pressure vessels without first obtaining approval from the Inspection & Technical Services (ITS).

As stated in Section 7, Design Registration, Minor in-service repairs and/or alterations to piping systems do not require individual approval by the Regulatory Authority provided the following conditions are met:

1. Minor repairs and alterations meet the original design conditions
2. Minor repairs and alterations are performed in accordance with the applicable requirements of this Quality Program.

12. WELDING/ BRAZING CONTROL

12.1 Scope

This section applies to welding and brazing processes for pressure retaining components and systems.

12.2 Purpose

The purpose of this procedure is to ensure that welding and brazing processes meet the requirements of Section IX of the ASME Boiler and Pressure Vessel Code and the applicable Code of Construction of the ASME Code.

12.3 Procedure

Welding/brazing shall conform to the requirements of Section IX of the ASME Boiler and Pressure Vessel Code and to additional requirements of the applicable Code of Construction of the ASME Code.

12.3.1 Welding/Brazing Procedure Specifications and Procedure Qualification Records for In-House Welders

The WL Work Control Manager:

1. Shall develop a generic WPS/BPS, for each specific process.
2. Shall arrange and conduct welding/brazing procedure qualification tests in the presence of the AI. Welding/brazing processes, base materials, and consumables shall be in accordance with the requirements of ASME Section IX.
3. Shall arrange the required tests and examinations of the weld/braze.
4. Shall record the results of tests and examinations in the PQR.
5. Shall certify the PQR and submit it to the AI for approval and registration.
6. Shall file the registered PQR in the appropriate Records file.
7. Shall maintain a current list of WPSs/BPSs and PQRs (to be located in the WL Records Vault).

12.3.2 Qualifications of In-House Welders/Brazers

The Work Control Manager:

1. Shall develop a generic WPS/BPS, for each specific process.
2. Shall arrange and conduct welder/brazer qualification tests by third party company possessing a Certificate of Authorization to perform welder/brazer performance testing. Welding/brazing processes, base materials, and consumable shall conform to the requirements of ASME Section IX. Welder/brazer qualification tests shall be performed in accordance with a registered WPS/BPS and production welds shall not be used when welder testing is required.
3. Shall arrange the required tests and examinations of welder/brazer specimens.
4. Shall record the results of tests and examinations in the welder/brazer qualification record.
5. Shall submit the welder/brazer qualification record to the AI for approval and registration.
6. Shall file the registered welder/brazer qualification record in the appropriate records file.
7. Shall issue an identification stamp to each welder/brazer qualified.
8. Shall maintain a current list of welder/brazer qualification records and shall ensure a record is kept of the processes used by each welder/brazer to maintain their qualified status.
9. Shall submit the documentation to the Jurisdiction for issuance of the welder’s license on behalf of the welder and to ensure the license is restricted to this QCP
10. Shall have the pressure welders/brazers re-qualified as per the Manitoba Steam and Pressure Plants Act S210 by third party company possessing a Certificate of Authorization to perform welder/brazer performance testing upon expiry. The welder/brazer shall also be requalified, in accordance with ASME Section IX QW-322.1 and QB-322 when one of the following conditions occurs:
    a. The welder/brazer has not performed the process for a period of six months.

b. There is a specific reason to question the ability of the welder/brazer to perform the process to meet the specification.

11. Authorized Inspector has the right to require re-qualification of the welder

12.3.3 Qualification of Contract Welders

1. All Contract Welding Companies shall have a quality control program and qualified welding procedures certified and registered with ITS. The Contract Welder shall provide copies of these documents to the Work Control Manager.
2. The Work Control Manager is responsible for verifying that the contract welder has valid licenses for the weld procedures he/she has been hired to perform.
3. The Contractor shall provide a copy of the welder's license and a copy of the Weld Procedure Specification and the PQRs. These copies will be placed in the PITP/MITP.

12.3.4 Performance of Welding/Brazing Work by In-House Welders

1. The Design Representative will specify joint configuration and when and if applicable, weld process, and acceptable consumables for each weld on the drawings.
2. The QCR shall prepare a job-specific WPS for each welding job, and the Work Control Manager shall approve it. The job-specific WPS shall be supported by, and be referenced to, an existing PQR.
3. All changes to essential, supplementary essential or nonessential variables of WPSs/BPSs shall be controlled by revision number and date.
4. The Work Control Manager shall control the issue and distribution of WPSs/BPSs.
5. The Work Control Manager shall ensure the welder/brazer and the WPS/BPS used in production are within their range of qualification.
6. The welder/brazer shall ensure:
   a. He/she is licensed for the specific process to be used.
   b. The specified WPS/BPS and materials are used.
   c. Consumables are ordered with correct SFA and AWS designation, stored and traceability is maintained in accordance with WL Working Procedure WLCS-01913-WP-2203 [20], Control of Brazing/Welding Consumables and that for low-hydrogen electrodes, maximum time exposure from the oven or sealed package shall be not greater than four hours. The welder/brazer is also responsible for the issue and return of welding material.
   d. Work is identified by the welder/brazer identification symbol in accordance with the requirements of the WL Working Procedure WLCS-01913-WP-2202 [21], Control of Brazing/Welding Processes.

12.3.5 Performance of Welding/Brazing Work by Contract Welders

1. The Design Representative in consultation with the QCR and Work Control Manager will specify joint configuration, weld process, and acceptable consumables for each weld on the drawings.

7. The Work Control Manager shall ensure that the Contract Welder has the required qualifications for the requested welds.
8. Consumables used by the Contract Welder shall be controlled by the Pipefitters Lead Hand in accordance with WLCS-01913-WP-2203 [20], Control of Brazing/Welding Consumables.

9. The Job Contact shall ensure;
    a. Contract welders have proper supervision
    b. The specified WPS/BPS and materials are used.
    c. Work is identified by the welder/brazer identification symbol in accordance with the requirements of WLCS-01913-WP-2202 [21], Control of Brazing/Welding Processes.

12.3.6 Weld/Braze Repairs to Base Material or Components

1. When a base material or component is found to be defective, repair shall be carried out in accordance with Section 10, Correction of Non-conformances.
2. The Work Control Manager shall prepare a repair procedure for weld/braze repairs to base materials or components. The procedure shall include, where required by the applicable ASME Code of Construction, the method of removal of defects, thermal preheat and post-weld heat treatment, the proposed WPS/BPS, examination requirements, and other precautions to be taken. The weld procedure shall be approved by a Design Engineer.
3. If required, the Design Representative shall obtain Regulatory Authority approval before performing the repair (See Section 11 of this QAP).
4. The type and extent of examination shall, at least, be the same as for the original material and the applicable Section of the ASME Code.

12.3.7 Rework of the Welds/Brazed Joints

The following condition constitutes a “Rework” to pressure retaining components or systems: “the correction of defects in weld/braze material, identified non-destructively during construction. A rework procedure will be required if the original weld/braze procedure specification cannot be used.”

12.3.8 Tack Welds

Tack welds, and joining of brackets and other attachments to pressure retaining materials shall be carried out by qualified welders. Tack welds shall be visually examined by QC for defects based on the acceptance criteria specified on the design drawings. Tack welds found to be acceptable shall be properly prepared by grinding the welds at both ends (start and stop) and incorporated into the final weld. Besides grinding, other suitable means of weld preparation may be utilized. Rejected tack welds shall be removed. The Work Control Manager shall assign an appropriate and qualified WPS for such welds.

13. NON-DESTRUCTIVE EXAMINATION

13.1 Scope

This section applies to Non-Destructive Examinations (NDE) of pressure retaining components & systems which must meet requirements of CSA Standard B51.

13.2 Purpose

To describe the system in use for control of non-destructive examination of pressure retaining components and systems.

13.3 Responsibilities

1. The Design Representative shall specify the extent and acceptance criteria for examinations required on pressure retaining components and systems. For pressure retaining components and systems manufactured to an external customer's design documents, the applicable Customer Representative shall ensure that examination & test methods and their extent and acceptance criteria are specified in the design documents.
2. When NDE is to be conducted by a contractor under a Purchase Order, the Requisitioner, normally the QCR, shall furnish Purchasing with a Purchasing/Quotation Requisition, identification/ traceability requirement and applicable Technical Specifications for the NDE.
3. The QCR is responsible for performing and/or overseeing the required non-destructive examinations. The QCR is also responsible for making the all NDE results, including film and interpretation sheets available for review and acceptance by the Authorized Inspector upon request by the AI.
4. The authorized Inspector has the right to require re-qualification of the NDE personnel and procedures if necessary.
5. The Work Control Manager is responsible for appointing the NDE examiner who is a contracted, permanent or non-permanent staff with required qualifications below.

13.4 Personnel Qualifications

1. Personnel performing NDE shall be certified to Non-Destructive Testing (NDT) Level I, NDT Level II, or NDT Level III requirements as per Standard CAN/CGSB 48.9712 [22], Nondestructive Testing Qualification and Certification of Personnel. Contract, permanent or non-permanent staff shall meet these requirements.
2. NDE personnel qualification records shall be maintained by the Quality Control Representative.

13.5 Procedures

13.5.1 NDE Procedures

1. NDE procedures shall meet the requirements of ASME Code Section V, and other ASME Code Sections as applicable. Applicable operating procedures are listed below:
   - WL-508244-OP-008 [23] Magnetic Particle Examination
   - WL-508244-OP-009 [24] Liquid Penetrant Examination
   - WL-508244-OP-006 [25] General Procedure for Visual Examination of Welds
2. Visual inspection of welds shall be performed in accordance with requirements of the applicable ASME Code Section and WL-508244-OP-006 [25], General Procedure for Visual Examination of Welds.
3. Specific NDE techniques required by Code shall be filed in WL Records by the QCR for use.

14. HEAT TREATMENT

14.1 Scope

This section applies to heat treatment of materials requiring conformance to CSA Standard B51.

14.2 Purpose

This procedure establishes controls to ensure that heat treatment operations carried out on material, components, and assemblies meet the requirements of the applicable ASME Code.

14.3 Responsibility

The Work Control Manager shall ensure that heat treatment is carried out as required by Design specifications/drawings, and that heat treatment records are generated and verified.

14.4 Procedure

14.4.1 General

1. Technical specifications or drawings, approved by the Design Representative, shall furnish the technical requirements for heat treatment. The specifications shall meet requirements of applicable Codes and jurisdictions.
2. Heat treatment records shall be generated showing results of the heat treatment operation, for example, thermal cycle chart and chronological time and temperature log. The records shall be traceable to the heat treated item and the job specification/drawing, and shall be signed and dated by the Operator.
3. The QCR shall verify heat treatment records to ensure compliance with the specifications. The records shall be made available to the AI for reviews, when required.

14.4.2 WL Heat Treatment

1. When heat treating is to be conducted by WL personnel, the Work Control Manager is responsible for preparing a heat treatment procedure to meet the requirements of the job specification and the applicable Section of the ASME code, and indicating quality control requirements on the ITPs.
2. The Instrumentation Group is responsible for maintenance and calibration on a scheduled basis of furnace controls and recording instrumentation which is used in heat treatment operations.

14.4.3 Contractor Heat Treatment

1. When heat treatment is to be conducted by a contractor under a Purchase Order, the Requisitioner, normally the Job Contact or the Work Control Manager, shall furnish Purchasing with a Purchasing/Quotation Requisition, identification/ traceability requirement and applicable Technical Specifications for the heat treatment.
2. The Design Representative shall approve the Purchase/Quotation and Technical Specifications prior to issue of the order. The contractors shall provide calibration certificates for all heat treatment instrumentation for acceptance by the design representative.
3. The Work Control Manager or Design Representative shall accept the contractor’s heat treatment procedure prior to the start of heat treatment.
4. The contractor’s heat treatment procedure shall include instructions for proper placement of thermocouples.

14.4.4 Records

Records pertaining to heat treatment shall be maintained in the Job File for the part that was heat treated.

15. CALIBRATION OF MEASURING AND TEST EQUIPMENT

15.1 Scope

This section applies to measuring and test equipment used for pressure retaining components and systems.

15.2 Purpose

The purpose of this section is to document a system used to ensure the accuracy of measuring and test equipment.

15.3 Application

Specifically, this procedure applies to:

1. Reference Measurement Standards, e.g., ring gauges, gauge blocks
2. Dead weight testers,
3. Test pressure gauges,
4. Final point inspection measuring and test equipment (QC tools),
5. WL Work Control Branch measuring and testing - equipment,
6. Non-destructive testing equipment, and
7. Torque Wrenches.

15.4 Responsibilities

Both the Quality Control of the WL Licensing and Quality Management Branch and the Instrumentation Group of the WL Work Control branch have measuring and test equipment that is used in the inspection, manufacturing, or monitoring the operation of pressure vessels and pressure retaining components. These groups have different responsibilities but, must calibrate their equipment to a similar quality level.

15.4.1 Quality Control Representative

The QCR shall perform the following activities in accordance with WL-508237-OP-001 [26], Quality Control Calibration Procedure.

1. Develop and maintain a calibration recall system encompassing M&T equipment requiring periodic calibration.
2. Develop and maintain written instructions for calibration of measuring and test equipment.
3. Perform and report calibrations as required. This responsibility includes retrieval of the specific piece of measuring and test equipment that has been called up for calibration.
4. Maintain quality records showing calibration reports traceable to the measuring and test equipment, and, ultimately, to a reference measurement standard.
5. M&T equipment are typically replaced rather than repaired. In the case that M&T equipment was repaired the QCR Shall maintain a “Repairs Log Book” that will list the status of all M&T equipment

which has been sent out for repair.

15.4.2 Instrumentation Group

The Instrumentation Group shall perform the following activities in accordance with the WLCS-108700-MAN-004 [27], WL Instrumentation Services Calibration Procedures Manual:

1. Compile and maintain a current listing of, and identify measuring and test (M&T) equipment, included in the WLCS-108700-MAN-004[27], WL Instrumentation Services Calibration Procedures Manual.
2. Assign and maintain a calibration accuracy, frequency, and schedule, and maintain a retrieval system encompassing measuring and test equipment requiring periodic calibration.
3. Develop and maintain written instructions for calibration of measuring and test equipment.
4. Perform and report calibrations as required, and on schedule. This responsibility includes retrieval of the specific piece of measuring and test equipment that has been called up for calibration.
5. Maintain quality records showing calibration reports traceable to measuring and test equipment, and, ultimately, to a reference measurement standard.
6. Test pressure gauges used for pressure testing of pressure retaining components and systems shall be calibrated in accordance with WLCS-108700-MAN-004 [27], WL Instrumentation Services Calibration Procedures Manual.

15.4.3 Work Control Manager

The Work Control Manager shall:

1. Be responsible for promptly locating any M&T equipment in his control.
2. Ensure that all M&T equipment that has been returned by the QCR or the Instrumentation Group as "Not Calibrated" will be kept out of service until it is repaired or discarded as appropriate. The QCR or the Instrumentation Group shall be duly notified of the action taken.
3. Ensure that all M&T equipment, after repair, is returned to the QCR or the Instrumentation Group for recalibration.
4. Compile and maintain a current listing of M&T equipment included in the Calibration Recall System. All such equipment shall be identified by a unique serial number.
5. Be responsible for determining what M&T equipment requires testing.

15.5 Personnel Qualifications

15.5.1 Quality Control Representative

Quality Control Representatives (QCR) performing calibrations of non-destructive testing equipment shall be qualified to NDT Level I, Level II, or Level III requirements for those non-destructive testing methods governed by the Canadian General Standards Board. For testing methods outside the jurisdiction of the Canadian General Standard Board, personnel qualifications will be justified by experience and skill.

15.5.2 Instrumentation Group Personnel

Instrumentation Group personnel who perform calibrations of measuring and test equipment shall be certified as journeyman industrial instrument mechanics, or instrumentation technologists. WL Work Control Branch shall maintain records detailing training periods, examinations, and certifications.

15.6 Procedure

1. The calibration of measuring and test equipment shall be traceable to a National Standard such as NRC or NIST.
2. Procedures for calibration of measuring and test equipment are detailed in the Quality Control Calibration Procedure, WL-508237-OP-001 [26], and the Whiteshell Instrumentation Services Calibration Procedures Manual, WLCS-108700-MAN-004 [27]. The same requirements, with exceptions listed below, shall be followed for calibration of measuring and test equipment used in the fabrication, alteration, or repair of pressure retaining components fabricated to requirements of this QAP.
    a. Unless the measuring and test equipment has been calibrated within the pre-set calibration interval specified in WL-508237-OP-001 [26], Quality Control Calibration Procedure or WLCS-108700-MAN-004 [27], WL Instrumentation Services Calibration Procedures Manual, it shall be calibrated prior to the next use.
    b. Where the QCR is required to perform final point inspection of components or parts fabricated or repaired to requirements of this Manual, then any precision measuring and test equipment used in the inspection, whether included in Section 15.3 or otherwise, shall be in a calibrated state at the time of inspection.

16. RECORDS RETENTION

16.1 Scope

This section applies to essential records related to the design, construction, examination, and inspection of pressure retaining components and systems which must meet the requirements of CSA Standard B51.

16.2 Records Management Procedures

Procedures describing methods for retention of essential records are included in Manuals and Procedures specific to functional units involved in design, construction, examination, and inspection of pressure retaining components and systems.

16.3 File Retention Period

All files are to be retained for 10 years after the expiry date of the licence to abandon the WL site in accordance with 900-511300-FID-002, Process to Create, Capture and Use Information [28], and 900-511300-STD-003, Standard Format and Presentation of CNL Documents [29].

16.4 Engineering Records

Methods used to control design documents are described in WLD-511300-PRO-001 [30], WL Engineering Records Management.

16.4.1 Registration Files

The Registration File for pressure retaining components or systems shall contain all design registration documents used for registering the system or component.

16.4.2 Engineering Job Files

Documents contained in the Engineering Job Files are documents generated during the design process. They include but are not limited to: Design drawings, Informal document files, Formal document files.

16.5 Construction Records

Methods used to control construction documents are described in WLD -511300-PRO-002 [31], Construction Document and Record Control.

16.5.1 Construction Job Files

Documents contained in the Construction Job Files are documents generated during the construction process. They include but are not limited to Work Request and Job Index Files.

16.5.2 Registered WPS and/or BPS and PQR

Registered Welding and/or Brazing Procedure Specifications are classified as permanent records while Procedure Qualification Records are considered non-permanent records.

16.5.3 Welder's and Brazer's Qualification Records

Records of Welder and Brazer Qualification shall be retained as non-permanent records.

16.5.4 Inspection Records

Methods used to control issue and retention of Inspection records are defined in WL-508244-OP-005 [32], Documentation Control Procedure for Quality Control Records.

17. CONTROL OF PRESSURE RELIEF VALVES

RV repair and servicing will be outsourced to a vendor that is National Board certified and/or ITS authorized. WL Operating Procedure WL-508238-OP-002 [33], Control of Pressure Relief Valve will be used to control the repairing, testing, servicing and purchasing of pressure relief valves at CNL-WL.

18. REGULATORY AUTHORITY

18.1 Scope

This section applies to Regulatory interface activities for design, construction, examination, and in service inspection of boilers, pressure vessels, piping systems, and pressure retaining components and systems.

18.2 Purpose

This section describes the interface with the Regulatory Authority.

18.3 Regulatory Authority Interfaces

1. As a condition of the WL Site Licence issued by the Canadian Nuclear Safety Commission (CNSC), it is a Company obligation to assist the Authorized Inspector (AI) in the performance of their duties.
2. Requirements additional to those specified in applicable Codes and this QAP may be imposed by the Regulatory Authority.
3. The AI shall have full access to all specifications, calculations, drawings, procedural records, test results, or any other documents, and to all parts of the shop that concern the construction of pressure retaining components and systems.
4. At the discretion of the AI, re-qualification of equipment, procedures, and personnel for welding/brazing and non-destructive examinations may be required when a specific reason exists as to the validity of such qualifications.
5. The Regulatory Authority has jurisdiction over the following activities addressed in this QAP:
    a. Design Registration (see Section 7),
    b. Approval of alterations and repairs (see Section 11),
    c. Designation of “Hold Points” during construction (see Section 7),
    d. Witnessing of weld/braze procedure qualification tests and registration of Welding/Brazing Procedures (see Section 12),
    e. Witnessing and acceptance of welder/brazer performance qualification tests (see Section 12) and
    f. “Hold Point” inspections (see Section 18.6).

18.4 Contact Persons

1. The Design Representative is the contact person for matters dealing with design and in-service inspection of pressure retaining components and systems.
2. The Work Control Manager is the contact person for matters dealing with qualification of welding/brazing procedures, procedure qualification tests, and welder/brazer qualifications.
3. The QCR and/or Design Representative can act as the contact person for notifying the Authorized Inspector for “Hold Point” or final inspection of components.

18.5 Responsibilities

18.5.1 WL Work Control Manager

The Work Control Manager shall:

1. Ensure welders/brazers and welding/brazing procedure specifications to be used in construction of pressure retaining components or systems are qualified as required by Section 12, Welding/Brazing Control,
2. Ensure that an Inspection & Test Plan (PITP or MITP) is prepared in accordance with Section 9, Examination & Inspection Program,
3. Ensure completion of construction and acceptance of the item and
4. Sign the Manufacturer’s Data Report for Pressure Vessel.

18.5.2 The Design Representative

The Design Representative shall prepare the Manufacturer's Data Report for Pressure Vessel in readiness for Work Control Manager signature and AI review.

18.5.3 The Quality Control Representative

The QCR responsibilities are specified elsewhere, as follows:

1. Section 2 - Authority and Responsibility
2. Section 8 - Material Control
3. Section 9 - Examination & Inspection Program
4. Section 10 - Correction of Non-conformances
5. Section 12 - Welding/Brazing Control
6. Section 13 - Non-Destructive Examination
7. Section 15 - Calibration of Measuring and Test Equipment
8. Section 18 - Regulatory Authority

18.6 Procedure

18.6.1 Construction of Components - WL Actions

1. Construction personnel shall proceed with procurement of materials and construction of pressure retaining components and systems in accordance with "For Construction" drawings and specifications, an approved PITP or MITP, and this Quality Control Plan.
2. The Work Control Manager or Job Contact shall notify the QCR when the vessel or component is ready for AI "Hold Point" or final inspection.
3. The Quality Control Representative(QCR) interfaces with the AI for "Hold Point" and ensures the following:
   a. Design documents have been registered with the Regulatory Authority.
   b. The ITP, including required design drawings and documents, are with the component, and all operations and tests preceding the "Hold Point" have been completed and the item is ready for AI inspection.
   c. The vessel nameplate is in place and is correctly identified (see Paragraph 18.6.2.1 below).
   d. The pressure gauge to be used for a pressure test is the correct range and is in a calibrated state.
   e. The Manufacturer's Data Report for Pressure Vessel is available for AI review and signature (see paragraph 18.6.2.2 below).
   f. Welder/brazer and welding/brazing procedure qualification records are available to the AI.
   g. NDE procedures and personnel qualification records are available to the AI.
4. The Design Representative and/or QCR shall notify the AI at least 48 hours in advance for "Hold Point" inspection or final inspection. A QCR shall be present at the time of AI inspection. Subject to prior approval by the Regulatory Authority, AI inspection may involve only witnessing of pressure testing of components or systems, (as per Section 9 of this QAP).

18.6.2 AI Acceptance of Construction

18.6.2.1 Nameplate/Identification

1. Identification shall be by Nameplate stamping (See Section 20, Sample Forms List), or marking directly on the item. The Design Representative shall specify Nameplate data on the design documents in accordance with applicable Code requirements. The nameplate stamping shall include the Canadian Registration Number (CRN).
2. The completed component shall be marked by Construction personnel as required by the applicable design documents and to the satisfaction of the AI. Markings shall be legible and permanent.
3. The QCR shall verify that nameplate marking data is complete and correct.
4. The Nameplate for registered vessels will be stamped by the AI after inspection and approval.

18.6.2.2 Manufacturer's Data Report

1. When the item has been satisfactorily constructed, examined, and accepted, the Design Representative shall complete, and the Work Control Manager shall sign the appropriate Manufacturer's Data report for Pressure Vessel (see Section 20, Sample Forms List). The AI will countersign the same Report.
2. The AI and/or the Jurisdiction of the Province of installation shall be provided with one copy of the signed Manufacturer's Data Report for Pressure Vessel. A copy of the same Report shall also be filed in the Construction Job Files.

18.6.2.3 Alteration and Repair Record

The Work Control Manager and the AI shall complete and sign applicable Alteration and Repair Records (see Section 20, Sample Forms List). Copies of these reports shall be filed in WL Records.

19. REFERENCES

[1] *Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories*, WL-508200-PRO-212.

[2] *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024*, WLD-508760-HBK-002.

[3] *Pressure Boundary Training Program Requirements,* WL-508140-TPL-001.

[4] *Design Authority & Design Engineering,* 900-508120-PRD-001.

[5] *Construction Document & Record Control,* WLD-511300-PRO-002.

[6] *WL Engineering Governing Documentation Index,* WLD-508120-GDI-001.

[7] *Governing Documentation Index Design Authority & Design Engineering,* 900-508120-GDl-001.

[8] *Engineering Change Control,* 900-508130-MCP-001.

[9] *WL Pressure Vessel and System Compliance*, TN-49W82-2.

[10] ITS –Safety Bulletin OFC ITSM 18-001

[11] http://www.firecomm.gov.mb.ca/itsm_steam_pressure.html

[12] *Obtaining and Controlling Material,* WL-508238-OP-003.

[13] *General Procedure for Receiving Inspection,* WL-508244-OP-003.
[14] *Quality Program Selection,* Form, 900-514200-FM-029.
[15] *Supplementary Information Form (SIF),* 900-505210-DM-067.
[16] *Preparation of Inspection & Test Plans,* WL-508238-OP-001.
[17] *Managing Quality Control Stamps at Whiteshell Laboratories*, WL-508244-OP-010.
[18] *Control of Non-Conformances,* WL-508238-OP-004.
[19] *Improvement Action (Impact) Corrective Action Program,* 900-514000-MCP-004.
[20] *Control of Brazing/Welding Consumables,* WLCS-01913-WP-2203.
[21] *Control of Brazing/Welding Processes,* WLCS-01913-WP-2202.
[22] CAN/CGSB 48.9712, Non-destructive Testing Qualification and Certification of Personnel
[23] *Magnetic Particle Examination*, WL-508244-OP-008.
[24] *Liquid Penetrant Examination,* WL-508244-OP-009.
[25] *General Procedure for Visual Examination of Welds,* WL-508244-OP-006.
[26] *Quality Control Calibration Procedure*, WL-508237-OP-001.
[27] *WL Instrumentation Services Calibration Procedures Manual,* WLCS-108700-MAN-004.
[28] *Process to Create, Capture and Use Records*, 900-511300-FID-002.
[29] *Creation, Capture and use of Information Assets,* 900-511300-STD-003.
[30] *WL Engineering Records Management,* WLD-511300-PRO-001.
[31] *Construction Document and Record Control,* WLD -511300-PRO-002.
[32] *Documentation Control Procedure for Quality Control Records,* WL-508244-OP-005.
[33] *Control of Pressure Relief Valve,* WL-508238-OP-002.
[34] *Supply Chain,* 900-505210-PRD-001.
[35] *WL Engineering Drawing Office Manual, WLD-01150-MAN-001*

20. SAMPLE FORMS

TITLE	PAGE
Pressure Vessel Specification	50
Pressure Vessel Nameplate	51
Manitoba Labour and Immigration, Boilers and Pressure Vessels Repair & Alteration Report	52, 53 & 54
Alteration or Repair Record - Piping Systems	55
Alternative or Repair Record - Fittings	56
Manitoba Labour and Immigration, Boiler and Pressure Vessel Design Registration Application	57
Manitoba Labour and Immigration, Valve & Fitting Design Registration Application	58
Manitoba Labour and Immigration, Piping Design Registration Application for Systems Over 17 Cubic Feet	59
Manitoba Labour and Immigration, Manufacturer's Data Report for Pressure Vessels	60 & 61
Hydrostatic Test Report	62
Pneumatic Test Report	63

PRESSURE VESSEL SPECIFICATION

CONSTRUCTION CODES:

(1) CSA STANDARD B51
(2) ASME CODE, SECTION V111 - DIVISION- 1, EDITION 1992, LATEST EDITION.
(3) PROVINCIAL REGISTRATION REQUIRED - YES - WITH THE MANITOBA DEPARTMENT OF LABOUR.

(4) CANADIAN REGISTRATION NUMBER: ______________________________

MATERIAL SPECIFICATION: (UNLESS OTHERWISE SPECIFIED)

SHELL SA516 GR. 70 ELLIPTICAL HEADS: SA516, GR. 70. NORMALIZED
FLANGES: SA105N FITTINGS SA105
PIPE: TUBING:

DESIGN DATA:

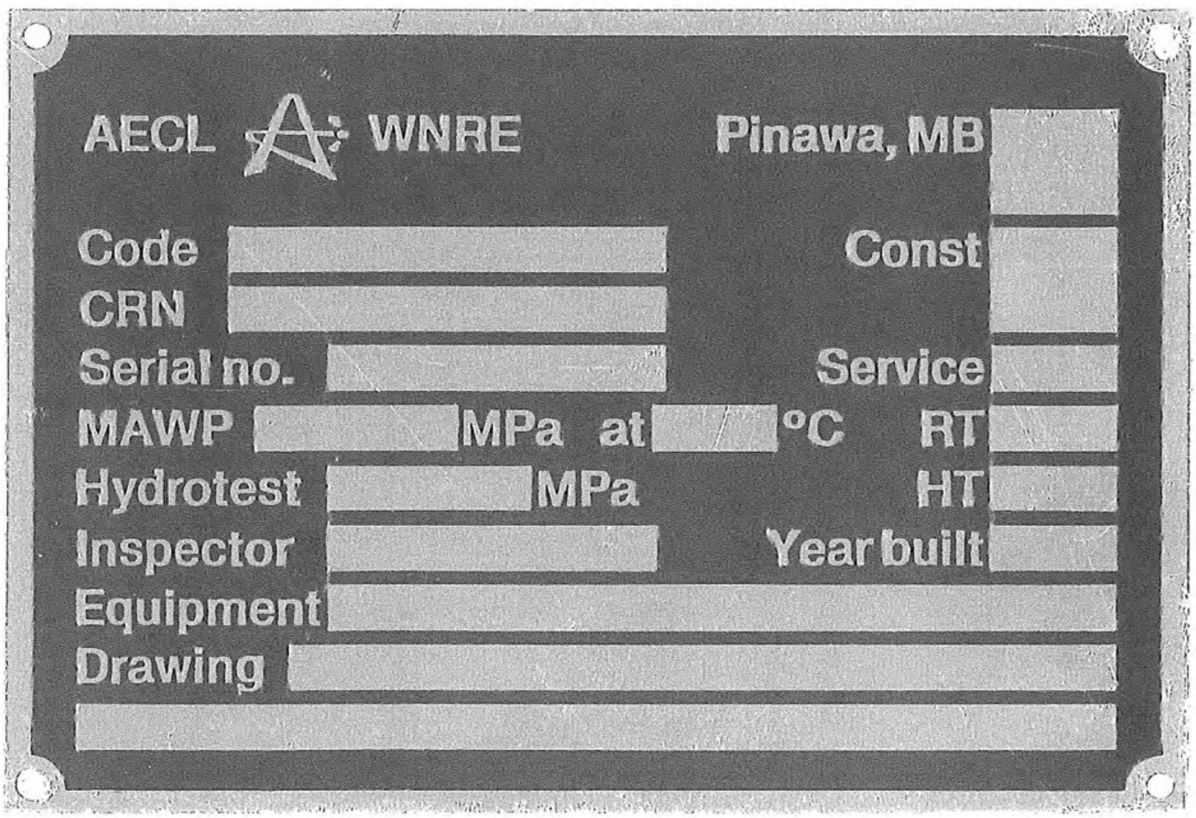
DESIGN PRESSURE: 5.0 MPa(g) (725 psig) @ 38'C (100'F)
MAX. ALLOW. WORKING PRESSURE (MAWP): 5.0 Mpa(g) (725 psig) @ 38'C (100'F)
OPERATING PRESSURE: UP TO 5.0 MPa (g) (725 psig) @ 38'C (100'F)
DESIGN STRESS: HEADS 120.7 MPa (17500 psi) 0 38'C (100'F)
DESIGN STRESS: SHELL 120.7 MPa (17500 psi) 0 38'C (100'F)
TYPE OF HEADS: ELLIPTICAL DISHED
POSTWELD HEAT TREATMENT REQUIRED: NO
LIQUID PENETRANT INSPECTION: YES, WELD ROOT AND FINAL PASS (GROOVE AND FILLET WELDS ONLY)
RADIOGRAPHIC EXAMINATION: 100%
JOINT EFFICIENCY: LONGITUDINAL: 1 CIRCUMFERENTIAL: 1
MINIMUM DESIGN METAL TEMPERATURE (MDMT): -7' C (19' F)
DESIGN CORROSION ALLOWANCE: HEAD: 3.2mm (0.125") SHELL: 3.2mm (0.125')
DESIGN THICKNESS: HEADS: (CAP) 19.0 mm (0.749") TOP FLANGE: AS PER ASME/ANSI 616.5
SHELL: 19.6 mm (0.772')
NOMINAL THICKNESS: HEADS: (CAP) 25.4 mm (1.0') TOP FLANGE: AS PER ASME/ANSI 816.5
SHELL: 25.4 mm (1.0')
HYDROSTATIC TEST PRESSURE: 7.50 MPa(g) 1088 psig AT 20'C (68'F) (HOLD FOR ONE-HALF HOUR)
VESSEL CONTAINS: DISPOSABLE GROUT CONTAINER.

MASS AND CAPACITY: (WITHOUT TEST COMPONENT)
MASS EMPTY: 3675kg (8084 lbs) CAPACITY: litres [gal.(Imp.)]

WELDING REQUIREMENTS
WELD PREPARATION AS SHOWN ON DRAWING.
WELDER AND WELD PROCEDURE MUST BE REGISTERED WITH THE MANITOBA DEPARTMENT OF LABOUR

REMARKS
ALL INTERIOR AND EXTERIOR SURFACES TO BE PAINTED WITH RED OXIDE PRIMER.

EXAMPLE


AECL
WNRE
Pinawa, MB
Code
CRN
Serial no.
MAWP
MPa at
°C
Hydrotest
MPa
Inspector
Equipment
Drawing
Const
Service
RT
HT
Year built

MANITOBA DEPARTMENT OF LABOUR AND IMMIGRAITON
MECHANICAL & ENGINEERING

BOILERS AND PRESSURE VESSELS REPAIR & ALTERATION REPORT

OWNER EQUIP NO.: ________________

REPAIR ☐ **and/or** **ALTERATION** ☐ **Partial** ☐ **Final** ☐

1. Name and Address of Organization doing Repair/Alteration ____________________

____________________ Manitoba Quality Control Program #: ____________________

Location of Installation ____________________

2. Name of Owner ____________________ Address ____________________

3. Boiler/Pressure Vessel Description ____________________ CRN ____________________

Manufacturer's Name ____________________ National Board # : ____________________ Serial No. ____________________

4. **Design Conditions**:
a) Vessel/Shellside/Boiler: Max Allowable Working Press. __________ Min/Max Design Temp ______/__________
b) Jacket/Tubeside: Max Allowable Working Press. __________ Min/Max Design Temp ______/__________

5. Description of defects (location and types of deterioration that resulted in the repair/alteration).____________________

6. **ASME Code Edition and Addenda** used for work: ASME Sect. _______ Year _____ Addenda ____________

7. **Repair/Alter. Description of Work.** Step by step description of repair/alteration method, attach additional sheets as needed.

Note 1: Repair/Alteration Procedure to be accepted by the Mechanical & Engineering Design Engineer prior to start of work.

Mechanical and Engineering District Boiler/Pressure Vessel Inspector may grant a temporary approval of the above repair/alteration in an emergency condition. This shall be used only when the pressure vessel or boiler or pressure piping is required in the continued operation of the heating or processing plant. Dept. of Labour Design Engineer approval shall be acquired within two business days.

DOL Inspector ____
NAME (Please Print) SIGNATURE DATE

8. **Material** – List any material used in repair/alteration and any base material welded on:

Item	Material Spec.	Thick/ Sch	Diam	Item	Material Spec.	Thick/ Sch	Diam
Shell/Drum				Heads/Ends			
Tubesheet				Tubes			
Nozzles				Flanges/Fittings		Class	

9. **Welding Procedure** __________ Registration Number WP-_________ WPS Numbers used: ___________________

10. **Heat Treatment:** Bake Out (Temp. /Time) ____________________________/________ Preheat Temp ______________

Post Weld HT (Temp. /Time) ______/_______

11. **Non Destructive Examination** (Specify type and extent).____

____

____

____

DEPT. OF LABOUR REPAIR/ALTERATION APPROVAL #__________________OWNER EQUIP NO.__________

12. Pressure Test Vessel/Boiler/Shellside Tubeside/Jacket

a) Hydrostatic______________________________ ____

b) Other Test_______________________________ ____

13. **Welded Replacement Parts:** Attached are Manufacturer's Partial Data Reports or Repair/Alteration Reports properly identified and signed by Authorized Inspectors for the following items of this report: (Welded parts supplied by others).____

14. **Responsibility Owner/Client:** Identify below items that the owner/client has assumed responsibility for. **Note (2)**

a) Design Submission: _______ b) Repair/Alteration Procedure: ___________ c) Material Control ___________

d) Welding Control: _________ NDE __________ f) Heat Treatment: _________g) Pressure Test ____________

Note 2: Owner/client must have a valid M.B.Quality Program for the scope of work performed, to assume responsibility for function c, d, e, f, or g.

15. **REMARKS:** ____

____

____

____

____

____

____

____

____

____

____

16. **CERTIFICATE OF COMPLIANCE**

We certify that the statements made in this Report are correct and that all design, material, construction and workmanship on this repair/alteration conform to the requirements of the Manitoba Steam and Pressure Plants Act and Regulations.

a) For all items except for items identified in 14:

____
(Repair/Alteration Organization Name)

____
(Q.C.P. Number & Expiry Date)

____
(Signature & Date)

____
(Print Name)

b) For items identified in 14 only:

____
(Owner/Client Organization Name)

____
(Q.C.P. Number & Expiry Date)

____
(Signature & Date)

____
(Print Name)

17. DATE WORK WAS COMPLETED: ________________________

18. **CERTIFICATE OF INSPECTION**

I have inspected the repairs and/or alterations described in this report. To the best of my knowledge this work has been done in accordance with the Manitoba Steam and Pressure Plants Act and Regulations.

a) Repair/Alteration Organization

____
Company Name, Q.C.P. # & Expiry Date

____
Q. C. M. Signature & Date

____
Name (Please Print)

b)

____
Mechanical & Engineering Inspector, Signature & Date

____
Print Name

Report Received by Department of Labour and Immigration
Mechanical & Engineering:

____

____
Date

NOTES:

Dept. of Labour Approval Stamp
Dept. of Labour Design Engineer

AECL EACL

ALTERATION OR REPAIR RECORD

Piping Systems

Owner/ Facility Manager: ______________________

Location (Bldg. No.): ______________________

C.R.N. for Piping System: ______________________

Project Designer: ______________________

Design Code: ______________________

Reference Drawing/Specification: ______________________

Engineering Change Notice No.: ______________________

Manufacturing Inspection and Test Plan No.: ______________________

REMARKS:

I certify that the repairs/alteration described above was done in accordance with the requirements of the WL Quality Control Manual-Pressure Retaining Components and Systems, CSA B51, ASME Codes, Steam and Pressure Plant Act.

DATE: __________ SIGNATURE: ______________________
(Construction)

INSPECTION USE ONLY

I certify that I have inspected the piping system described above and to the best of my knowledge it was repaired/altered in conformance with the WL Quality Control Manual-Pressure Retaining Components and Systems, CSA B51, ASME Codes, Steam and Pressure Plant Act.

HYDROSTATIC PRESSURE TEST: ______________________ DATE: __________

INSPECTOR: ______________________ NO. __________

AECL EACL

ALTERATION OR REPAIR RECORD

Registered Fittings

Owner/ Facility Manager: ______________________

Location (Bldg. No.): ______________________

C.R.N. for Fitting: ______________________

Project Designer: ______________________

Design Code: ______________________

Reference Drawing/Specification: ______________________

Engineering Change Notice No.: ______________________

Manufacturing Inspection and Test Plan No.: ______________________

REMARKS:

I certify that the repairs/alteration described above was done in accordance with the requirements of the WL Quality Control Manual-Pressure Retaining Components and Systems, CSA B51, ASME Codes, Steam and Pressure Plant Act.

DATE: ________ SIGNATURE: ______________________

(Construction)

INSPECTION USE ONLY

I certify that I have inspected the piping system described above and to the best of my knowledge it was repaired/altered in conformance with the WL Quality Control Manual-Pressure Retaining Components and Systems, CSA B51, ASME Codes, Steam and Pressure Plant Act.

HYDROSTATIC PRESSURE TEST: ______________________ DATE: ________

INSPECTOR: ______________________ NO. ________

Manitoba

LABOUR AND IMMIGRATION
Mechanical and Engineering Branch

BOILER AND PRESSURE VESSEL DESIGN REGISTRATION APPLICATION

500-401 York Avenue
Winnipeg MB R3C OP8
CANADA
[204] 945-3373
[204] 948-2309 Fax
www.gov.mb.ca/labour/safety

APPLICATION CHECKLIST
HAVE YOU ENCLOSED ...?

- ☐ This completed form
- ☐ Two sets of drawings/calcs/cataglogues
- ☐ If reg'd in another Jurisdiction, proof of reg'n

DATE ________________

- ☐ NEW SUBMISSION
- ☐ RE-SUBMISSION
- ☐ REVISION OR REPAIR TO REG'D DESIGN CRN ______

MANUFACTURER

Company Name		
Mailing Address		
City	Province/State	Postal Code/ZIP
Contact Person		
Telephone	Fax	E-mail
Certificate of Authority №		

SUBMITTED BY (IF DIFFERENT FROM MANUFACTURER)

Name		
Mailing Address		
City	Province/State	Postal Code/ZIP
Contact Person		
Telephone	Fax	E-mail
Certificate of Authority №		

BOILER/PRESSURE VESSEL DETAILS

EXAMPLE

Description (i.e. type of boiler; heat exchanger etc)		Existing CRN, if applicable (Attach proof of reg'n)	
Manufacturer Authorized Inspection Agency Name and Address (if vessel manufactured outside Canada)			
Drawing №	Model №	Code Built to	
Test Pressure psig @ ° F/C	Design Pressure psig @ ° F/C	Capacity	c.ft c.m
Diameter	Length	Contents	Heating Surface
Shell Thickness	Shell Material	Manitoba Stamp of Acceptance	
Head Thickness	Head Material		

OFFICE USE ONLY

Date Received	
Date Approved	
Our File No.	
CRN	

Manitoba

LABOUR AND IMMIGRATION
Mechanical and Engineering Branch

500-401 York Avenue
Winnipeg MB R3C OP8
CANADA
[204] 945-3373
[204] 948-2309 Fax
www.gov.mb.ca/labour/safety

VALVE & FITTING DESIGN REGISTRATION APPLICATION

APPLICATION CHECKLIST
HAVE YOU ENCLOSED ... ?

- ☐ This completed form
- ☐ Two sets of drawings/calcs/cataglogues
- ☐ If reg'd in another Jurisdiction, proof of reg'n
- ☐ Statutory Declaration for Reg'n of Fittings

Date___

MANUFACTURER

Company Name				
Mailing Address				
City		Province/State	Postal Code/ZIP	
Contact Person	Telephone	Fax	E-mail	
Certificate of Authority №				

SUBMITTED BY (IF DIFFERENT FROM MANUFACTURER)

Name				
Mailing Address				
City		Province/State	Postal Code/ZIP	
Contact Person	Telephone	Fax	E-mail	
Certificate of Authority №				

EXAMPLE

VALVE/FITTING DETAILS

Description	Existing CRN, if applicable
Drawing №	Catalogue №
Code Built to	Medium for which the valve/fitting is designed
	Jurisdictional Stamp of Acceptance

OFFICE USE ONLY

Date Received	
Date Approved	
Our File No.	
CRN	
Remarks	

Labour and Immigration

Piping Design Registration Application for Systems Over 17 Cubic Feet

Manitoba

Form MAE-F-0101

Room 500 - 401 York Avenue Winnipeg, Manitoba R3C 0P8 Tel. 945-3373

APPLICATION CHECKLIST
HAVE YOU ENCLOSED....?

- ☐ One form per design use
- ☐ Two sets of drawings/calcs/catalogues
- ☐ NDE Documentation
- ☐ Have all vessels and fittings been registered. Provide list of associated CRN's

Date	
Signature	

Name of Manufacturer (company name)			Postal Code/ZIP
Mailing address	City	Province/State	Phone Number
Contact Name	Email		Fax Number
Certificate of Authority No. (MB QA No.)		Expiry Date	

Ultimate Owner (company name)			Postal Code/ZIP
Mailing address	City	Province/State	Phone Number
Contact Name		Email	Fax Number

PIPING DESIGN DETAILS

Design Use (Air, Hydronic Heating, Steam, Etc.)			
Installation Name			
Installation Address		City	
Drawings Prepared By: (Firm, Stamped and signed by P.Eng)			
Drawing No.	Code Built to	Pipe Specification	System Contents
List Approved Weld Procedure Numbers			

Test Pressure ________ psig @ ________ °F/C		**Manitoba Stamp of Acceptance**
Design Pressure ________ psig @ ________ °F/C		
Capacity	c. ft	
OFFICE USE ONLY		
Date Received		
Date Approved		
Our File No.		
CRN		

EXAMPLE

Manitoba

LABOUR AND IMMIGRATION
Mechanical and Engineering

500-401 York Avenue
Winnipeg MB R3C OP8
[204] 945-3373
[204] 948-2309 Fax
www.gov.mb.ca/labour/safety

Manufacturers Data Report for Pressure Vessels

Partial ☐

Upon shipment of a boiler this form fully and correctly filled in must be mailed to the office of the Chief Inspector in the province of installation in accordance with the regulations under the Act governing the construction and installation of boilers.

Manufactured by	Name and Address of Manufacturer
Manufactured for	Name and Address of Purchaser or Consignee
Ultimate Owner	Name and Address
Location of Installation	Address

Pressure Vessel

Type	Serial Number	Year Built	Overall Length
Provincial Registration - CRN	National Board Number	Drawing Number	Diameter

The Chemical and physical properties of all parts meet the requirements of material specifications of the A.S.M.E Code.

The Design, construction and workmanship conform to the CSA B51	A.S.M.E Sec.	Division	Addenda	Code Case Number

Manufacturer's partial data reports properly identified and signed by authorized inspectors have been furnished for the following items of the report, and attached to this report:

Name of Parts	Item Number	Manufacturer's Name	Identifying Stamp

EXAMPLE

Shell

Descript'n	Mat'l	Thknss	Corr. Allow	Dia.	Longitudinal Joints Type	R.T.	Eff	P.W.H.T Temp	Time	Girth Joints Type	R.T.	Number of courses

Heads

Description	Min. Material	Thknss	Corr. Allow	Crown Radius	Knuckle Radius	Ellipse Ratio	Conical Apex Angle	Hemi Radius	Flat Dia	Side to Pressure

Removable bolts used (describe other fastenings)	Material Specification	Grade	Size

Pressure – Temperature

Pressure Vessel Part	Constructed for MAWP	At Max Temp (°C)	Min Temp @ pressure	Test Pressure (hydrostatic, pneumatic or combination)
			°C @ kPa	

Manufacturers Data Report for Pressure Vessel, Page 2

Tube section

Tubesheet	Material	Diameter	Nominal Thickness	Corr Allowance	Attachment
Tube	Diameter	Nominal Thickness	Number	Type (Straight or U)	Heating Surface

Jacket

Type of Jacket	Jacket Closure	Proof Test	Heating Surface	Sketch

Safety Valve Outlets

Number	Dimension	Location

Nozzles and Openings

Purpose	Number	Dimension	Type	Material	Nom Thknss	Reinforce Material	How Attached	Location

Supports

Skirt		Lugs	Legs	Other	Attached
Yes ☐	No ☐				

Remarks

Certificate of Compliance

We certify that the statements made in this data report are correct and that the said vessel has been constructed in accordance with the Provincial Registered design below and the requirements of Standard CSA B51.

Provincial Registered Design ____________________

Manufacturer ____________________

Signature ____________________

Date ____________________

Certificate of Shop Inspection

I, the undersigned, a duly authorized Boiler and Pressure Vessel Inspector
Employed by ____________________

of ____________________
have inspected the above vessel and state that to the best of my knowledge and belief, the manufacturer has constructed the vessel in accordance with the Provincial registration CRN: __________
and the requirements of standard CSA B51.

Inspector's Name ____________________

Signature ____________________

Date ____________________

Certificate of Compliance/Field Work

We certify that the field inspection of all parts of the vessel conforms with the requirements of Provincial Regulations

Installer's Name ____________________

Signature ____________________

Date ____________________

Certificate of Field Inspection

I, the undersigned, a duly authorized Boiler and Pressure Inspector

Employed by ____________________

have inspected the items not covered by the Shop Inspection Certificate and the installation of the items and state that to the best of my knowledge and belief the construction and assembly of the items are in accordance with the Provincial Regulations.

Inspector's Name ____________________

Signature ____________________

Date ____________________

CNL
Whiteshell Laboratories
Quality Control

WL-508244-390-000
Official Use Only

Ref. IRR No. ________

HYDROSTATIC TEST REPORT

Design Job No. - DWG. No.	**Project - Job Title**
Spool Piece - Line - Vessel No.	**Spec. - Code - Eng. Std.**
Test Procedure No.	

TEST DATA

Test Medium	**Temperature of Test Medium**
System Vented	**Location of Pressure Gauge**
Pressure Gauge Serial Number	**Pressure Gauge Range**
Pressure Gauge Calibration Date (Due)	**Application Pressure**
Pressure Holding Time	**Examination Pressure**

TEST RESULTS

Inspector's Findings:

Weeping or Leakage	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]
Fall in Pressure	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]
Visible Permanent Distortion	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]

Comments: (If Any) ____
____

Accept ☐

Reject ☐

Inspector ____________________

Date ____________________

QA 150 (2017-11)

CNL
Whiteshell Laboratories
Quality Control

WL-508244-390-000
Official Use Only

Ref. IRR No. __________

PNEUMATIC TEST REPORT

Design Job No. - DWG. No.	**Project - Job Title**
Spool Piece - Line - Vessel No.	**Spec. - Code - Eng. Std**
Test Procedure No.	

TEST DATA

Test Medium	**Location of Pressure Gauge**
Pressure Gauge Serial Number	**Pressure Gauge Range**
Pressure Gauge Calibration Due Date	**Application Pressure**
Pressure Holding Time	**Examination Pressure**

TEST RESULTS

Inspector's Findings:

Leakage (Soap Bubble Test)	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]
Fall in Pressure	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]
Visible Permanent Distortion	**No**	[ ]
If Yes, Give Details	**Yes**	[ ]

Comments: (If Any) ______________________________
____

Accept ☐

Reject ☐

Inspector ____________________

Date ____________________

QA 152 (2017-11)

EXAMPLE

APPENDIX A CROSS REFERENCE TABLE

This cross-reference table identifies how the requirements for the QC Program for the manufacture, installation, repair, replacement and modification of pressure retaining components to the CSA B51, CSA B52 and ASME Section I, IV, VIII Div 1, B31.1, B31.3, B31.5 and B31.9 Codes are met in this QA Manual and the referenced documents.

ASME Section VIII Division 1 Section 10-2 outlines the features to be included in the written description of the Quality Control System as follows:

ASME Sec VIII-1 Quality Control System Requirement	Manual Section/Title	CSA B51/B52 Program– Supporting Procedure or Referenced Documents	Reference Company-Wide Program or Procedures
10-3 Authority and Responsibility	2. Authority and Responsibility		
10-4 Organization	3. Organization		
10-5 Drawings, Design Calculations, and Specification Control	6. Drawings, Design Calculations, and Specification Control	*Production Of Design Documents,* 900-508120-MCP-002 *Design Authority & Design Engineering,* 900-508120-PRD-001 [4] *Engineering Change Control,* 900-508130-MCP-001 [8] *Drawing Office Manual,* WLD-01150-MAN-001 *Construction Document & Record Control,* WLD-511300-PRO-002 [31] *Governing Documentation Index Design Authority & Design Engineering,* 900-508120-GDI-001 [6]	*Quality Program Selection* 900-514200-MCP-007 *Design and Development Review and Design Verification,* 900-508120-MCP-003
10-6 Material Control	8. Material Control	*Obtaining and Controlling Material,* WL-508238-OP-003 [12]	*Supply Chain,* 900-505210-PRD-001 [34] *Design and Development Review and Design Verification,* 900-508120-MCP-003

ASME Sec VIII-1 Quality Control System Requirement	Manual Section/Title	CSA B51/B52 Program– Supporting Procedure or Referenced Documents	Reference Company-Wide Program or Procedures
			Requisition of Goods and Services Using Oracle iProcurement, 900-505210-OI-001 *Supplier Qualification Activities,* 900-514200-MCP-005
10-7 Examination and Inspection Program	9. Examination & Inspection Program	*Preparation of Inspection & Test Plans,* WL-508238-OP-001 [16]	*Managing Quality Control Stamps At Whiteshell Laboratories* WL-508244-OP-010 [17]
10-8 Correction of Nonconformities	10. Correction of Non-conformances	*Control of Non-conformances,* WL-508238-OP-004 [18]	*Improvement Action (Impact) Corrective Action Program,* 900-514000-MCP-004 [19]
10-9 Welding	12. Welding/ Brazing Control	*Control of Brazing/Welding Processes,* WLCS-01913-WP-2202 [21] *Control of Brazing/Welding Consumables,* WLCS-01913-WP-2203 [20]	
10-10 Non-destructive Examination	13. Non-destructive Examination		*Magnetic Particle Examination,* WL-508244-OP-008 [23] *Liquid Penetrant Examination,* WL-508244-OP-009 [24] *General Procedure for Visual Examination of Welds,* WL-508244-OP-006 [25]
10-11 Heat Treatment	14. Heat Treatment		
10-12 Calibration of Measurement and Test Equipment	15. Calibration of Measuring and Test Equipment	*Quality Control Calibration Procedure,* WL-508237-OP-001 [26] *WL Instrumentation Services*	

ASME Sec VIII-1 Quality Control System Requirement	Manual Section/Title	CSA B51/B52 Program– Supporting Procedure or Referenced Documents	Reference Company-Wide Program or Procedures
		Calibration Procedures Manual, WLCS-108700-MAN-004 [27]	
10-13 Records Retention	16. Records Retention	*Documentation Control Procedure For Quality Control Records,* WL-508244-OP-005 [32]	*Records Management,* 900-511300-MCP-001
10-14 Sample Forms	20. Sample Forms		
10-16 Inspection of Pressure Relief Valves	17. Control of Pressure Relief Valves		*Control of Pressure Relief Valve,* WL-508238-OP-002 [33]

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Fitness for Service (PDD) REV 3

900-508230-PDD-001

Information Use

Approved by	Title	Date
David Meldrum	Mgr,Infrastructure Systems Eng	2023/07/19

Effective Date: 2023/08/02
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1. Scope and Applicability

This Company-wide Interpretation document applies to all activities unique to the Fitness for Service Function, performed by Canadian Nuclear Laboratories (CNL) across all sites. The main programs of this Functional Support Area (FSA) include Maintenance, Reliability, and Aging Management.

Maintenance applies to CNL maintained sites and facilities. Implementation of Maintenance elements is commensurate with the importance to safety, design function and required performance.

The applicability of Reliability and Aging management are best described by each specific programs and can be found in their respective management control procedure and standard.

Implementation of Fitness for Service involves the integration of key elements of Maintenance, Reliability, and Aging Management with each other and with interfacing groups and processes, such as Asset Management, Configuration Management, and Maintenance and Work Management.

This FSA excludes Informational Technology assets and systems.

2. Purpose

Fitness for Service:

- Ensures maintenance is carried out adequately and effectively.
- Decreases the likelihood, or impact of system, equipment, or component failures on nuclear safety, the health and safety of workers, public, security, environment, equipment, and property.
- Ensures safety-related systems function reliably in accordance with the relevant design and performance criteria, including any safety goals of the Facility and Canadian Nuclear Safety Commission.
- Enables evaluation of equipment, development, and implementation of long-term equipment improvement plans, monitoring of equipment performance and condition, and adjustment of preventive maintenance tasks and frequencies based on equipment performance.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [1] and the Glossary of CNSC Terminology [2] contain specific meanings for those words that require further clarification.

3.1 Definitions

Aging	The gradual change of the characteristics of a structure, system or component over time or with use. Note: One or more mechanisms may drive physical aging. Physical aging is due to physical, mechanical, thermal, electrical, chemical, irradiation and/or biological processes (aging mechanisms). Non-physical aging means becoming out of date (obsolete) due to the evolution of knowledge and technology and associated changes in codes and standards. [2]
Aging Management (AM)	Engineering, operations, inspection and maintenance actions to control, within acceptable limits, the effects of physical aging and obsolescence of structures, systems and components. [2]
Condition Monitoring	Continuous or periodic inspections, measurements or trending of the performance or physical characteristics of structures, systems and components, to indicate current or future performance and the potential for failure. [2]
Corrective maintenance	Actions that restore, by repair, overhaul or replacement, the capability of a failed structure, system or component to function within acceptance criteria. Corrective maintenance does not necessarily result in a significant extension of the expected useful life of a functional structure, system or component. Contrasted with preventive maintenance. [3]
Failure	The inability or interruption of ability of a structure, system or component to function within acceptance criteria. Also called fault. [2]
Fitness for Service	A safety and control area (SCA) that covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so. This SCA is one of the 14 within the CNSC SCA Framework. [2]
Periodic maintenance	Form of preventive maintenance consisting of servicing, parts replacement, surveillance, or testing at predetermined intervals of calendar time, operating time or number of cycles. Also termed time based maintenance. [3]

Planned maintenance	Form of preventive maintenance consisting of refurbishment or replacement that is scheduled and performed prior to unacceptable degradation of a structure, system or component. [3]
Predictive maintenance	Form of preventive maintenance performed continuously or at intervals governed by observed condition to monitor, diagnose or trend a structure, system or component's condition indicators; results indicate present and future functional ability or the nature of and schedule for planned maintenance. Also termed condition based maintenance. [3]
Preventive maintenance (PM)	Actions that detect, preclude or mitigate degradation of a functional structure, system or component to sustain or extend its useful life by controlling degradation and failures to an acceptable level. Preventive maintenance may be periodic maintenance, planned maintenance or predictive maintenance. Contrasted with corrective maintenance. [3] Also called preventative maintenance. [2]
Reliability-centred maintenance (RCM)	A process for specifying applicable preventive maintenance requirements for safety related systems and equipment in order to prevent potential failures or to control the failure modes optimally. RCM utilizes a decision logic tree to identify the maintenance requirements according to the safety consequences and operational consequences of each failure and the degradation mechanism responsible for the failures. [3]
Obsolescence	With respect to structures, systems and components, the process of becoming out of date in comparison with current knowledge, standards and technology. [2]
Preventive Maintenance Technical Basis (PMTB)	A documented justification of a component's Preventive Maintenance (PM) strategy which ties PM tasks to a component's dominant failure mechanisms.
Reliability	The ability of a structure, system or component to perform, in accordance with its defined specifications, its required function under given conditions for a defined time period or upon demand. [2]
Availability	The fraction of time that a component or system is able to function. Availability can also mean the probability that a component or system will be able to function at any given time. [2]

Run to Failure (RTF)	A maintenance strategy whereby Structures, Systems, and Components (SSCs) are run until breakdown ensues. An RTF strategy is selected when the breakdown condition is readily evident to operating staff, when replacement items or spare parts are readily available, and when safety, operational, or economic impacts of failure are acceptable.
Structures, Systems and, Components (SSCs)	A general term encompassing all of the elements of a facility or activity that contribute to protection and safety. Structures are the passive elements: buildings, vessels, shielding, etc. A system comprises several components, assembled in such a way as to perform a specific (active) function. A component is a discrete element of a system. Some examples are wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valves. [2]
System Health Report (SHR)	The System Health Report is used to document and communicate the overall condition (health) of the system based on inputs from monitoring activities and key performance indicators. The evaluation covers issues affecting the system related to aging, obsolescence, maintenance, configuration, spare parts availability, as well as design or procedural deficiencies. Short-term and long-term corrective actions and recommendations should be specified and justified, including development of strategies for major component overhauls or replacement. The System Health Report also details significant action taken, current to the time the report is prepared, and the results of the action, if available.
System Performance Monitoring Plan (SPMP)	The SPMP will identify key system functional requirements, degradation mechanisms, methods, and frequencies to monitor degradation and system performance indicators.

3.2 Acronyms

AM	Aging Management
CM	Corrective Maintenance
CMMS	Computerized Maintenance Management System
DfM	Design for Maintainability
PM	Preventive Maintenance
PMTB	Preventive Maintenance Technical Basis
RCM	Reliability-Centered Maintenance

RTF	Run to Failure
SHR	System Health Report
SHT	System Health Team
SPMP	System Performance Monitoring Plan
WP&C	Work Planning & Control

4. Roles and Responsibilities

The roles described are functional titles that may be fulfilled by different positions within line organizations. Some of those roles maybe fulfilled by the same person.

4.1 Functional Support Manager

The Functional Support Manager (FSM) is responsible for:

- Establishing and maintaining effective Fitness for Service programs for CNL maintained facilities that meet the requirements as described in *Fitness for Service* Program Requirement Document [4].
- Planning, resourcing, and overseeing the development of Fitness for Service documentation, and training of the Fitness for Service processes and related documents.
- Approving and releasing company-wide Fitness for Service process documents.
- Supporting facilities in the implementation of the Fitness for Service programs.
- Establishing performance indicators to determine the effectiveness of the program and performing routine self-assessments to ensure adequacy and effectiveness of Fitness for Service processes and procedures.
- Reporting to the Responsible Executive on the process performance and any non-compliance issues.
- Benchmarking with external organizations to promote incorporate of industry best practices.

4.2 Maintenance Technical Representatives

Maintenance Technical Representative is used to describe a functional role that has been assigned maintenance and reliability technical responsibilities. Positions that fulfill this role may include, but are not limited to, titles such as System Engineer, Component Engineer, Maintenance Specialist or Maintenance Engineer.

Maintenance Technical Representatives are responsible for:

- Conducting component evaluation and categorization.
- Developing Technical Basis for PMs (PMTB).
- Acting as a technical expert to Asset Custodians and Maintenance and Work Management group.

- Investigating causes of equipment failures and initiating corrective actions to prevent recurrence.
- Monitoring the effectiveness of the PM activities and making changes to the strategy based on the results.
- Engaging Maintenance Personnel in assessment activities to promote continuous improvement of the program.
- Benchmarking industry best practices and driving continuous improvement to PM implementation.

4.3 Maintenance and Reliability Subject Matter Experts

Subject Matter Experts (SMEs) are resources knowledgeable in maintenance, reliability, and aging management requirements and standards. SMEs are appointed by the FSM.

SMEs are responsible for supporting the implementation of the Fitness for Service FSA, by providing subject matter expertise in different fitness for service areas. This role may also be performed by the Maintenance Technical Representative. Specifically, the SMEs assist the FSM in:

- Providing Company wide support and guidance on the Fitness for Service function and its interfacing functions within the Management System.
- Developing and maintaining the implementing Fitness for Service functional documents.
- Monitoring compliance to document requirements, assessing record preparation and retention, completion assurance, final distribution and storage of records.
- Planning and conducting various surveillance activities, reviews, and assessments on the implementation of the Fitness for Service function, and participating in internal or external audits as the Fitness for Service SMEs.

4.4 Maintenance Personnel (Workers)

Maintenance Personnel encompasses workers who are formally qualified and licensed for particular certified trades under a provincial or federal jurisdiction. Maintenance Personnel may also include workers who are not certified trades people but have been trained and qualified to perform specific facets of trades-related work such machinery lubrication or verifying functionality of electrical systems (such as Electrical/Mechanical Service Attendants).

Maintenance Personnel are responsible for:

- Performing only work activities that they are trained and qualified to perform.
- Performing work in accordance with instructions and adhering to all the requirements of the supporting documents, permits and clearances.
- Documenting as-found-condition and maintenance results and providing feedback, comments, or recommendations to drive improvements on completion of work.

4.5 Line Management

Line Management includes roles such as Facility Authorities (FAs), Facility Managers (FMs), Managers Responsible for System Health, and Maintenance Managers and Supervisors. Line Management has overall responsibility for the systems in their facility.

Management is responsible for:

- Overseeing the implementation of and the compliance to the Fitness for Service processes within their facility.
- Ensuring that necessary surveillance, monitoring, maintenance, or inspection activities are carried out and providing program metrics to measure performance.
- Implementing actions related to Fitness for Service issues or deficiencies that put facility safety or operations at risk.
- Ensuring Maintenance Technical Representatives are nominated for their area.

4.6 System Specialists

A System Specialist is a person assigned as the system performance owner for the individual system as per the Equipment Reliability Program and provides oversight of system performance improvement.

The System Specialists are responsible for:

- Developing and maintaining System Performance Monitoring Plans (SPMPs) for assigned systems.
- Preparing System Health Reports (SHRs).
- Acting as the lead of the System Health Team (SHT).
- Reporting on system issues and developing improvement actions.
- Monitoring results of improvement initiatives.

4.7 System Health Team

A System Health Team (SHT) consists of people with an interest in the performance of a system such as, the System Specialists, FMs, FAs, System Users / Customers. The members of the SHT support the System Specialist in creating an accurate description of a system’s health and work together to increase the long-term reliability of that system. Together they initiate actions that lead to improved reliability, including the following:

- Monitoring system and equipment performance.
- Identifying common and recurring problems.
- Executing Aging Management plans.

5. Functional Programs

Fitness for Service is an intrinsic part of implementing CNLs Property/Asset Management strategy. Fitness for Service ensures availability of assets as defined by CNLs Strategic Plans and systems specific Asset Management Plans [5]. Fitness for Service involves various activities throughout the period of service life. The Fitness for Service FSA ensures all these activities are managed in a systematic way, by planning and coordinating three specific programs of Fitness for Service: Maintenance, Reliability, and Aging Management. Due to complexity of covering all possible scenarios for specific sites, some latitude has been incorporated into the Functional Programs.

When implemented together, Maintenance, Reliability, and Aging Management interact to provide each program the means to achieve their program specific goals. The aging management and reliability requirements provide information to the maintenance program for the identification, selection and frequency of maintenance activities to maintain the effectiveness of a system. Consistent PM leads to improvements in failure trends. Maintenance activities, both preventive and corrective, compensate for degradation of equipment due to aging. Consideration of operation and maintenance history then provides information on how the maintenance program affects system reliability and understanding of how systems age. This systematic and integrated approach in turn provides important inputs to maintenance and operations (information is fed back into the maintenance program to improve its effectiveness).

Assets such as vehicles and tools are maintained differently than SSCs due to their mobile nature, and the ability, or often requirement, for service to be performed offsite by external bodies.

To ensure efficient implementation, Fitness for Service requires a minimum of maintenance related information to be compiled. At least, a Computerized Maintenance Management System (CMMS), or an equivalent process, is used to control the initiation, planning, scheduling, execution and close-out of maintenance work and to maintain electronic records of maintenance history. An Enterprise Asset Management System (EAMS) may also be used at some of CNL sites. An EAMS allows use of a unified platform for managing assets across the enterprise. An EAMS includes maintenance management capabilities such as those found in CMMS, but offers a broader range of features [6].

The information management system (CMMS or EAMS) interacts with CNL Facility Information System (FIS) to ensure that their basic asset information matches the one in FIS (building and room structure, approval authorities, building contacts such as, Area Owner, FM, FA and designates, etc.)

The Uptime® Elements™ model [7] provides a source of industry best practices to include in CNL's Fitness for Service approach which have provided input into Fitness for Service processes. CNL has not fully implemented all elements of the model. CNL is on a 'reliability journey'. As such, the Uptime® Elements™ model provides a roadmap for CNL to enhance availability and reliability and ensure fitness for service.

Figure 1 presents an overview of the Fitness for Service framework and Figure 2 provides an overview of the Uptime® Elements™ model.

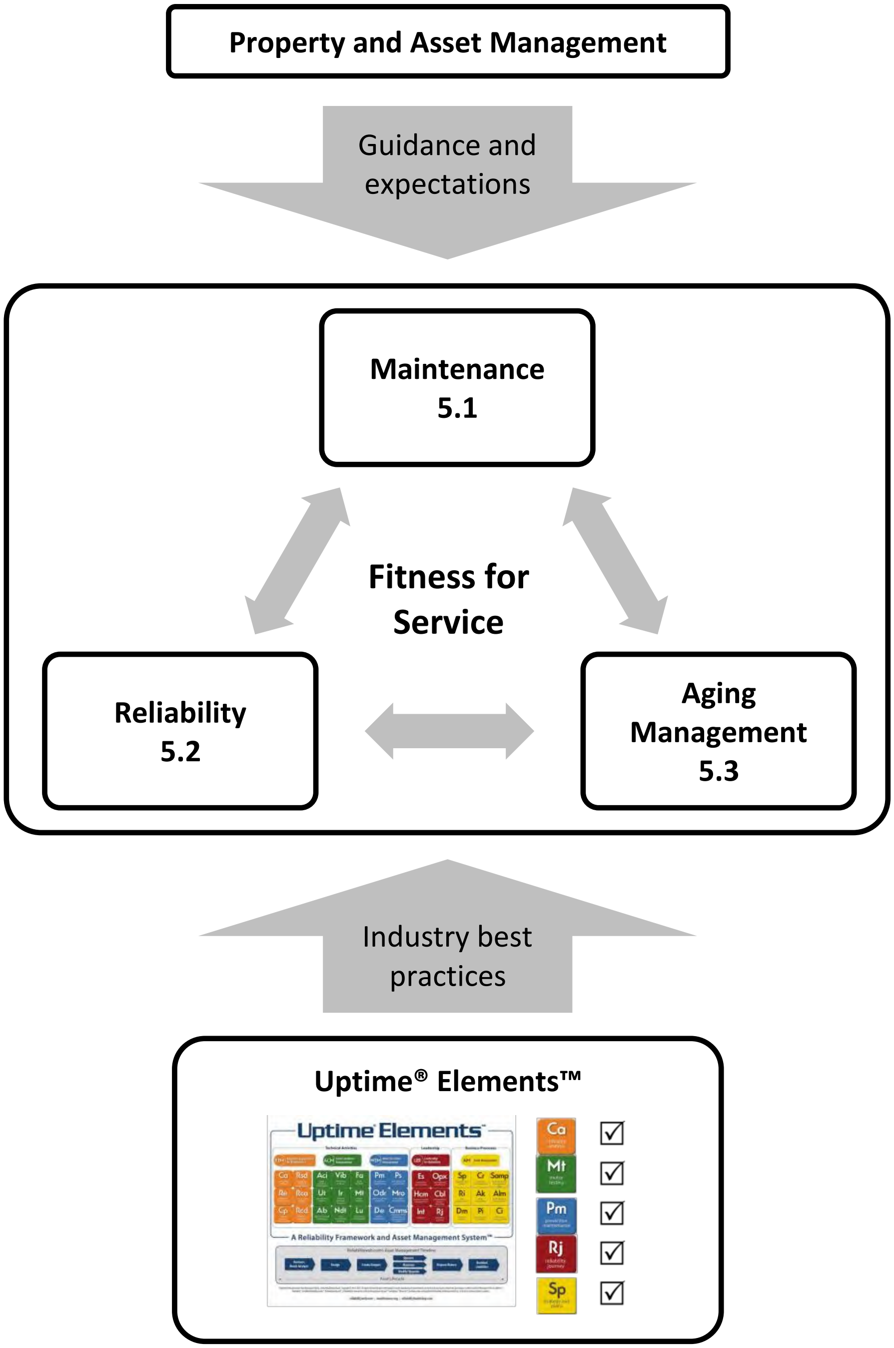

Figure 1: Overview of the Fitness for Service framework.

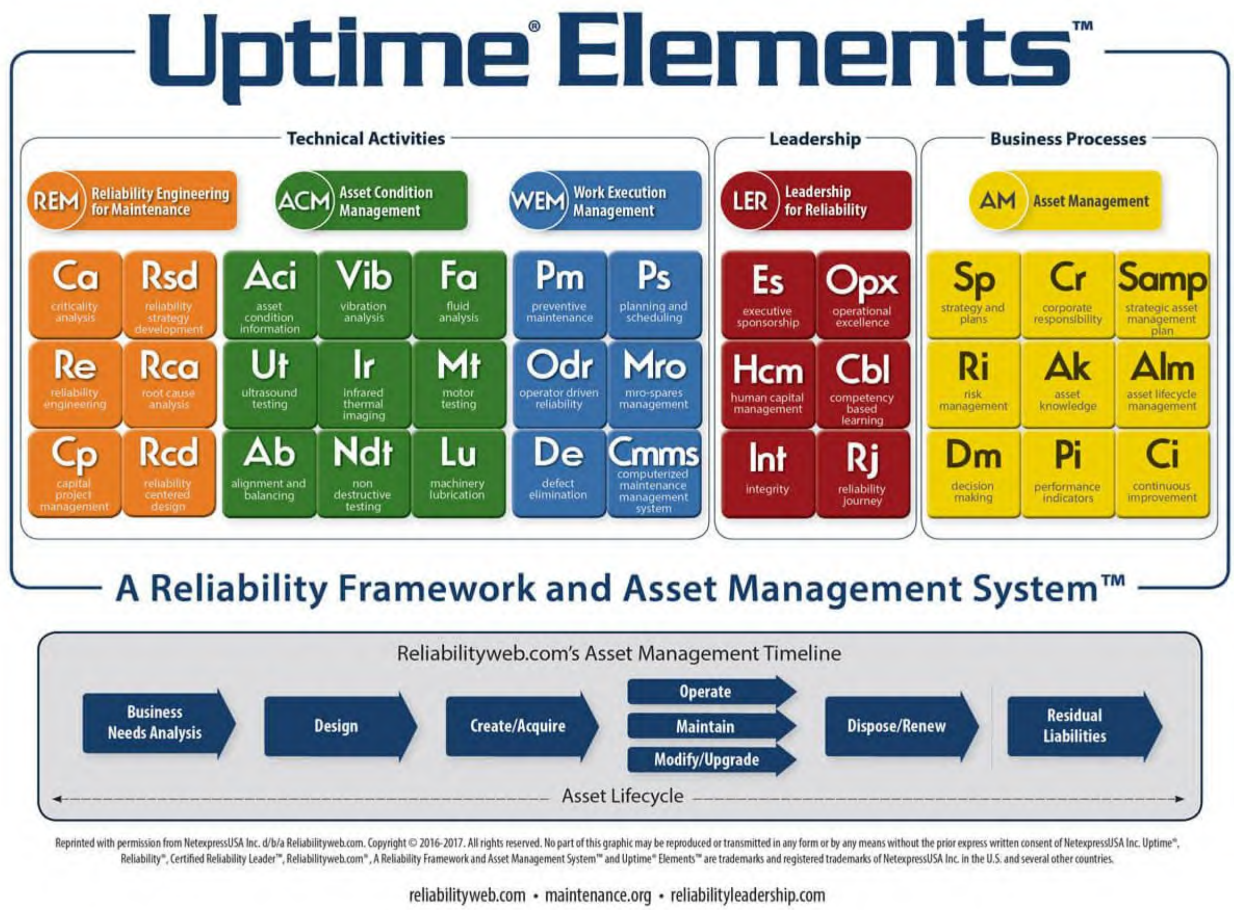

Figure 2: Uptime® Elements™ model overview.

5.1 Maintenance

5.1.1 SSC Maintenance

This section contains an overview of the elements and activities that form the basis for all implementing procedures of the Maintenance process.

The primary objective of the Maintenance process is to provide Asset Custodians with a strategy, identifying which maintenance activities are to be performed, on which SSC's, and at what intervals. The type and frequency of maintenance activities applied to each SSC are commensurate with the importance to safety, design function and required performance.

CNL Maintenance process supports Fitness for Service in ensuring that SSCs are maintained in such a way that they function as per design, and that equipment availability and reliability margins support customer expectations. Elements of this process help to improve the life and reliability of the SSC as well as avoid any unplanned maintenance activities.

Consideration for maintainability must be included early during the design phase. This is done by applying Design for Maintainability (DfM) concepts. DfM allows for the integration of operations and maintenance considerations into project planning and design to achieve effectiveness, safety, and economy of maintenance tasks during the lifespan of an asset.

Figure 3 provides an overview of the maintenance process.

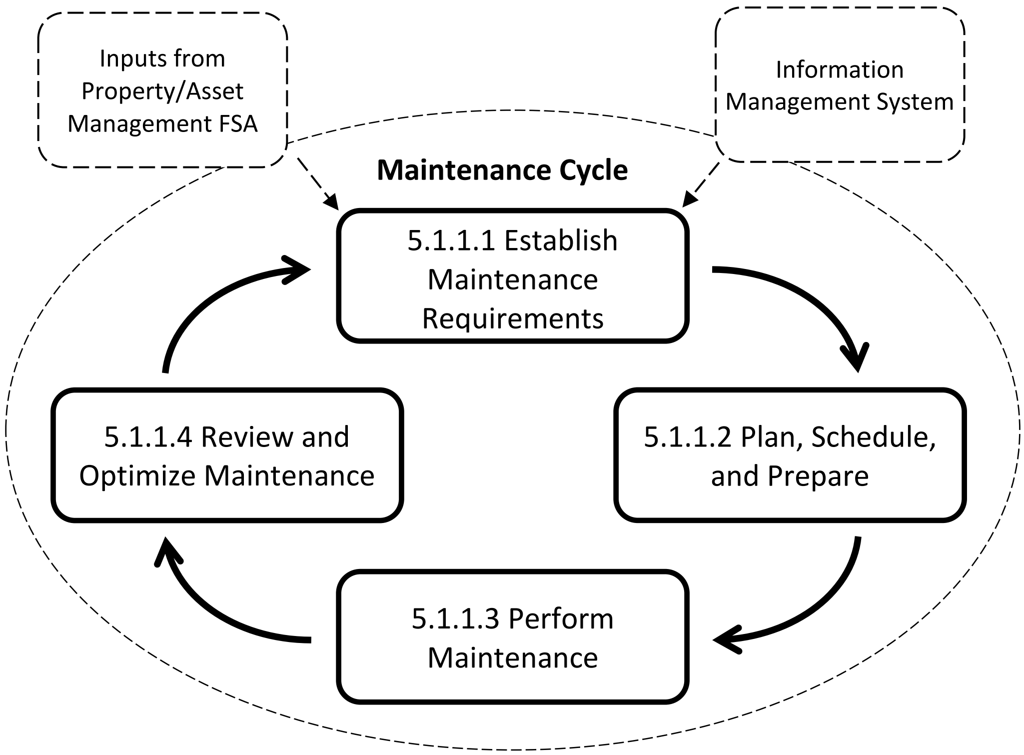

Figure 3: Overview of the Maintenance process.

5.1.1.1 Establish Maintenance Requirements

Establishing maintenance requirements for SSCs forms the bases of the entire Maintenance process. The key elements are listed below in Figure 4.

Figure 4: Establish maintenance requirements.

Identification of SSCs and Their Importance
This area identifies all the SSCs that may require maintenance to meet the program objectives. The primary source of this information is the Master Equipment List (MEL) available in the CMMS or the EAMS. The inclusion of all SSCs to be maintained and the accuracy of the information within MEL is critical to the program throughout the entire lifecycle of the SSC requiring participation and cooperation of all functions. This includes Design Authority and Design Engineering, Construction, Commissioning, Supply Chain, and Configuration Management during initial phases of asset lifecycle but also during latter phases of the asset lifecycle (such as Dispose/Renew). Once SSCs are identified they are categorized based on their relative importance.

Maintenance Categorization
Maintenance Categorization [8] describes the process for categorizing components at CNL. This process provides clear understanding of which components merit most attention and ensures PM and equipment reliability resources are expended on the right equipment. Some of the main inputs to categorization include assets information, expected level of service, reliability, performance, and availability. These inputs are obtained from design documentation, systems specific Asset Management Plans [5], MEL, as well as expressed by the Asset Custodians. The equipment category chosen through this process determines if the PM strategy optimizes reliability or reduces total maintenance cost.

Identification of Maintenance Tasks
Selection of the required PM task and frequency is based on categorization of the SSCs. PM tasks are developed based on design or regulatory requirements, manufacturer's recommendations, OPEX, and codes and standards. This includes applicable maintenance requirements for Pressure Boundary ([9] [10] [11]) and Electrical Safety (Section 5 of [12]). It also considers any reliability results from SHRs (Section 5.2 and [13]) and criticality, duty cycle, and service condition. This technically based maintenance strategy for equipment is documented into PMTB. The objective is to have a maintenance strategy which provides the highest reliability for category 1 and 2 equipment, and the lowest total maintenance cost for category 3 equipment. *Preventive Maintenance* [14] describes the process for implementing PM activities. The process is a living cyclical one starting with the development of PM strategies and developing PM jobs then following the PM work order cycle of planning, scheduling, execution and returning with reviewing results and optimization of the PMs (see additional details in Section 5.1.1.2, 5.1.1.3, and 5.1.1.4). CM activities form a percentage of the overall maintenance strategy for components that are categorized as "Run-to-Failure" (RTF).

5.1.1.2 Plan, Schedule, and Prepare

This element consists of PM jobs and tasks development as well as an integrated set of processes for Work Planning & Control (WP&C). This ensures that maintenance activities are properly screened, planned, scoped, prepared and scheduled for execution. The level of detail of the actions associated with this element are commensurate with the nature of the work. A graded approach is applied so work can be performed in a safe, efficient, and effective manner.

Typically, incoming maintenance work requests are screened to determine how work will be planned, prioritized and executed. Scoping happens at the individual job level and scheduling level to determine what work will be performed and in what given time frame the work will occur. Schedules are developed that integrate all scoped work into a specific work week. Finally work is prepared for stakeholder review to ensure work can be supported and performed as scheduled.

Preventive Maintenance [14] provides details on maintenance planning, scheduling, and preparation considering that those activities are specific to the CMMS or EAMS utilized to manage maintenance activities. In addition, due to the complexities of defining WP&C across CNL, Line Managements are required to develop specifically tailored flow down processes that align with each mission and organizational structure and that adhere with the elements of the overall Maintenance process. *Maintenance Work Planning & Control* [15] provides requirements and guidance on maintenance WP&C process at CNL. In all cases, work is planned in accordance with requirements and standards from the Integrated Work Control (IWC) process [16].

5.1.1.3 Perform Maintenance

This element constitutes the field work portion of the Maintenance process. It is supported by all the other maintenance process elements to ensure that the correct maintenance activities are performed on SSCs at the appropriate time. It also ensures that SSCs are in the proper configuration and maintenance is carried out using approved work instructions and parts.

Some support activities are required for the safe and effective performance of maintenance. Typically, the implementing Line Organization ensures that activities and services such as the following, are established and provided:

- Staffing, hiring, and training for maintenance activities (including skilled trades and contractors).
- Work control and oversight of CNL maintenance personnel and temporary and contract personnel.
- Parts and material management (including consumables).
- Availability and calibration of measuring and test equipment.
- Availability and servicing of maintenance tools.
- Availability of manufacturer’s manuals and equipment files.
- Maintenance shop services.

This element also includes the proper documentation of the as-found-condition and any observations, feedback, or recommendation related to the maintenance activity performed. This will support further review and optimization.

Preventive Maintenance [14] provides details on performance of maintenance activities (PM execution). In addition WP&C processes (developed as per [15]), support the process to ensure the safe, effective, and efficient execution of all work performed by Site Maintenance personnel.

5.1.1.4 Review and Optimize Maintenance

The review and optimization element drives continuous improvement in the Maintenance process but also provides meaningful performance data to the Reliability and the Aging Management process. Implementing processes use the data and metrics from the other elements to provide the feedback loop necessary to assess the effectiveness of those processes. This impacts those elements in the following ways:

- Reviewing PM trade execution feedback, job closing comments, and as-found-condition-codes provides the information required to continually improve the quality of work instruction provided and to make adjustment to maintenance strategy for an SSC (Condition Based Maintenance / Predictive Maintenance).
- Post execution critiques of the scheduled work identify issues and opportunities related to the scoping, planning, scheduling, and preparation elements.
- Maintenance rework tracking can drive improvements in maintenance work practices, as well as help identify chronic equipment performance trends.

- Maintenance data review and maintenance WP&C activities review, are used as inputs to System Health monitoring process to maintain and improve levels of safety and reliability (see Section 5.2).

Review and optimization of maintenance also includes self-assessment and audit on Line Management maintenance related key performance indicators to help assess the overall health of the Maintenance process.

Preventive Maintenance [14] provides an overview of PM review and optimization. *Maintenance Performance* [17] provides further detail on maintenance review and performance measurement.

5.1.2 Non-SSC Maintenance

Fleet Maintenance

The Fleet Maintenance [20] process applies to non-SSC assets that can be described as vehicles (cars, heavy equipment, UTVs), mobile (trailers, portable containers) or combustion powered tools (chainsaws, generators, etc.).

The fleet maintenance process ensures:

- Vehicles are maintained to be safe for operation.
- Vehicles are maintained to be reliable.
- Vehicles are maintained to ensure the validity of their warranties.

Fleet maintenance will be tracked in a CMMS or Fleet Database and maintenance history will be recorded to document maintenance for warranty, recall, and asset management purposes.

5.1.2.1 Tool Maintenance

The tool maintenance process applies to non-SSC maintainable tools. This does not include calibrated monitoring and measuring equipment which is maintained and calibrated under *Care and Control of Calibrated Monitoring and Measurement Equipment* [18].

The tool maintenance procedures ensures that:

- Maintainable tools are safe for operations.
- The tools are available when needed.
- Tool lifecycle costs are minimized.

5.2 Equipment Reliability

The Reliability Program provides a framework (Figure 5) for the collection of data coming from system performance, maintenance activities, and asset condition surveillance, and transforming the data into information to be used to meet the reliability and availability requirements specified by the Property/Asset Management function. The *Equipment Reliability Program* [13] describes this process of monitoring system and equipment performance and recommending appropriate changes or improvements.

The degree of applicability of the Reliability process is proportional to the reliability/availability required on the system and the system complexity. Some systems require few or none of the aspects of the Reliability process, while others will need all aspects of the process and a substantial technical effort and financial investment to achieve their reliability and availability goals.

Which aspects are applicable and recommended for a system are determined on an individual system basis, taking into consideration the complexity of the system, where it is located, reliability/availability targets, accessibility and the quality and condition of the equipment installed. The reliability/availability target are specified, and a strategy to achieve that target is created by taking the aforementioned aspects, and budget, into consideration. It is expected that if targets are not met, the missed targets are not a failure of the Reliability process but will provide guidance towards improved engineering designs, staffing adjustments, or adjusted resources, and lead to a better understanding the reliability budget going forward.

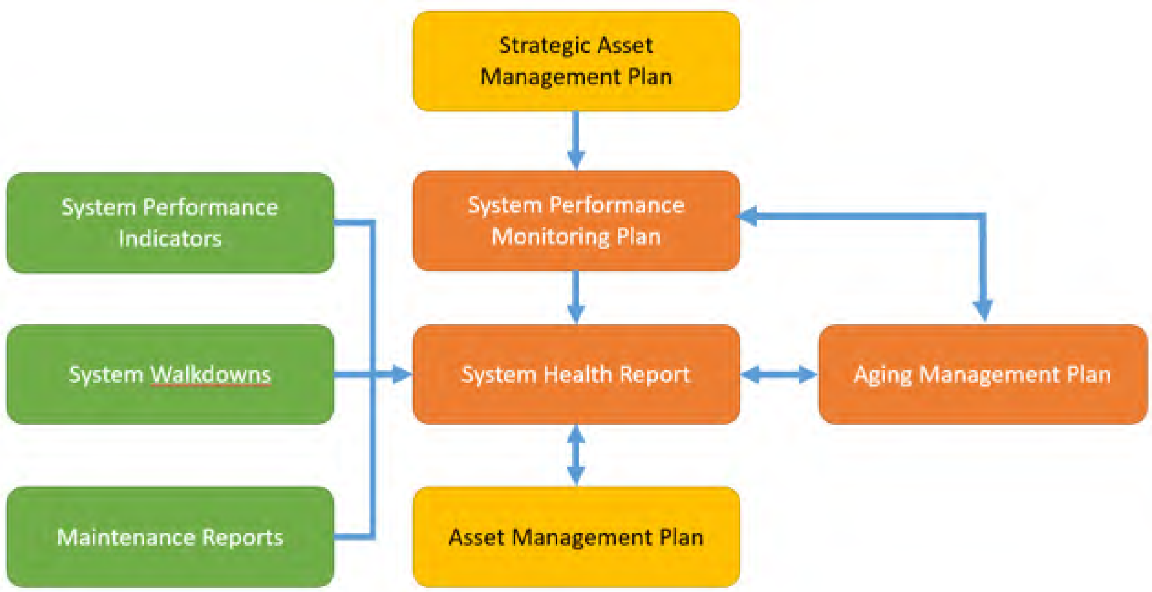

Figure 5: Reliability framework.

Consideration for reliability and availability requirements must be included early during the design phase. This should be done by applying the concept of Reliability Centered Design. Reliability Centered Design ensures that reliability, maintainability, availability, safety, and sustainability are design attributes and are addressed during capital project execution.

5.2.1 Understand Current Threats to Reliability

There are many factors which can compromise the reliability of an SSC. Included below are several measures that are used to indicate when reliability has been compromised. The application of which methods and their level of implementation for determining threats to reliability are determined by the system health team based on the level of reliability required for the system.

System Walkdowns
System Walkdowns should be performed and documented [19] to maintain awareness of system conditions and status. System Walkdowns provide an opportunity to trend the condition of a system, and track reliability. This information is part of the monitoring activities that form the basis of the SHR.

System Parameter Trending
Key system parameters are identified in the SPMPs. Trending and evaluation of these parameters is part of the Equipment Reliability Process and significant trend variations are assessed and reported through the Equipment Reliability Reporting Process. System parameter trending provides valuable information on the reliability of a system.

Aging Management
The changes in reliability of SSCs with respect to age related degradation should be understood. Condition monitoring through preventive maintenance and performance measures determined in SPMPs are used to identify degradation that will impact the reliability of SSCs. SHRs will trend performance over time to identify long-term degradation. SSC Specific Aging Management plans may be used to manage aging. Life management plans and storage with surveillance plans may also be used to manage the aging of SSCs.

5.2.2 Identify and Mitigate Unexpected Failures

Risk mitigation implementation is the process of executing risk mitigation actions. Risk mitigation progress monitoring includes tracking identified risks, identifying new risks, and evaluating risk process effectiveness throughout the work. Below are several measures to utilize for risk mitigation as appropriate to the value and complexity of the asset and the scale of severity of the risk.

System Health Reports (SHRs)
SHRs consolidate information from a number of sources to create a snapshot of the health and reliability of a system. These periodic reports are designed to document and communicate system health status. SHRs are also used to identify potential system threats in a comprehensive and actionable format, based on performance goals and targets to address equipment failures, degraded conditions or improvement opportunities, and provide clear direction and ownership of the decided path forward, including closure criteria.

5.3 Aging Management

Aging Management consists of an integrated set of actions to control the effects of physical aging and obsolescence of SSCs throughout their entire lifecycle, from design to fabrication, construction, installation, commissioning, operations, and decommissioning. Systems specific Aging Management Plans derived from systems specific Asset Management Plans [5] provide applicability and strategies for aging management. *Maintenance Categorization* [8] describes the process for SSCs categorization which supports identifying aging management applicability.

Effective implementation of aging management strategies depends on maintenance activities being carried out at the scheduled frequency and following the proper procedures. The PMTBs developed as part of the PM process [14] include aging management strategies and recommendations documented in SPMPs.

SSCs as-found-condition, maintenance history, and performance data gathered through execution of maintenance activities [14] and maintenance review and optimization [17], as well as other aging related failures or significant degradation, help understand aging challenges and assess aging degradation effects on SSCs. Corrective actions may then be initiated by revising aging management strategies (systems specific Aging Management Plans [5]) and implemented through revision of PMTB and maintenance activities [14].

6. Interfaces

6.1 Internal Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Construction	• Ensuring that configuration information is kept up to date with modifications and new installations. • Drawings reflect changes. • Assets properly labeled to match design.	Meetings, email, telephone	Directors, Managers, Department Staff

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
	• MEL is updated (positions & assets). • Manufacturer's manuals and information is properly gathered and turned over. • Construction activities that use the maintenance elements are defined and controlled.		
Commissioning	• Ensuring that configuration information is kept up to date with modifications and new installations. • Drawings reflect changes. • Assets properly labeled to match design. • MEL is updated (positions & assets). • Relevant commissioning data is properly turned over. • Manufacturer's manuals and information is properly gathered and turned over. • Maintenance requirements are established.	Meetings, email, telephone	Directors, Managers, Department Staff
Environmental Remediation Management	• SSCs reviewed and categorized based on importance and life cycle. • PMs are adjusted based on SSC review. • MEL is kept current through the decommissioning cycle for all SSCs. • Ensure maintenance is performed to align with this PDD.	Meetings, email, telephone	Directors, Managers, Department Staff
Design Authority and Design Engineering	• Maintenance of facility configuration documents, drawings to support maintenance, including MEL. • Provide oversight of all SSCs and overall ownership of the MEL.	Meetings, email, telephone	Directors, Managers, Department Staff

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
	• Own technical basis for maintenance activities on safety related and safety support SSCs. • Ensuring the design and safety requirements established for SSCs including maintenance requirements. • Provide engineering support on defining maintenance activities. • Design and implement changes to plant SSCs such that they meet codes, standards and requirements. • Specifying replacement parts. Procurement engineering and ensuring MEL, reflects changes.		
Configuration Management	• Maintenance of facility configuration documents, drawings to support maintenance, including MEL. • Provide oversight of all SSCs and overall ownership of the MEL. • Own technical basis for maintenance activities on safety related and safety support SSCs. • Ensuring the design and safety requirements established for SSCs including maintenance requirements. • Provide engineering support on defining maintenance activities. • Design and implement changes to plant SSCs such that they meet codes, standards and requirements. • Specifying replacement parts. Procurement engineering and ensuring MEL, reflects changes.	Meetings, email, telephone	Managers, Department Staff
Infrastructure Development	• Refer complex real property systems which may benefit from the Reliability process.	Meetings, email, telephone	Managers, Department Staff

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Fire Protection	• Integrated Work Control.	Meetings, email, telephone, walkdown	Department Staff
Occupational Safety and Health	• Provide services to implementing organization (e.g. Integrated Work Control, Hazard identification, work risk reviews, working at height plans, PP&C requirements, IH). • Maintaining processes that support the maintenance cycle.	Meetings, inspections, walkdown, email, telephone	Directors, Managers, Department Staff
Pressure Boundary	• Provide oversight to ensure maintenance activities are compliant to requirements.	Meetings, inspections, email, telephone	Directors, Department Staff
Procurement and Supply Chain	• Establish processes to procure, receive, store, secure and issue spare parts, tools and materials for maintenance. • Ensure qualified suppliers are identified for replacement parts. • Ensure qualified contractor for performing maintenance are provided. • Ensure a process exists to perform PM on materials and equipment in storage. • Manage obsolescence actions / spare parts.	Meetings, email, telephone,	Directors, Managers, Department Staff
Property/Asset Management	• Integrate with Fitness for Service Function to ensure a consistent approach to the management of asset conditions and risks, maintenance, and investment priorities. • Provide Asset Management Plans. • Provide long term strategies for asset management as inputs to Maintenance process.	Meetings, email, telephone	Asset Custodians, Property/Asset Management Advisory Committee, Director Asset Management

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
	• Refer complex real property systems which may benefit from the Reliability process.		
Radiation Protection	• Provide resources required to support work. (E.g. Integrated Work Control, providing radiological work plans, radiations surveys, participate in planning/scheduling).	Meetings, email, telephone	Directors, Managers, Department Staff
Safety and Licensing	• Provide Safety Related systems list and Safety Related equipment list. • Review the output of aging management monitoring to verify the validity of the safety case.	Meetings, email, telephone	Directors, Managers, Department Staff
Waste Management	• Manages the program to ensure that waste materials produced form maintenance activities are properly stored or disposed.	Meetings, email, telephone	Directors, Managers, Department Staff
Electrical Safety	• Provide oversight to ensure maintenance activities are compliant to requirements. • Integrated Work Control.	Meetings, email, telephone	Directors, Managers, Department Staff

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
TSSA	• Inspection of Pressure Boundary and elevators related work.	Meetings, formal correspondence, site visits	Directors, Managers, Department Staff
Local or regional Authorities Having Jurisdiction (such as Ontario ESA)	• Inspection of Electrical related work.	Meetings, formal correspondence, site visits	Directors, Managers, Department Staff

7. References

[1] *Glossary of Controlled Terms and Acronyms*, Terms and Definitions

[2] *Glossary of CNSC Terminology*, REGDOC-3.6, Canadian Nuclear Safety Commission, December 2019.

[3] *IAEA Safety Glossary : Terminology Used in Nuclear Safety and Radiation Protection - 2018 edition*, International Atomic Energy Agency, Vienna, June 2019.

[4] *Fitness for Service*, 900-508230-PRD-001, 12494664.

[5] *Property/Asset Management*, 900-508400-PDD-001, 35284904.

[6] Tracy S. Smith, *EAMS/CMMS – Know the Difference*, Reliabilityweb.com, Accessed on: 2020/07/30. [Online]. Available: https://reliabilityweb.com/articles/entry/eam-and-cmms-know-the-difference

[7] *Uptime® Elements™ – A Reliability Framework and Asset Management System™*, Reliabilityweb.com, Accessed on: 2020/07/30. [Online]. Available: https://reliabilityweb.com

[8] *Maintenance Categorization*, 900-508230-MCP-001, 40848511.

[9] *Canada Occupational Health and Safety Regulations*, SOR/86-304.

[10] *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, N285.0-17, Canadian Standards Association, July 2017.

[11] *Boiler, pressure vessel, and pressure piping code*, B51-14, Canadian Standards Association, January 2014.

[12] *Workplace electrical safety*, Z462-18, Canadian Standard Association, January 2018.

[13] *Equipment Reliability Program*, 900-508222-MCP-001, 40845170.

[14] *Preventive Maintenance*, 900-508230-MCP-002, 35286334.

[15] *Maintenance Work Planning & Control*, 900-508230-STD-002, 54511428.

[16] *Integrated Work Control*, 900-514100-STD-002, 51505551.

[17] *Maintenance Performance*, 900-508230-MCP-004, 35284702.

[18] *Care and Control of Calibrated Monitoring and Measurement Equipment*, 900-514200-STD-003, 40767163.

[19] *System Performance Monitoring*, 172-508222-HBK-001, 55063218.

[20] *Fleet Maintenance,* 900-508230-STD-004, 55631901

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Fitness for Service REV 3

900-508230-PRD-001

Revision 3.0

Information Use

Approved by:	David Meldrum	2024/01/22
	Manager,Infrastructure Systems	Date

Effective Date: 2024/03/01
Expiry Date: 2027/02/28

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
3	2024/01/17	Issued as “Approved for Use”	S. Cameron	D. Meldrum	D. Meldrum
3D1	2023/02/28	Issued for “Review and Comment”. Major changes include: Adding *Port Hope Area Initiative Waste Management Project – Waste Nuclear Substance Licence WNSL-W1-2310.00/2032* *Updating the revision of the CRL, WL, and NPDLCHs* *Updating to new template*	S. Cameron	S. Scott D. Meldrum S. Mackie A. Rehman J. DeRuiter G. Kaufmann J. Williams J. Slade A. Dash	
2	2022/03/11	Issued as “Approved for Use”.	S. Cameron	D. Meldrum	D. Meldrum
2D2	2021/09/02	Issued for “Review and Comment” to include additional reviewers.	S. Scott	C. Ball M. English A. McMurray D. Onagi J. Therrien S. Toelly	
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Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
		64-508760-HBK-001, Licence Conditions Handbook for NPD Waste Facility 22-508760-HBK-002, License Conditions Handbook for Douglas Point Waste Facility CSA N292.0-14, General principles for the management of radioactive waste and irradiation fuel SOR/86-304, Canada Occupational Health and Safety Regulations N285.0-17, General requirements for pressure retaining systems and components in CANDU nuclear power plants B51-14, Boiler, pressure vessel, and pressure piping code Added Requirements and Flow down sources for N286-12 (R2017), Management system requirements for nuclear facilities, to include the following: 6.9.3, 7.6.11, 7.9.10, 8.9.3, 9.9.3. Added Requirements and Flow down sources for CAN/CSA-ISO 9001:16, Quality management systems – Requirements, to include the following: 8.5.1 Added Requirements and Flow down sources for REGDOC-2.6.3, Aging Management, to include the following: 4, 4.2, 4.3, 4.4.2, 4.4.3, 4.4.4, 4.5, 4.7, 4.8, 4.9, 4.10			
1	2019/02/06	Issued as “Approved for Use”	T. Resmer		D. Hill
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		WL, PH, PG LCH requirements removed. Changes made to "Program" references updated to reflect Function as requested. Included requirements from SOC and TCA, ISO 9001. CSA N292.0-14, *General principles for the management of radioactive waste and irradiated fuel*			
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				B. Sanderson J. Schnelle A. Stewart	

Table of Contents

Section **Page**

1. Scope and Applicability

This Company wide Document applies to all activities unique to Fitness for Service, performed by Canadian Nuclear Laboratories' employees, contractors, and sub-contractors, as well as third parties engaged through external partnerships or collaborations that perform work for and/or on behalf of CNL.

Fitness for service consists of two primary elements: maintenance and equipment reliability. Aging management is accomplished through executing equipment reliability on systems within scope as determined by site licence condition handbooks.

Maintenance applies to all CNL sites and facilities. Implementation of Maintenance elements is commensurate with the importance to safety, design function and required performance.

Reliability and Aging Management apply to all systems important to safety within licensed nuclear facilities. Reliability and Aging Management may also be implemented to complex systems in other facilities using a graded approach.

2. Purpose

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment, and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flow down

The list below provides the requirements for the Fitness for Service Program:

- Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence NRTEOL-01.00/2028, Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Revision 3 / CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023
- Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-8.00/2024, Licence Conditions Handbook, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-HBK-002 Revision 1, Canadian Nuclear Safety Commission, April 3, 2023.
- Prototype Waste Facilities – Waste Facility Decommissioning Licence, Gentilly-1 Waste Facility WFDL-W4-331.00/2034, Licence Conditions Handbook, WFDL-LCH-W4-331.00/2034 Revision 1 / 61-00580-HBK-001 Revision 0, Canadian Nuclear Safety Commission, 2019 July 15.
- Nuclear Power Demonstration Waste Facility Prototype Waste Facilities – Waste Facility Decommissioning Licence WFDL-W4-342.00/2034, Licence Conditions Handbook, WFDL-LCH-W4-342.00/2034 Revision 2/64-508760-HBK-001, Revision 2, Canadian Nuclear Safety Commission, August 15, 2023.

- Prototype Waste Facilities – Waste Facility Decommissioning Licence, Douglas Point Waste Facility WFDL-W4-332.03/2030, Licence Conditions Handbook, WFDL-LCH-W4-332.03/2030, Revision 0 / 22-508760-HBK-002 Revision 0, Canadian Nuclear Safety Commission, 2021 June 11.
- Port Hope Area Initiative Waste Management Project – Waste Nuclear Substance Licence WNSL-W1-2310.00/2032, Licence Conditions Handbook, LCH-WNSL-W1-2310.00/2032 Revision 0 / 4500-508760-HBK-001 Revision 0, Canadian Nuclear Safety Commission, 2023 January 1
- Aging Management, REGDOC-2.6.3, Canadian Nuclear Safety Commission, March 2014.
- General principles for the management of radioactive waste and irradiated fuel, CSA N292.0-14, Canadian Standards Association, March 2019. Table 3-8
- Agreement for the Management and Operation of Certain Properties and Assets that are the Responsibilities of Atomic Energy of Canada Limited, SOC Agreement (SOCA), 2015.
- Agreement for the Work to be Undertaken on a Target Cost Basis in order to Effect the Closure of the Nuclear Power Demonstration Reactor, NPD Agreement (NPD TCA), 2015.
- Agreement for the Work to be Undertaken on a Target Cost Basis in order to Effect the Closure of the Whiteshell Laboratories, WL Agreement (WL TCA), 2015. Table 3-10
- Management system requirements for nuclear facilities, N286-12 (R2022), Canadian Standards Association, June 2012.
- Quality management systems - Requirements, CAN/CSA-ISO 9001:16 (ISO 9001:2015, IDT), Canadian Standards Association, February 2016.
- Canada Occupational Health and Safety Regulations, SOR/86-304.
- General requirements for pressure-retaining systems and components in CANDU nuclear power plants / Material Standards for reactor components for CANDU nuclear power plants, N285.0-17/N285.6 Series-17, Canadian Standards Association, July 2017. Table 3-14
- Boiler, pressure vessel, and pressure piping code, B51-19, Canadian Standards Association, January 2019.

Table 3-1: CRL-508760-HBK-002, Licence Conditions Handbook for Chalk River Laboratories.

Licence Conditions Handbook for Chalk River Laboratories			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
6.1: Fitness for Service Program	The licensee shall implement and maintain a fitness for service program. […] **Licensing Basis Publications** REGDOC-2.6.3 Aging Management, 2014.	*Fitness for Service*, 900-508230-PDD-001 *Ageing Management Program*, 900-508222-STD-001	**Guidance Documents** REGDOC-2.6.2 Maintenance Programs for Nuclear Power Plants, 2017 REGDOC-2.6.2 is listed under this section as a guidance to support a Fitness for Service Program. Refer to *Fitness for Service*, 900-508230-PDD-001. Compliance to REGDOC-2.6.3 is shared with other functions. Refer to Table 3-7.

Table 3-2: WLD-508760-HBK-002, Licence Conditions Handbook for Whiteshell Laboratories.

Licence Conditions Handbook for Whiteshell Laboratories			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
6.1: Fitness for Service Program	The licensee shall implement and maintain a fitness for service program.	*Fitness for Service*, 900-508230-PDD-001 *Ageing Management Program*, 900-508222-STD-001 WLD-106100-PLA-001 Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers	**Guidance Documents** REGDOC-2.6.3 Aging Management, 2014 REGDOC-2.6.3 is listed under this section as a guidance to support a Fitness for Service Program. Refer to *Fitness for Service*, 900-508230-PDD-001.

Table 3-3: 61-00580-HBK-001, Licence Conditions Handbook for Gentilly-1 Waste Facility.

Licence Conditions Handbook for Gentilly-1 Waste Facility			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
8.1: Fitness for Service Program	The licensee shall implement and maintain an aging management plan for the maintenance of systems, components and structures for the facility. […] **Licensing Basis Publications** REGDOC-2.6.3 Aging Management, 2014.	*Fitness for Service*, 900-508230-PDD-001 *Ageing Management Program*, 900-508222-STD-001	

Table 3-4: 64-508760-HBK-001, Licence Conditions Handbook for NPD Waste Facility.

Licence Conditions Handbook for NPD Waste Facility			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/ Comments**
8.1: Fitness for Service Program	The licensee shall implement and maintain an aging management plan for the maintenance of systems, components and structures for the facility. […] **Licensing Basis Publications** REGDOC-2.6.3 Aging Management, 2014.	*Fitness for Service*, 900-508230-PDD-001 *Ageing Management Program*, 900-508222-STD-001 64-1600-SWS-001 Storage with Surveillance Plan 64-20000-680-001 Life Management Plan for NPD Structures	

Table 3-5: 22-508760-HBK-002, Licence Conditions Handbook for Douglas Point Waste Facility.

Licence Conditions Handbook for Douglas Point Waste Facility			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/ Comments**
6.1: Fitness for Service Program	The licensee shall implement and maintain a fitness for service program. […] **Licensing Basis Publications** REGDOC-2.6.3 Aging Management, 2014.	*Fitness for Service*, 900-508230-PDD-001 *Ageing Management Program*, 900-508222-STD-001	

Table 3-6: 4500-508760-HBK-001, Licence Conditions Handbook for Port Hope Area Initiative Waste Management Project

Licence Conditions Handbook for Douglas Point Waste Facility			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/ Comments**
5.1: Fitness for Service Program	The licensee shall implement and maintain a fitness for service program. […]	Fitness for Service, 900-508230-PDD-001	

Table 3-7: REGDOC-2.6.3, *Aging Management*.

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
3. Proactive Strategy for Aging Management			
3.4 Operation	Licensees shall establish and implement processes, programs and procedures to manage ageing and obsolescence of SSCs, to ensure that required safety functions are maintained during the facility operation phase.	*Fitness for Service*, 900-508230-PDD-001	*Shared with Conduct of Operations* Also covered by *Life Management Program for Douglas Point Structures,* 22-20000-680-001 *Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers*, WLD-106100-PLA-001
3.4 Operation	Corrective actions identified by AM plan activities shall be managed within the reactor facility's corrective action program.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Improvement Action (ImpAct) Corrective Action Program* 900-514000-MCP-004	Shared with *Performance Assurance*, 900-514000-PDD-001
4. Integrated Aging Management			
4. Integrated Aging Management	Licensees shall apply a systematic and integrated approach to establish, implement and improve appropriate programs to manage aging and	*Fitness for Service*, 900-508230-PDD-001	Shared with *Property/Asset Management*, 900-508400-PDD-001

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	obsolescence of SSCs. Reactor facility management processes shall include requirements to ensure there is a documented overall integrated AM program framework for the reactor facility that addresses the following elements: 1. organizational arrangements 2. data collection and record keeping 3. screening and selection process for aging management 4. evaluations for aging management 5. condition assessments 6. SSC-specific AM plans 7. management of obsolescence 8. interfaces with other supporting facility programs 9. implantation of AM program and plans 10. review and improvement of AM program and plans SSC-specific AM plans shall be implanted in accordance with the overall integrated AM program framework.		
4.2 Data collection and record-keeping system to support aging management	The licensee shall have an appropriate data collection and record-keeping system to support aging management activities and to provide a basis for decisions on the type and timing of aging management actions. Data entered into the system shall be auditable to demonstrate an adequate verification of the data entered, detailed description of the basis for any conclusion, and to trace all applicable sources of information.	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Work Planning & Control*, 900-508230-STD-002	Shared with *Information Management,* 900-511300-PDD-001.
4.3 Screening and selection of structures, systems and components	A documented screening and selection process shall be used to establish the list of SSCs to be included in the scope of the overall integrated AM program framework. This process shall include SSCs	*Maintenance Categorization*, 900-508230-MCP-001	*Shared with Safety Analysis*, 900-508770-PDD-001

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	susceptible to aging degradation or aging effects that can, directly or indirectly, have an adverse effect on the safe operation of the reactor facility. The process shall include SSCs that do not have safety functions, but whose failure could prevent safety-related SSCs from performing their intended functions.		
4.4 Evaluations for aging management 4.4.2 Preventive actions to minimize and control aging degradation	Methods to prevent and control aging degradation shall be evaluated to establish appropriate actions that can be taken.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Design Authority and Design Engineering*, 900-508120-PDD-001
4.4 Evaluations for aging management 4.4.3 Methods for detecting, monitoring, and trending aging effects	Methods for the detection, monitoring, and trending of aging effects shall be evaluated to establish appropriate actions that can be taken.	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004	Also covered by *Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers,* WLD-106100-PLA-001 *Life Management Program for NPD Structures,* 64-20000-680-001 *Life Management Program for Douglas Point Structures,* 22-20000-680-001 Douglas Point Waste Facility Storage with Surveillance Activates & Schedules, 22-00960-SWS-002 *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan*, 61-508330-SWS-001

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
4.4 Evaluations for aging management 4.4.4 Methods for mitigating aging effects and corrective actions	Methods for mitigating aging effects shall be evaluated to establish appropriate corrective actions that can be taken.	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Improvement Action (ImpAct) Corrective Action Program* 900-514000-MCP-004	Also covered by *Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers,* WLD-106100-PLA-001 *Life Management Program for NPD Structures,* 64-20000-680-001 *Life Management Program for Douglas Point Structures,* 22-20000-680-001 Douglas Point Waste Facility Storage with Surveillance Activates & Schedules, 22-00960-SWS-002 *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan*, 61-508330-SWS-001
4.5 Condition assessments	Reactor facility management processes shall include requirements to evaluate the actual condition of a structure, system or component at the initiation of the SSC-specific AM plan and at periodic intervals throughout the service life of the reactor facility or structure, system or component, as required, to validate the AM plan's effectiveness. The procedure for conducting condition assessments and the results shall be documented.	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Equipment Reliability Program,* 900-508222-MCP-001	
4.7 Management of obsolescence	The licensee shall have a managed process for obsolescence. The provisions for the management of obsolescence shall be documented in the licensee's management system.	*Maintenance Work Planning & Control*, 900-508230-STD-002	Shared with *Design Authority and Design Engineering*, 900-508120-PDD-001 and *Property/Asset*

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
		Equipment Reliability Program, 900-508222-MCP-001 *Obsolescence Management Program,* 900-508222-MCP-002	*Management*, 900-508400-PDD-001
4.8 Interfaces with other supporting programs	All supporting programs and activities that are credited as an integral part of the reactor facility's aging management shall be identified, and their interfaces and information requirement defined in the overall integrated AM program framework document.	*Fitness for Service*, 900-508230-PDD-001	Shared with *Property/Asset Management*, 900-508400-PDD-001
4.9 Implementation of aging management programs	Data identified in AM plans shall be collected and recorded to provide a basis for decisions on the type and timing of aging management actions.	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Aging Management,* 900-508222-STD-001	Shared with *Design Authority and Design Engineering*, 900-508120-PDD-001 and *Property/Asset Management*, 900-508400-PDD-001 Also covered by *Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers,* WLD-106100-PLA-001 *Life Management Program for NPD Structures,* 64-20000-680-001 *Life Management Program for Douglas Point Structures,* 22-20000-680-001 *Gentilly-1 Waste Facility Decommissioning Storage with Surveillance Plan*, 61-508330-SWS-001

Aging Management			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
4.10 Review and improvement	The licensee shall update AM plans and interfacing programs, and their implementation, to improve their effectiveness based on the results of the review as appropriate.	*Fitness for Service*, 900-508230-PDD-001	Shared with *Design Authority and Design Engineering*, 900-508120-PDD-001 and *Property/Asset Management*, 900-508400-PDD-001 Also covered by Douglas Point Waste Facility Storage with Surveillance Activates & Schedules, 22-00960-SWS-002

Table 3-8: CSA N292.0-19, *General principles for the management of radioactive waste and irradiated fuel*.

General Principles for the management of radioactive waste and irradiated fuel			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
4 General requirements			
4.16 Aging management			
4.16.1	An aging management program shall be established to assess and mitigate service-life-limiting characteristics of safety critical components (safety related systems, structures, components, containers, and barriers), with the purpose of assuring that waste packages are maintained and contained in a safe, stable, secure, controlled, and monitored environment.	*Ageing Management Program*, 900-508222-STD-001	Planned to be transferred to Design Authority and Design Engineering
4.16.2	The aging management program shall a) provide for condition assessments of safety critical components; b) provide for the inspection and maintenance of safety critical components; c) confirm that safety critical components remain effective and operational for their intended use;	*Fitness for Service*, 900-508230-PDD-001 *Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002	Shared with *Property/Asset Management*, 900-508400-PDD-001, and *Management System*, 900-514100-MAN-001

General Principles for the management of radioactive waste and irradiated fuel			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	d) make allowance for maintenance or replacement of safety critical components; e) be proactive; and f) be auditable and effective.	*Maintenance Performance*, 900-508230-MCP-004	
4.16.3	The effectiveness of the aging management program shall be periodically reviewed using feedback from the program and performance indicators.	*Ageing Management Program*, 900-508222-STD-001	Planned to be transferred to Design Authority and Design Engineering
4.16.4	The aging management program for SSCs in a waste management facility shall demonstrate that a) all SSCs susceptible to aging degradation or aging effects that can, directly or indirectly, have an adverse effect on the safe operation of the facility have been evaluated for the proposed period of operation; ***Note:*** *for example, consideration of the containment system and the monitoring changes in its characteristics.* b) the effects of aging will continue to be identified and managed for the SSCs susceptible to aging degradation during the planned period of operation; and c) all safety analyses involving time-limited assumption are validated for the proposed period of operation to ensure that the aging effects will be effectively managed and the intended function of an SSC will remain within the design safety margins through the planned period of operation. ***Note:*** *Aging effects can include, but are not limited to, corrosion, deformation, and embrittlement.*		

Table 3-9: Site Operating Company Agreement (SOCA).

Site Operating Company Agreement (SOCA)			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
9.2 Maintenance of the Sites, the Facilities and the Assets	CNL shall maintain, service, repair, improve, restore or replace, as applicable, the Sites, the Facilities and the Assets (but not, for greater clarity, the Excluded Resources) in furtherance of the objectives specified in, and as reasonably necessary to perform, the Statement of Work and the other provisions of this Agreement, in each case consistent with the Existing Work Plans and Budget during the Transition-In Phase and otherwise the Accepted Plans, taking into account any demolition or Decommissioning plans contemplated thereby. Without limiting the generality of the foregoing, CNL shall maintain, service, repair, improve, restore or replace, as applicable, and operate the Sites, the Facilities and the Assets in a manner that: (a) except to the extent otherwise contemplated in the Existing Work Plans and Budget during the Transition-In Phase and otherwise in the Accepted Plans, or unless otherwise consented to in writing by the Contracting Officer, ensures that such property and assets are and will continue to be "fit for use". For these purposes, "fit for use" refers to a condition, state or manner that can effectively, efficiently and safely support the satisfaction of the objectives contemplated in the Statement of Work, including as necessary to keep such property and assets current to the extent contemplated by the 10-Year Capital Plan that is included in the Accepted 10-Year Plans and to enable CNL to successfully perform the obligations contemplated in the Statement of Work and the other provisions of this Agreement;	*Fitness for Service*, 900-508230-PDD-001 *Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	The Fitness for Service Function provides the strategy for resources at CNL to maintain SSC's. The scope of the *Fitness for Service* PDD does not include all CNL assets.

Site Operating Company Agreement (SOCA)			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	(b) promotes and continuously improves nuclear safety and operational safety; (c) protects the environment, employees and the public; (d) to the extent reasonably possible, taking into account all of the Work to be performed hereunder and Good Industry Practice, minimizes the use of energy resources; and (e) protects the investments of AECL and any third parties in the AECL Resources in order to ensure continuity and reliability of operations, fulfillment of program requirements and protection of life, property and the environment from potential hazards.		
SCHEDULE A - SOC STATEMENT OF WORK 5.3 Site Resource Management and Other Services	5.3.3 CNL shall perform overall integrated planning, acquisition, maintenance, operation, management and disposition of the AECL Resources and CNL-leased facilities and infrastructure. While performing this responsibility, CNL shall align its actions with the long-term planning requirements specified in the SOC Agreement. 5.3.4 CNL shall ensure that all of the AECL Resources are maintained in accordance with the provisions of the SOC Agreement.	*Fitness for Service*, 900-508230-PDD-001 *Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	

Table 3-10: NPD Target Cost Agreement and WL Target Cost Agreement.

NPD Target Cost Agreement and WL Target Cost Agreement			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
10.2 Maintenance of the Site, the Facilities and the Assets	CNL shall maintain, service, repair, improve, restore or replace, as applicable, the Site, the Facilities and the Assets (but not, for greater clarity, the Excluded Resources) in furtherance of the objectives specified in, and as	*Fitness for Service*, 900-508230-PDD-001 *Maintenance Categorization*, 900-508230-MCP-001	The Fitness for Service Function provides the strategy for resources at CNL to maintain SSC's. The scope of the

NPD Target Cost Agreement and WL Target Cost Agreement			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	reasonably necessary to perform, the Statement of Work and the other provisions of this Agreement, in each case consistent with the Performance Baseline, taking into account any Decommissioning and Waste Management plans contemplated thereby. Without limiting the generality of the foregoing, CNL shall maintain, service, repair, improve, restore or replace, as applicable, and operate the Site, the Facilities and the Assets in a manner that: (a) except to the extent otherwise contemplated in the Performance Baseline or unless otherwise consented to in writing by the Contracting Officer, ensures that such property and assets are and will continue to be "fit for use". For these purposes, "fit for use" refers to a condition, state or manner that can effectively, efficiently and safely support the satisfaction of the objectives contemplated in the Statement of Work, including as necessary to keep such property and assets current to the extent contemplated by the Performance Baseline and to enable CNL to successfully perform the obligations contemplated in the Statement of Work and the other provisions of this Agreement; (b) promotes and continuously improves nuclear safety and operational safety; (c) protects the environment, employees and the public; (d) to the extent reasonably possible, taking into account all of the Work to be performed hereunder and Good Industry Practice, minimizes the use of energy resources; and (e) protects the investments of AECL and any third parties in the AECL Resources in order to ensure continuity	*Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004	*Fitness for Service* PDD does not include all CNL assets. Also covered by *WL Integrated Work Control Process Procedure*, WL-508310-PRO-002, and *Integrated Work Control*, 900-514100-STD-002

NPD Target Cost Agreement and WL Target Cost Agreement			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	and reliability of operations, fulfillment of program requirements and protection of life, property and the environment from potential hazards.		

Table 3-11: N286-12 (R2022), *Management system requirements for nuclear facilities*.

Management system requirements for nuclear facilities			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
6 Specific requirements for uranium processing and fuel manufacturing facilities			
6.9 Operations			
6.9.3 Monitoring	Structures, systems, and components shall be controlled through (a) performance monitoring; (b) periodic testing; and (c) periodic inspection.	*Fitness for Service*, 900-508230-PDD-001 *Preventive Maintenance*, 900-508230-MCP-002 *Equipment Reliability Program*, 900-508222-MCP-001	
6.9.4 Maintenance	Structures, systems, and components shall be maintained in accordance with a maintenance strategy that includes (a) a definition of the frequency and type of maintenance to be performed. This should take into account, but not be limited to, (i) supplier recommendations; (ii) risk analyses; (iii) periodic inspection requirements; (iv) operating experience; (v) cost-benefit analyses; and (vi) service conditions; (b) repair or replacement of malfunctioning structures, systems, and components; and (c) conducting the maintenance activities in accordance with	*Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	

Management system requirements for nuclear facilities			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	approved documentation or practices.		
7 Specific requirements for high energy reactor facilities			
7.6 Supply Chain			
7.6.11 Planning for replacement parts	There shall be alignment and integration between the maintenance program and the availability of acceptable replacement parts, including (a) integration of the supply plan with the facility life-cycle plan; (b) integration of the supply plan with the facility life-cycle plan: (c) definition and sourcing strategy for crucial spares; (d) proactive obsolescence strategies; (e) demand planning based on past demand and predicted usage; (f) stratification of inventory based on usage history; and (g) inventory strategy and management.	*Fitness for Service, 900-508230-PDD-001* *Equipment Reliability Program*, 900-508222-MCP-001 *Maintenance Work Planning & Control*, 900-508230-STD-002 *Obsolescence Management Program,* 900-508222-MCP-002	Shared with *Property/Asset Management*, 900-508400-PDD-001, and *Supply Chain*, 900-505210-PRD-001. *Materials and Logistics Management 900-505210-STD-002336*
7.9 Operations			
7.9.9 Maintenance	Structures, systems, and components shall be maintained in accordance with a maintenance strategy that includes (a) a definition of the frequency and type of maintenance to be performed. This should take into account, but not be limited to, (i) supplier recommendations; (ii) safety analyses; (iii) periodic inspection requirements; (iv) operating experience; (v) cost-benefit analyses; and (vi) service conditions;	*Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	

Management system requirements for nuclear facilities			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	(b) repair or replacement of malfunctioning structures, systems, and components to re-establish conformance with requirements; (c) maintenance activities in accordance with approved procedures or practices; and (d) preventative measures to eliminate structural, system, and component damage or the contamination of systems with foreign material.		
7.9.10 Systems health monitoring	Structures, systems, and components shall be evaluated in order to (a) gauge performance; (b) identify common and recurring problems; and (c) recommend changes or improvements.	*Equipment Reliability Program*, 900-508222-MCP-001	
8 Specific requirements for research and isotope processing facilities			
8.9 Operations			
8.9.3 Monitoring	The condition of structures, systems, and components shall be controlled through (a) performance monitoring; (b) periodic testing; and (c) periodic inspection.	*Fitness for Service*, 900-508230-PDD-001 *Preventive Maintenance*, 900-508230-MCP-002 *Equipment Reliability Program*, 900-508222-MCP-001	
8.9.4 Maintenance	Structures, systems, and components shall be maintained in accordance with a maintenance strategy that includes (a) a definition of the frequency and type of maintenance to be performed. This should take into account, but not be limited to, (i) supplier recommendations; (ii) risk analyses;	*Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004	

Management system requirements for nuclear facilities			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	(iii) periodic inspection requirements; (iv) operating experience; (v) cost-benefit analyses; and (vi) service conditions; (b) repair or replacement of malfunctioning structures, systems, and components; and (c) conducting maintenance activities in accordance with approved documentation or practices.	*Maintenance Work Planning & Control*, 900-508230-STD-002	
9 Specific requirements for radioactive waste management facilities			
9.9 Operations			
9.9.3 Monitoring	Structures, systems, and components shall be controlled through (a) performance monitoring; (b) periodic testing; and (c) periodic inspection.	*Fitness for Service*, 900-508230-PDD-001 *Preventive Maintenance*, 900-508230-MCP-002 *Equipment Reliability Program*, 900-508222-MCP-001	
9.9.4 Maintenance	Structures, systems, and components shall be maintained in accordance with a maintenance strategy that includes (a) a definition of the frequency and type of maintenance to be performed. This should take into account, but not be limited to, (i) supplier recommendations; (ii) risk analyses; (iii) periodic inspection requirements; (iv) operating experience; (v) cost-benefit analyses; and (vi) service conditions; (b) repair or replacement of malfunctioning structures, systems, and components; and	*Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	

Management system requirements for nuclear facilities			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	(c) conducting the maintenance activities in accordance with approved documentation or practices.		

Table 3-12: CAN/CSA-ISO 9001:16, *Quality management systems – Requirements*.

Quality management systems – Requirements			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
7 Support			
7.1 Resources 7.1.3 Infrastructure	The organization shall determine, provide and maintain the infrastructure necessary for the operation of its processes and to achieve conformity of products and services. NOTE Infrastructure can include: a) buildings and associated utilities; b) equipment, including hardware and software; c) transportation resources; d) information and communication technology.	*Fitness for Service*, 900-508230-PDD-001 *Maintenance Categorization*, 900-508230-MCP-001 *Preventive Maintenance*, 900-508230-MCP-002 *Maintenance Performance*, 900-508230-MCP-004 *Maintenance Work Planning & Control*, 900-508230-STD-002	The Fitness for Service Function provides the strategy for resources at CNL to maintain SSC's. Note: this function does not include all infrastructure as defined by this national standard.
8 Operation			
8.5 Production and service provision 8.5.1 Control of production and service provision	The organization shall implement production and service provision under controlled conditions. Controlled conditions shall include, as applicable: […] d) the use of suitable infrastructure and environment for the operation of processes;	*Fitness for Service*, 900-508230-PDD-001	

Table 3-13: SOR/86-304, *Canada Occupational Health and Safety Regulations*.

Canada Occupational Health and Safety Regulations			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
Part V Boilers and Pressure Vessels			
Use, Operation, Repair, Alteration and Maintenance	5.7 All repairs and welding of boilers, pressure vessels and pressure piping systems shall be carried out in accordance with the standards referred to in clauses 6.1, 7.1 and 8.1 of Part I of the Boiler Code.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-002	Boiler Code requirements are included when applicable in completing Preventive Maintenance (PM) Technical Basis, PM development, and work planning. Shared with *Pressure Boundary,* 900-508140-PRD-001
Use, Operation, Repair, Alteration and Maintenance	5.8 No person shall alter, interfere with or render inoperative any fitting attached to a boiler or pressure vessel except for the purpose of adjusting or testing the fitting.	*Maintenance Work Planning & Control*, 900-508230-STD-002	Shared with *Pressure Boundary,* 900-508140-PRD-001
Records and Reports	5.17 The employer shall keep and maintain a record of every boiler, pressure vessel and pressure piping system to which this Part applies and that is under the employer's control.	*Maintenance Performance*, 900-508230-MCP-004	Shared with *Pressure Boundary,* 900-508140-PRD-001

Table 3-14: N285.0-17, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*.

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
7. Design			
7.1 Rules			
7.1.7 Periodic Inspection	Items shall be inspected periodically in accordance with CSA N285.4, N285.5, and N285.7 and shall be designed to allow access as required for such inspections.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
9 Fabrication & Installation			
9.1 General Requirements	Fabrication and installation shall be carried out under a quality assurance program in accordance with Clause 10 and shall include preparation of the following documentation: a) fabrication and installation documents, instructions, and procedures that include verification; b) records to demonstrate the completion of all required tests, inspections, examinations, and treatments, including the qualification of the personnel and procedures used; c) records to demonstrate the acceptance of the inspection and test plan by the authorized inspector; d) permanent and non-permanent records for the applicable period of time (see Clause 12); and e) records showing actual stamping of the nameplate (e.g., a photocopy, photograph, or rubbing).	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
9.2.1 Class 1 components and non-standard fittings	The licensee shall have Class 1 components and nonstandard fittings fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, NB-4000.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
9.2.2 Class 2components and non-standard fittings	The licensee shall have Class 2 components and nonstandard fittings fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, NC-4000	*172-508230-PRO-001, CRL Site Infrastructure Work Planning Process* *CRL-508230-PRO-609, Route Sheet for ASME Section III Work*	
9.2.3 Class 3 components and non-standard fittings	The licensee shall have Class 3 components and nonstandard fittings fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, ND-4000	*172-508230-PRO-001, CRL Site Infrastructure Work Planning Process*	

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
9.2.4 Class 1C, 2C, and 3C components and non-standard fittings	The licensee shall have Class 1C, 2C, or 3C components and non-standard fittings fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, NB-4000, NC-4000, or ND-4000, respectively, except where specific requirements are given in Annex E, in which case these components and non-standard fittings shall be fabricated and installed to these requirements.	172-508230-PRO-001, CRL Site Infrastructure Work Planning Process	
9.2.6 Class 6 or Class Exempt components and fittings	The licensee shall have Class 6 or Class Exempt components and fittings that are required to be registered, fabricated and installed to comply with the requirements of CSA B51	172-508230-PRO-001, CRL Site Infrastructure Work Planning Process *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
9.2.7 Metallic Inserts	Helical coil or other threaded inserts shall be installed in accordance with the manufacturer's instructions and design requirements	172-508230-PRO-001, CRL Site Infrastructure Work Planning Process	

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
9.3Welding and Brazing			
9.3.1	The licensee shall retain records in accordance with Clause 12 to demonstrate that the welding or brazing procedure performed inside Canada on any Class 1, 1C, 2, 2C, 3, 3C, or 4 component meets the requirements of the ASME **BPVC**, Section III, Division 1, NB-, NC-, ND-, NE-, or NF-4300, and that the procedure has been registered with the authorized inspection agency, as required by Clause 6.1.11.1 of this Standard. Annex G contains guidelines that may be used for in-service plugging by fusion welding of Class 1, 2, and 3 heat-exchanger tube or tube sheet holes with a one-inch maximum diameter	CRL-508241-OP-001, Qualifying Welding Procedure Specifications	
9.3.2	The licensee shall retain records in accordance with Clause 12 to demonstrate that the welding or brazing procedure performed outside Canada on any Class 1, 1C, 2, 2C, 3, 3C, or 4 component meets the requirements of the ASME BPVC, Section III, Division 1, NB-, NC-, ND-, NE-, or NF-4300.		
9.4 Support for Class 1, 1C, 2, 2C, 3, 3C, and 4 Components			
9.4.1	The licensee shall have supports fabricated and installed to comply with the requirements of the ASME BPVC, Section III, Division 1, NF-4000.	172-508230-PRO-001, CRL Site Infrastructure Work Planning Process *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
9.4.2	The licensee shall have integral attachments fabricated and installed to comply with the fabrication and installation requirements for the component to which they are attached	172-508230-PRO-001, CRL Site Infrastructure Work Planning Process *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
11 Examination and Pressure Testing			

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
11.1.1	The licensee shall have documentation to demonstrate that Class 1 components have been examined in accordance with the requirements of the ASME BPVC, Section III, Division 1, NB-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME BPVC, Section III, Division 1, NB-5000.		
11.1.2	The licensee shall have documentation to demonstrate that Class 2 components have been examined in accordance with the requirements of the ASME BPVC, Section III, Division 1, NC-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME BPVC, Section III, Division 1, NC-5000.		
11.1.3	The licensee shall have documentation to demonstrate that Class 3 components have been examined in accordance with the requirements of the ASME BPVC, Section III, Division 1, ND-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME BPVC, Section III, Division 1, ND-5000.		

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
11.1.5	The licensee shall have documentation to demonstrate that Class 4 components have been examined in accordance with the requirements of the ASME BPVC, Section III, Division I, NE-5000. For repairs and replacements to Class 4 component(s), the licensee shall have documentation to demonstrate that examination is in accordance with the requirements of the original design. For repairs and replacements, newer procedures and techniques may be used.		
11.1.6	The licensee shall have documentation to demonstrate that supports have been examined in accordance with the requirements of the ASME BPVC, Section III, Division 1, NF-5000. The effective date shall be established in accordance with Clause 4.3. Examination procedures and techniques for repairs and replacements may be in accordance with a later edition of the ASME BPVC, Section III, Division 1, NF-5000.		
11.1.8	The licensee shall have documentation to demonstrate that for examinations performed on any pressure-retaining component, the persons performing the non-destructive examinations were, at the time of the examinations, qualified in accordance with Clause 11.3, and possessed current, valid qualification documentation.		
11.2 Examination Methods			
11.2.1	The licensee shall have documentation to demonstrate that all non-destructive examination procedures performed on Class 1, 1C, 2, 2C, 3, 3C, and 4 components comply with Clause 11.1.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
11.4 Pressure Testing of Components			

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
11.4.1	The licensee shall have documentation to demonstrate that all new components have been subjected to a pressure test in accordance with Clause 11.4.		
11.4.3	The licensee shall retain the data report to demonstrate that a pressure test has been performed to the satisfaction of an inspector, who has countersigned the data report (See Table 3-1).		
11.4.4	The licensee shall have documentation to demonstrate that Class 1 component(s) have been tested in accordance with the requirements of the ASME BPVC, Section III, Division 1, NB-6000.		
11.4.5	The licensee shall have documentation to demonstrate that Class 2 component(s) have been tested in accordance with the requirements of the ASME BPVC, Section III, Division 1, NC-6000.		
11.4.5	The licensee shall have documentation to demonstrate that Class 3 components have been tested in accordance with the requirements of the ASME BPVC, Section III, Division 1, ND-6000.		
11.4.6	The licensee shall have documentation to demonstrate that Class 3 components have been tested in accordance with the requirements of the ASME BPVC, Section III, Division 1, ND-6000.		
11.4.7	The licensee shall have documentation to demonstrate that in addition to the requirements of Clause 11.4.4, 11.4.5, and 11.4.6, component(s) classified as Classes 1C, 2C, and 3C have been tested in accordance with the requirements of Annex E.		

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
11.4.8	The licensee shall have documentation to demonstrate that components classified as Class 4 have been tested in accordance with the requirements of the ASME BPVC, Section III, Division I, NE-6000.		
11.4.9	The licensee shall have documentation to demonstrate that Class 6 components have been tested in accordance with the requirements of CSA B51.		
12 Documentation			
12.4.1.1	The certificate holder shall complete and submit a data report for each component and for tubular products welded with filler metal in accordance with the requirements of Clause 12.4.		
12.4.1.2	Data reports shall be on forms of the type shown in Figures 3 to 8 and 12. Reports for repairs, replacements, or modifications shall be of the type shown in Figures 9 and 10. Variations of these forms may be used, provided that the applicable essential data and sign-off areas are included.		

12.4.1.3	The data report shall be signed by the certificate holder after all inspections, examinations, and tests required by this Standard have been completed. It shall then be countersigned by the inspector required by Table 3-1, who shall ensure that a) the shop is qualified for the work to be performed; b) the design drawings are registered c) the quality assurance program has been accepted as required by Clause 10; d) the welding procedures are registered; e) the welders and welding operators are qualified; f) non-destructive examination procedures are qualified; g) persons performing non-destructive examinations are qualified and certified; h) materials comply with requirements; i) he pressure boundary integrity dimensions are within drawing tolerances; j) the heat treatment operation has been performed in accordance with specified requirements; k) all required examinations and tests have been performed; l) work is in compliance with the quality assurance program; m) the pressure tests required by this Standard have been completed; and n) the reconciliation statements for differences between the registered designs and the as-built item(s) have been certified by the designer.		
12.4.1.6	The certificate holder other than the licensee shall submit a completed data		

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	report, a certificate of conformance, or a certificate of compliance to the licensee as required by Table 3-1 for supports or separately registered integral attachments. Supports of the same design may be covered by a single data report or certificate of conformance. Note: A data report or certificate of conformance is not required for non-welded supports that are furnished as material.		
13 In-service requirements			
13.1 General requirements	Components covered by this Standard shall be subject to inspections in accordance with CSA N285.4, CSA N285.5, and CSA N285.7.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001
13.2 Inaugural or baseline inspections	When the pressure boundary of a component that is subject to periodic inspection is repaired, replaced, or otherwise changed, it shall receive, before being put into service, an inaugural or baseline inspection as required by CSA N285.4, CSA-N285.5, and CSA N285.7.	*Maintenance Work Planning & Control*, 900-508230-STD-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
14 Repairs, replacements, and modifications			
14.2 Repairs			
14.2.3	The licensee shall have documentation to demonstrate that the authorized inspector accepted the repair procedure before the repair was undertaken		
14.2.5	The licensee shall have documentation to demonstrate that the authorized inspector has been notified before commencing repairs that involve welding of the pressure boundary.		
14.2.6	Repairs carried out by the licensee on the pressure boundary that include welding shall comply with Clauses 6.1.11 and 9.3.		

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
14.2.7	Inspection, examination, and testing of repairs carried out by the licensee shall comply with Clauses 11 and 14.6		
14.2.8	Documentation, in the form of both permanent and non-permanent records, shall be maintained by the licensee as required by Clause 12.		
14.2.9	The effective date for the standards covering materials, including welding and brazing consumables that are used in a repair shall be the effective date of the standard used in the design and construction of the component. However, if the licensee has demonstrated to the authorized inspector that a material manufactured to a more recent standard is functionally, chemically, and metallurgically compatible with the system or component, such a material may be used.		
14.3 Replacement items			
14.3.5	The replacement item shall not have experienced any significant deterioration in storage that might adversely affect its structural integrity or operability.	*Material Control for ASME Section III & Environmentally Qualified Work*, CRL-508140-PRO-005	Shared with *Pressure Boundary,* 900-508140-PRD-001.
14.3.6	The licensee shall have documentation to demonstrate that the procedure for installing a replacement item was accepted by the authorized inspection agency before installation commenced.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001.
14.3.7	The licensee shall have documentation to demonstrate that the authorized inspector was notified before the installation of replacement items involving welding of the pressure boundary.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001.
14.3.8	Replacements carried out by the licensee on the pressure boundary that include welding shall comply with Clauses 6.1.11 and 9.3.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
14.3.12	Documentation, in the form of both permanent and non-permanent records, shall be maintained by the licensee as required by Clause 12. The licensee shall have documentation that traces the replacement item to its certified design specification and this documentation shall be available to the authorized inspection agency for review.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.3.13	Replacement items shall be purchased, shipped, handled, and stored in accordance with the licensee's instructions and procedures to prevent damage, deterioration, or loss. These procedures shall ensure that the necessary identification, traceability, and records are maintained by the licensee as specified by this Standard.	*Material Control for ASME Section III & Environmentally Qualified Work*, CRL-508140-PRO-005	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.3.14	The licensee shall identify items with limited shelf life and shall implement procedures to control their storage. The licensee shall quarantine and dispose of items that cease to conform to the requirements of this Standard.	*Material Control for ASME Section III & Environmentally Qualified Work*, CRL-508140-PRO-005	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.5 Modifications			
14.5.2 Existing components			
14.5.2.6	The licensee shall have documentation to demonstrate that the procedure for the installation of modifications was accepted by the authorized inspection agency before installation commenced.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.5.2.7	The licensee shall have documentation to demonstrate that the examination and testing of modifications complies with Clause 11, except for pressure testing, which shall have documentation demonstrating compliance with Clause 14.6.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
14.5.2.8	Permanent records required by Clause 12.2.1 shall be included in the history docket.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.6 Pressure testing			
14.6.1 General requirements			
14.6.1.1	For replacement items and items used in a piping system modification, the licensee shall have a pressure test performed in accordance with the requirements of the design and fabrication standards. The licensee may substitute the piping system pressure test for the item pressure test, provided that the requirements of the design standards are met.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.6.1.2	Where a modification consists of increasing the design pressure or temperature of a component, the licensee shall pressure test the component in accordance with the design and fabrication standard.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.6.1.3	When a new self-contained system is added, the licensee shall pressure test prior to operation in accordance with Clause 11.4.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.6.1.4	The licensee shall pressure test the tie-in joints involving welding or brazing of items in accordance with Clause 14.6.2 or 14.6.3, as applicable.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001
14.6.1.5	After welding or brazing on a pressure-retaining boundary, the licensee shall perform a pressure test in accordance with a) Clause 14.6.2 for Class 1, 1C, 2, 2C, 3, 3C, or 4 items; or b) Clause 14.6.2 or 14.6.3 for Class 6 items.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
14.6.2 Piping system pressure testing			
14.6.2.1	Where a pressure test is required by Clause 14.6.1, unless the welds or repairs are exempted by Clause 14.6.2.2, the piping system shall be filled with fluid and pressurized so that all welding or brazing repairs and tie-in welds are tested in accordance with Clause 14.6.2.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001

14.6.2.7	Where the licensee carries out pressure testing at a reduced pressure, as permitted by Clause 14.6.2.5, and in addition to those examinations required by Clause 11, the licensee shall perform the following: a) For butt welds of Class 1 or 1C component(s), the licensee shall perform an additional volumetric examination using a method different from the volumetric method required by the design and fabrication standards, in accordance with the ASME *BPVC*, Section III, Division 1, NB-5000. For other types of welds, the licensee shall perform a surface liquid penetrant (PT) or magnetic particle (MT) examination. b) For butt welds smaller than or equal to NPS 2-1/2 in Class 1 or 1C component(s) (excluding feeders), the licensee may perform the following in lieu of the second volumetric examination described in Item (a): i) for pipe sizes NPS 3/4 and smaller, a visual inspection of the root pass; or ii) for pipe sizes greater than NPS 3/4 and smaller than or equal to NPS 2-1/2, a visual inspection of the root and fill passes. Welds made in accordance with Item (b) shall be performed using gas tungsten arc welding (GTAW) only and welders shall be qualified on pipe coupons of the same diameter or a smaller diameter than the production pipe size being welded. c) For all welds of Class 2 or 2C component(s), the licensee shall perform a surface PT or MT examination. d) For butt welds of Class 3 or 3C components, the licensee shall perform a volumetric examination. For other types of welds, the licensee shall perform a surface PT or MT examination. The examinations outlined in Items (a) to (d) shall meet the applicable	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001

General requirements for pressure-retaining systems and components in CANDU nuclear power plants			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	acceptance criteria of the design and fabrication standards. Examinations carried out to fulfill the requirements of the inaugural inspection for a periodic inspection program may be credited towards the requirements specified in this Clause.		
14.6.2.8	Any item within the pressure test boundary that the licensee considers unsuitable for exposure to the test pressure (e.g., instrumentation, pressure-relief devices) may be isolated, or removed prior to the application of pressure.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001.
14.6.3 Operational pressure testing			
14.6.3.4	When conducting an operational pressure test, the piping system pressure and temperature shall be determined by normal system instrumentation, test instrumentation, or through confirmation that the system is operating at its operating conditions. Records of the test shall be maintained in accordance with Clause 12.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary,* 900-508140-PRD-001.
14.7 Alternative pressure testing of Class 1, 2, 3, and 6 systems after repairs, replacements, and modifications			
14.7.1 Requirements			
14.7.1.1 General			
14.7.1.1.1	As an alternative to the requirements of Clauses 14.6.1 to 14.6.3, Clause 14.7 may be used for the pressure testing of a repair, replacement, or modification to the pressure boundary of an existing Class 1, 2, 3, or 6 system.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	Shared with *Pressure Boundary*, 900-508140-PRD-001

Table 3-15: B51-19, *Boiler, pressure vessel, and pressure piping code*.

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
4 General requirements			
4.7 In-service repairs and alterations			
4.7.1	Owners of boilers, pressure vessels, fired-heater pressure coils, and pressure piping shall ensure that pressure equipment is maintained and operated safely	*Preventive Maintenance*, 900-508230-MCP-002	
4.7.2	Repairs and alterations shall not be made to a pressure-retaining component of a boiler, pressure vessel, fired-heater pressure coil, or piping without the prior agreement of the regulatory authority in whose jurisdiction the component is installed. Notes: 1) Subject to the approval of the regulatory authority, Part 3 of the National Board Inspection Code may be used as a guide in developing repair or alteration procedures. 2) Where jurisdictional regulations permit, prior agreement for repair or alteration work may be established by the development of a quality control program that uses the guidelines in Annex B and is satisfactory to the regulatory authority. See also Clause 4.9.3 regarding quality control systems	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
4.7.3	Hot tapping should be considered only when no alternative method is feasible or practical. Regulatory authority acceptance of the proposed procedure, including joint design, welding method, and base material identification, shall be obtained when required. Appropriate safety precautions shall be taken. The hot tapping experience and competency of the company and personnel performing this activity may be considered by the regulatory authority.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
4.15 Piping			
4.15	When required by the regulatory authority in the province of installation, the piping fabricator or installer shall furnish an acceptable piping data report to the regulatory authority. Note: See Figures D.5 a), D.5 b), and D.5 c) for sample report forms.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
5 Identification			
5.1 Nameplates			
5.1.1	The nameplate stamping of every boiler, pressure vessel, and Category G fitting (see Table 3-1) shall include the Canadian Registration Number (CRN) or Canadian Central Registration Number (CCRN). The nameplate shall be stamped in accordance with the requirements of the appropriate section of the ASME Code, except for a) fusible plugs; and b) pressure relief valves (PRVs) used in propane service which are only UL listed as described in Clause 12.11. The stamping for other categories of fittings shall include, at a minimum, identification traceable to the manufacturer and to the CRN or CCRN. This identification shall be submitted to the regulatory authority or a central registration agency with the fitting registration	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
5.1.2	When a pressure vessel requiring a nameplate will be exposed to corrosive matter, the nameplate shall be attached in a manner that prevents accumulation of foreign material between the nameplate and the shell, head, or any other part of the pressure vessel subject to internal pressure.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
5.1.3	The designer of a fired-heater pressure coil shall provide a nameplate for the complete heater. The organization	*Route Sheet for ASME Section III*	

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	responsible for the field assembly shall be shown on this nameplate.	*Work*, 172-508230-PRO-003	
5.1.4	Only whole numbers shall be used for specifying pressure and temperature ratings on nameplates.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
5.2 Additional nameplates			
5.2	When an alteration to a boiler or pressure vessel is made, or when such an item is rerated (i.e., when the MAWP, the allowable temperature, or the minimum design metal temperature is changed), an additional nameplate shall be affixed next to the original nameplate of the boiler or pressure vessel. This additional nameplate shall specify a) whether it relates to an alteration or a rerating; b) the name of the company responsible for the change; c) the maximum allowable working pressure and temperature; d) the minimum design metal temperature (where applicable); e) the date of alteration; and f) the CRN.	*Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
8 Piping and fittings			
8.3	Welded joints in a pressure piping system shall not be painted or covered until all required inspections are completed by the owner and/or authorized inspection agency in accordance with the code of construction and the Act.	*Piping Installation/Modification/Welding Record*, 172-508230-FM-005	
8.4	Soldered joints shall not be permitted in services subject to shock or vibration.	*Piping Installation/Modification/Welding Record*, 172-508230-FM-005	
8.5	Bonding of non-metallic joints shall be performed in accordance with the applicable code of construction. Bonding procedure specifications, and	*Pressure Boundary Mechanical Joint*	

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	procedure and performance qualification testing, shall be subject to the acceptance of the regulatory authority. **Note:** *For an example of requirements for bonding, refer to Chapter VII of ASME B31.3.*	*Replacement, 172-508230-PRO-002* *Route Sheet for ASME Section III Work*, 172-508230-PRO-003	
12 Pressure relief devices			
12.5 Inspection			
12.5.1	The owner shall periodically visually inspect pressure relief devices to ensure that there are no impediments that will prevent them from operating properly.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
12.5.2	The frequency of the periodic visual inspection depends on the operating environment and the manufacturer's recommendations but shall not exceed five years.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001
12.5.3	The periodic visual inspection shall ensure that a) the outlet and, where applicable, weep hole are open and free to discharge; b) there are no signs of corrosion, cracks, debris, tampering, or other mechanical damage; c) there is no leakage; d) the manufacturer's data plate or markings are present in accordance with the applicable design code; e) the set pressure of the pressure relief device meets the specified requirements for the system; f) the pressure relief device discharge meets the requirements of Clause 12.2.2; g) the discharge capacity of the pressure relief device is equal to or greater than the boiler output capacity stamped on the boiler nameplate and complies with Clause 12.2.1.2; h) the seal (where applicable) has not been broken; and	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	i) the rain cap, where applicable, has been installed. Corrective action shall be taken if one or more of the above criteria are not met. **Note:** *See Figure H.1 for diagrams of typical internal and external propane pressure relief valves*.		
12.5.4	In addition to the periodic visual inspection specified in Clause 12.5.3, if the discharge piping in an LPG service governed by CSA B149.2 is fabricated from a material, such as carbon steel, that can corrode and form internal scale, the discharge piping shall be removed to inspect the pressure relief device and the piping. Any scale buildup in the discharge piping shall be removed.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001
12.6 In-service Testing	Pressure relief devices in steam or hot water service shall have a periodic manual lift or system test. Pressure relief devices with a lifting lever or equivalent device in compressed air service shall have a periodic manual lift test. See Table 3-5 for the frequency of in-service testing.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
12.9 Thermal expansion relief devices			
12.9.2	Thermal expansion relief valves shall be inspected periodically as specified in Clause 12.5. **Note:** *Thermal expansion relief valves need not comply with the requirements of Clause 12.7.*	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
12.9.3	Thermal expansion relief valves shall be replaced or serviced when there is evidence of damage or malfunction.	*Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
13 In-service inspection			
13.1	In-service inspection of systems shall be performed as required for the specific installation in accordance with the code of construction or code of inspection adopted by the authority having jurisdiction. Consideration shall be given	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-	Shared with *Pressure Boundary*, 900-508140-PRD-001

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	to the manufacturer's recommendations. Personnel performing in-service inspection shall be trained and competent in the duties for which they are responsible. **Note 1:** *In some cases, the authority having jurisdiction specifies in-service inspection intervals. Authorities having jurisdiction can be the electrical safety authority, fire services, a government ministry, etc.* **Note 2:** *In-service pressure equipment can be subject to in-service deterioration that can affect its pressure-retaining capability, and, therefore, periodic inspection is warranted to validate its continued suitability for service.*	002	
13.2 Pressure equipment not in service	Pressure equipment not in service shall be adequately protected against damage from environmental conditions. Safety precautions for entering confined spaces shall be followed when inspection and maintenance activities are performed. **Note 1:** *For inspection purposes, equipment not in service should be physically isolated from the process and lock-out safety measures put in place before inspection and maintenance activities begin. Safety procedures should be observed when the vessel is being prepared for inspection*. **Note 2:** *Equipment not in service should be completely disconnected from the process and content removed in accordance with approved procedures. Equipment removed from service that is intended to be returned to operation at a later date should be considered for layup or mothballing. Inspections should be carried out before such pressure equipment is returned to service*.	*Maintenance Work Planning & Control*, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary,* 900-508140-PRD-001
13.3 Inspection			
13.3.1 General	Periodic inspection of pressure equipment is intended to determine the condition of the equipment and its	*Preventive Maintenance*, 900-508230-MCP-	Shared with *Pressure Boundary*, 900-508140-PRD-001

Boiler, pressure vessel, and pressure piping code			
Source, Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	fitness to continue to operate safely. Inspection may be external and/or internal. Where appropriate, NDE may be used to collect certain data from equipment in operation.	002	
13.3.2 External inspections	External inspection can be a visual inspection and may be supplemented by NDE and carried out while the pressure equipment is in service to observe its behaviour under operating conditions. During external inspections, pressure equipment (e.g., its external surfaces; appurtenances such as fittings, protective devices, and foundation elements; insulation; equipment identification) shall be examined for nonconformities.	*Maintenance Work Planning & Contro*l, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001
13.3.3 Internal Inspection	Internal visual inspection of the internal surfaces of pressure equipment is carried out with the equipment not in service. In lieu of or in addition to visual inspection, NDE can be necessary to properly assess the condition of the equipment.	*Maintenance Work Planning & Contro*l, 900-508230-STD-002 *Preventive Maintenance*, 900-508230-MCP-002	Shared with *Pressure Boundary*, 900-508140-PRD-001

4. Requirements Applicability

The licence conditions handbooks are each applicable only to their associated site. All other requirements identified above are applicable to all sites, with the exception of the requirements referenced in Table 4-1.

Table 4-1: Requirements Applicability across CNL Sites

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Waste Storage Facility**	**Gentilly-1 Waste Management Facility**
REGDOC 2.6.3	Yes	No	Yes	Yes	No	Yes	No	No	Yes
CSA N292.0-14	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes
NPD Agreement (NPD TCA), 2015.	No	No	Yes	No	No	No	No	No	No
WL Agreement (WL TCA), 2015	No	No	No	No	No	Yes	No	No	No
General requirements for pressure-retaining systems and components in CANDU nuclear power	Yes	No	No	No	No	Yes	No	No	No

	Site								
Requirements	**CRL and Deep River Offices**	**Historic Waste Program Management Office**	**Nuclear Power Demonstration Reactor Waste Management Facility**	**Douglas Point Waste Management Facility**	**CNL Ottawa Office**	**Whiteshell Laboratories**	**CNL Site Offices (Fredericton, New Brunswick)**	**La Prade Heavy Waste Storage Facility**	**Gentilly-1 Waste Management Facility**
plants / Material Standards for reactor components for CANDU nuclear power plants, N285.0-17/N285.6 Series-17									
Boiler, pressure vessel, and pressure piping code, B51-14, Canadian Standards Association, January 2014.	Yes	No	No	No	No	Yes	No	No	No

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment.

Table 5-1: Assessment activities for Title of Source Document

Title of the Source Requirement Document (e.g. Reg Docs)/Grouping of Documents			
Source, Section, and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
REGDOC 2.6.3 – Aging Management section 4.10 Review and Improvement	The effectiveness of the overall integrated AM program framework and SSC-specific AM plans shall be periodically reviewed using feedback from the program and performance indicators.	Every 2 years	Self-assessment

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Plan

PERIODIC INSPECTION PLAN FOR WHITESHELL LABORATORIES WASTE MANAGEMENT AREA CONCRETE BUNKERS

WLD-106100-PLA-001

Revision 1

Prepared by
Rédigé par

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Approved by
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2018/12/19 | 2018/12/19
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Plan

Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers

Whiteshell Decommissioning

WLD-106100-PLA-001
Revision 1

2018 December

décembre 2018

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Revision History Liste de révisions

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CW-511300-FM-168 Rev. 2

Ref. Procedure CW-511300-PRO-161

Document No. / Numéro de document:	WLD	106100	PLA	001
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Document Details / Détails sur le document

Title Titre	Total no. of pages Nbre total de pages
Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers	31

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Revision History / Liste de révisions

Revision / Révision					
No./N°	Date (yyyy/mm/dd)	Details of Rev. / Détails de la rév.	Prepared by Rédigé par	Reviewed by Examiné par	Approved by Approuvé par
D1	2009/07/24	Issued for “Review and Comment” (Peer Review).	J.B. Martino	W.R. Ridgway	
D2	2009/08/19	Issued for “Review and Comment”.	J.B. Martino	J.W. Harding R.H. McCamis A. Dugard G. Scharer R.S. Swartz A.E. Aghoury	
0	2009/10/28	Issued as “Approved for Use”.	J.B. Martino	J.W. Harding	R.S. Swartz P.J. Ingham
1D1	2018/11/29	Changed from AECL template to CNL template, updated definitions to current conditions and nomenclature, Operations now performs the inspection so scope of inspection was expanded, updated sampling regime to current practice based on the steady results of the groundwater monitoring, updated Figure 2 to include SMAGS, removed five year inspection as the conduct of annual inspection covers most aspects of the five year inspection. Outstanding five year inspection details were moved and included in the detailed inspections.	J.B. Martino	R. S. Swartz C.S. Kim	

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CW-511300-FM-168 Rev. 2 Ref. Procedure CW-511300-PRO-161

Document No. / Numéro de document:	WLD	106100	PLA	001
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No./N°	Date (yyyy/mm/dd)	Details of Rev. / Détails de la rév.	Prepared by Rédigé par	Reviewed by Examiné par	Approved by Approuvé par
1	2018/12/19	Renumbered sections as required for this change. Minor wording corrections. Issued as "Approved for Use".	J.B. Martino	R.S. Swartz	D. Onagi

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FIGURES

APPENDICES

1. PURPOSE

The Periodic Inspection Plan (PIP) for the Whiteshell Laboratories (WL) Waste Management Area (WMA) bunkers describes methods for conducting scheduled inspection surveys of these facilities. The inspection is defined as examination, measurement and testing work done to ensure the bunker systems are functioning as designed and the bunkers remain fit for service.

The PIP includes:

- the scope of inspection;
- general inspection requirements;
- locations of components to be examined;
- methods of examination, measurements and testing;
- frequency and amount of examination, measurements and testing;
- acceptance criteria; and
- reporting and documentation requirements.

In terms of defining an activity (e.g., inspection), “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy in order to comply with the PIP; “should” is used to express a recommendation or that which is advised but not required; “may” is used to express an option or that which is permissible within the limits of the PIP; and “can” is used to express possibility or capability.

2. SCOPE

2.1 Scope of Periodic Inspection Plan

The scope of examination is the concrete waste storage bunkers in the WL WMA.

The two types of bunkers considered in this assessment are:

- Low-Level Waste (LLW) bunkers;
- Medium-Level Waste (ILW) bunkers; and
- The exterior concrete of the Shield Modular Above Ground Storage (SMAGS) Building.

The scope does not include:

- groundwater monitoring for identification of contaminant and groundwater flow conditions [1], [2]; and
- the condition of the waste packages and waste inside the bunkers or SMAGS.

2.2 Guidance for the Periodic Inspection Plan

The PIP shall follow the methods provided in ACI 201.1R-08 [3], Guide for Conducting a Visual Inspection of Concrete in Service. Further to ACI 201.1R-08, because the durability of concrete bunkers is impacted by the environment, consideration of the groundwater and soil in contact with the concrete is necessary. This is accomplished by reviewing water chemistry data, soil chemistry and soil physical characteristics. Water chemistry data are collected for the PIP by laboratory analysis of groundwater samples extracted from monitoring wells located within and adjacent to the WMA boundary. Soil chemistry and soil physical characteristics data are obtained by analysis of core samples as required. Baseline information is available on the soil [4].

Groundwater flow and contaminant conditions are being quantified by monitoring and testing in a series of nested-wells placed at strategic locations inside and outside the WMA.

3. ACRONYMS AND DEFINITIONS

3.1 Acronyms

CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
LLW	Low-Level Waste
ILW	Intermediate-Level Waste
PIP	Periodic Inspection Plan
WL	Whiteshell Laboratories
WLO	Whiteshell Laboratories Operations
WLCP	Whiteshell Laboratories Closure Project
WMA	Waste Management Area

3.2 Definitions

Abnormal/Environmental	A category of events that occurs during a postulated accident or an unusual environmental event, or both.
Bunker Performance	An evaluation of the performance of a component by review of data from examination, test/analysis or measurement of a bunker system attribute (e.g., concrete crack patterns). Bunker performance can be defined as acceptable, acceptable once specific issues are addressed, or unacceptable.
Bunker System	Roof, wall, floor slab, sump, footing or adjacent confining material (e.g., clay soil or groundwater).
Component	An element or part of a bunker system such as a roof, wall, floor slab, sump or adjacent confining material (e.g., clay soil).
Evaluation	An assessment of the results of an examination, test and/or analysis that determines whether a bunker system performs its design functions. Also see bunker performance.
Examination	Investigative activities (typically visual or non-destructive testing) to ensure integrity of a structure.
Facility Authority	The Facility Authority for the WMA facility is responsible for ensuring health, safety, environmental protection, and licensing compliance for all work at WMA. The Facility

	Authority is responsible for assigning a Facility Manager for the WMA.
Facility Manager	The WMA Facility Manager is responsible for ensuring all WMA operations are performed safely in compliance with the site licence, and in accordance with applicable Canadian Nuclear Laboratories (CNL) policies and procedures. This includes operational safety, environmental protection and licensing compliance issues.
WL Licensing Manager	The manager is responsible for coordinating all interactions between CNL-WL and the Canadian Nuclear Safety Commission (CNSC), obtaining and maintaining the CNSC Licence for WL.
Inspection	Examination, measurement, or testing to ensure the bunkers are functioning as designed and they remain fit for service. Note: Inspection can include visual assessments, non-destructive tests, invasive techniques and instrumented monitoring of a structure. The Inspector will provide the results and conclusions to the Facility Manager who will have them reviewed by a registered engineer.
Inspector	A registered engineer engaged by the WL Facility Authority to perform periodic inspections of the WMA bunkers.
Site and Nuclear Operations	Site and Nuclear Operations is the “owner/operator” of the WL WMA, responsible for ensuring the PIP is conducted as well as other jobs in the WMA.

4. RESPONSIBILITIES

4.1 Facility Authority

The responsibilities of the Facility Authority within the scope of the PIP are to:

a) Assign a registered engineer to perform periodic inspections of the WMA bunkers; and

b) Report the summary of the PIP inspections and actions in the Annual WL Safety Report, or in another suitable document, which would be submitted to the CNSC.

4.2 Facility Manager

The responsibilities of the Facility Manager within the scope of the PIP are to:

a) Ensure that the work of the PIP is carried out in accordance with CNL and WL Standard Policies and Procedures; and

b) Ensure that the personnel required to complete the work in the PIP are available and qualified.

c) Ensure that maintenance issues are dealt with through the site maintenance and planning system.

4.3 Inspector

The responsibilities of the inspector within the scope of the PIP are to:

a) Carry out the inspection duties specified in this plan; and

b) Report on the results of the inspection survey.

5. INSPECTION REQUIREMENTS

The overall requirement of the PIP is to ensure that the bunkers and SMAGS remain fit for service. The inspection shall be done in a cyclic manner. The inspection process includes an annual examination and a detailed examination of the bunkers and SMAGS as required, while those structures remain in service. Once a structure is removed from service it will no longer be inspected. The annual visual examination allows for early identification of maintenance issues and for a general assessment of the concrete. The inspections (visual and detailed) are typically conducted in the spring, unless operational requirements dictate otherwise. The inspection process is based on ACI 349.3R-02 [5], which recommends the inspection period not exceed five years. In this case, many of the concrete bunkers are older, with the oldest constructed in 1966[4] . Thus a more frequent, annual inspection schedule is warranted, with a more detailed inspection as required, based on the results of the annual inspections. The detailed inspection will also include all required elements of the annual visual inspection. Particulars on the inspection process are provided in Section 8.

6. LOCATION

6.1 Environment

The main WL site is located in southeastern Manitoba on the east bank of the Winnipeg River, approximately 100 km east northeast of Winnipeg. The site is 267 m above sea level in a broad zone where prairie grassland to the southwest mixes with boreal forest to the northeast [6]. It is on the western edge of the Canadian Shield. The WMA is a few kilometres to the northeast of the main WL site. The site experiences a mid-continental climate, with typically hot summers and cold winters. Results from a weather monitoring station active on the site between 1964 and 1998 indicate that mean temperatures remain below freezing from November to March [6], but some freeze-thaw cycling will occur in the months prior to and after this period. Typically, the near surface ground will begin to freeze in late October to early November; this area of southern Manitoba has approximately 110 frost-free days [7]. Using estimates of frost penetration into homogeneous soil [8], frost penetration would range from approximately 1 m (assuming 30 cm of snow cover) to approximately 2 m assuming no snow cover. Microclimates in sheltered areas, such as protected south facing walls of the bunker structures may experience localized freeze-thaw behaviour during the colder months. Snowfall accumulates during the winter months and will typically not melt until the spring. Measurements indicate precipitation is greatest in the spring and summer [6]. These conditions have historically limited the amount of freeze-thaw cycling occurring in a given year, but over longer time periods numerous freeze-thaw events will occur in the service life of the WMA bunkers. Additionally, the environmental conditions slow the rate of groundwater movement in the winter, as the supply of recharge water does not resume until spring melting.

6.2 Geology and Groundwater

A more detailed description of the WMA geology and groundwater condition is available in the fitness for service report [4]. WL and the WMA are located on terrain shaped by the last glacial period. The pH of the soils ranges from 5.4 to 8.0. This is considerably below the level of ordinary concrete (pH ~ 12), so some chemical interaction is expected where the concrete and soil are in contact, but it should not significantly impact the concrete.

Groundwater is locally recharged by precipitation through the Woodbridge sand unit, which is an exposed, slightly elevated region immediately to the east of the WMA. Precipitation migrates downward and laterally to recharge sand layers (Figure A-1) underlying the clay units. The WMA is generally considered to be in a groundwater discharge area (i.e., upward groundwater movement) as indicated in Figure A-1.

Sulphates in the soil can be dissolved and lead to Ca-Mg-Na-SO_4 type waters. The water table will vary depending on weather conditions and seasons, but is generally no lower than 2 m from the ground surface. Water movement through the clay is slower ($3x10^{-7}$ cm/s) than that through the basal sand, as a consequence most of the groundwater movement is in the basal sand layer.

6.3 Bunker Locations

All bunkers and SMAGS involved in this PIP are located within the boundaries of the WL WMA. The structures under consideration are ILW Bunkers 1 to 8, LLW Bunkers 1 to 6 and SMAGS (Figure A-2). MLW Bunkers 1 to 5 are essentially below the ground surface with the exception of their roof structures. MLW Bunkers 6 and 7 are partly below ground. LLW Bunkers 1 to 6 and ILW Bunker 8 are constructed surface bunkers. Sketches of the bunkers are provided in Figure A-3 to Figure A-9. SMAGS is pre-fabricated concrete slab type building located at the north end of the WMA.

7. SCHEDULE OF INSPECTION

Based on the WL WMA Bunkers' fitness for service report [4], the following inspections shall be made as part of the PIP:

- annual inspection (see Section 8.1); and
- detailed inspection as required (see Section 8.2).

It should be noted that the above schedule of examination does not exclude additional investigations to evaluate any unresolved issue with the performance of a bunker component or the overall bunker system. A detailed inspection will be performed as required.

8. INSPECTION METHOD

The American Concrete Institute document ACI 201.1R-08 [3] provides a checklist from which those items that are important or applicable for the inspection are selected. As mentioned in Section 7, additional investigations may be launched to evaluate any unresolved performance issues.

The general checklist includes the principal areas of review:

- description of structure;
- present condition of structure;
- nature of loading (e.g., snow load) and detrimental elements (e.g., chemical exposure, and sulphate rich groundwater);
- original condition of structure;
- materials of construction; and
- construction practices.

Each of these principal headings has subsections to guide the Inspector. For the WL WMA, much of the background information was gathered for the fitness for service report [4]. In some cases, details on the original condition of the structure and materials were no longer available.

8.1 Annual Inspection

In an annual inspection, the focus is to examine the bunkers for maintenance issues and to determine if visible changes have occurred since the previous survey. This includes conditions around the bunkers (e.g., standing surface water).

The inspection shall provide the following information:

- description of each structure (bunker/building type and number);
- photographs, general view and detailed close-up of condition of areas of interest as required;
- sketch map indicating orientation of bunkers and any areas of interest such as poorly drained areas or sufficient description to explain these conditions;
- present condition of structure;
- overall alignment with notes about any indications of structural movement (e.g., settling);
- areas showing distress;
- general surface condition (e.g., cracking and details of cracking, scaling, spalls, visible corrosion, cover remaining over rebar if spalling is noted, stains, exposed reinforcement,

previous patching, condition of visible waterproofing), note that not all these conditions may exist; and

- summary of weather conditions from the previous year.

For a typical inspection survey of a LLW bunker, the roof of each bunker is viewed from a ladder or mobile platform. The roof may also be accessed during these inspections. The survey methods will be adapted to account for anomalous conditions, problems or any other areas of interest.

Observation of the ground around the bunkers shall be conducted to ensure the ground remains sloped away from the structures and that low lying areas do not develop due to settling of graded material or that adjacent construction does not impact surface water movement.

Additionally, groundwater samples should be taken. Figure A-2 indicates the location of the monitoring wells used for taking samples from the WMA to measure groundwater chemistry. Sampling should be done once per year, typically around the time of the survey. The following chemical constituents are typically analyzed from the samples:

- Calcium: a baseline of calcium measurements should theoretically allow for calcium based leachate from a bunker to be detected, although the calcium could precipitate into the soil matrix, thus this is an indicator only;
- Magnesium: magnesium sulphates can be one of the more aggressive forms of sulphate which can attack concrete [4]; and
- Sulphate: sulphates can attack and weaken the structure of concrete.

Initially chlorides, which can cause corrosion of reinforcement, were tested for but the level was found to be very low [4]. This analysis may be repeated at a five-year interval to confirm the reading is still low.

The pH level of the groundwater was tested and found to be approximately 7. An increase in pH level is another indicator of an alkaline leachate from concrete structures. The pH should be tested annually.

Inspection work should include the condition of any roofing materials, gutters and structure-work (attached railings, ladders, etc.). Bituminous sealing compounds also have a finite lifespan, especially when exposed to the atmosphere and should be inspected to determine adherence to the concrete.

8.2 Detailed Inspection as Required

A detailed inspection shall be conducted if the annual inspections identify the need for a more in-depth inspection.

A more detailed examination of any cracks shall include measurements of crack extent and width if evidence from the annual inspection is indicating changes are occurring that require further investigation. The crack extent may be marked on the bunkers if the Inspector or Facility Manager believes an issue may be developing. The marks would be recorded by photos or mapping.

This may also include surveying the locations of the corners of the bunkers to determine if change has occurred. This can be accomplished by either traditional survey methods or by use of a sufficiently sensitive GPS device.

If sufficient degradation is noted, the concrete should be assessed by core sampling and analysis if evidence of degradation or alteration is noted in the routine inspections. A contractor skilled in the testing and analysis of concrete can be retained to provide assistance with sample coring, analysis and interpretation of results.

The locations of samples shall be determined in advance to provide representative samples from the following conditions:

- ILW bunkers at a depth where the groundwater table is present;
- ILW bunkers at a depth where the ground is seasonally dry; and
- ILW and LLW bunkers exposed to atmosphere.

It should be noted that 1) samples will not be collected from every location on every bunker, and 2) additional samples might be recovered from specific areas having anomalous conditions, problems or other issues.

As appropriate, the samples can be tested for:

- strength;
- density;
- alkali-aggregate or other reaction;
- bonding to aggregate;
- velocity;
- air content;
- chloride ion content;
- cover over reinforcing steel;
- reinforcement corrosion;
- corrosion of dissimilar metals;
- delamination;
- depth of carbonation;
- freezing and thawing attack;
- extent of deterioration; and

- aggregate portion and distribution.

Sample locations shall be patched and infilled with an appropriate cementitous compound and the surface sealed.

8.3 Abnormal/Environmental Conditions

In the event of abnormal or unusual conditions (e.g., a tornado in the immediate area of the WMA or vehicle collision with a bunker), an additional inspection may be requested by the Facility Authority or Facility Manager.

8.4 Issues from a Periodic Bunker Inspection

The Inspector shall report any issues identified from an inspection to the Facility Manager in a written document. At the request of the Facility Manager, the Inspector may return to inspect corrective work. E-mail communication from the Facility Manager or a completed work request in the site maintenance records system that the corrective work is complete shall be sufficient as a record of completed work.

Issues will be resolved by the Facility Manager with assistance from other personnel as required.

9. ACCEPTANCE CRITERIA

The results of the inspection will be subject to verification by providing them to a registered engineer assigned by the Facility Manager or Facility Authority. The assigned registered engineer will review the survey. In addition, any work requiring attention as indicated by the Inspector will be rated by importance and the reviewing engineer will verify the need for and order of the work to be done. Once this review is completed, the results of the inspection are deemed to be acceptable when agreed to by the Facility Manager. The memorandum or report produced (see Section 10) will be reviewed or approved by the Facility Manager and/or the Facility Authority. While the inspections are conducted to identify maintenance issues, overall the goal is to ensure that fitness for service requirements are met.

When considering the results of the inspections, in terms of fitness for service, the American Concrete Institute Service Life Prediction [9] recommends the definition of service life of concrete structures be based on a defined end-of-life which includes:

- unacceptable structural safety due to material degradation or exceeding the design load-carrying capacity;
- severe material degradation, such as corrosion of steel reinforcement initiated when diffusing chloride ions attain the threshold corrosion concentration at the reinforcement depth;
- maintenance requirements exceed available resource limits;
- aesthetics become unacceptable; and
- functional capacity of the structure is no longer sufficient for a demand.

It is important to note that all structures will have a finite lifespan and that the lifespan period requires periodic maintenance.

The fitness for service criteria for the bunkers in the WMA is their function of isolating the waste for an economic upkeep (repair) cost. If the structures are not performing that function then they cannot be considered fit for service.

10. REPORTING AND DOCUMENTATION

The inspections conducted following this PIP will generate communications, memorandums and reports. The results of inspections will be reported on CNL Memoranda and copied to the Facility Manager, Facility Authority and WL Licensing Manager. Inspection results will include conclusions to summarize the existing conditions and recommendations on how to correct issues as required by the findings.

A logbook will be maintained for inspections to record key details of the inspection; these details will be transferred to memorandums and reports as appropriate.

Key communications and e-mails shall be retained as records to indicate acceptance of inspection results, notification of issues and resolution of issues.

All communications, documents and records for this project shall be maintained according to the processes described under the WL Decommissioning Record Management and Retention procedure [10].

11. REFERENCES

[1] Dillon Consulting Limited, “Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions”, Revision 1, 2009 April.

[2] W.R. Ridgway, “Summary Report: Hydrogeology of the Waste Management Area, Landfill and Lagoon - Enhanced Monitoring Program”, WLDP-03704-ENA-009 Revision 0, 2008 March.

[3] American Concrete Institute, “Guide for Conducting a Visual Inspection of Concrete in Service”, ACI 201.1R-08, 2008 January.

[4] J.B. Martino, “Fitness-For-Service Report For Whiteshell Laboratories Waste Management Area Bunkers”, WLDP-03705-REPT-001, 2008 March.

[5] American Concrete Institute, “Evaluation of Existing Nuclear Safety-Related Concrete Structures”, ACI 349.3R-02, 2002.

[6] Atomic Energy of Canada Limited, “Whiteshell Laboratories Decommissioning Project: Comprehensive Study Report, Vol. 1: Main Report, Vol. 2: Appendices, Vol. 3: Addendum”, 2001 March - Vol. 1 and Vol. 2, 2001 November – Vol. 3.

[7] The National Atlas of Canada, 5th Edition, Natural Resources Canada.

[8] Tech Solutions 605.0 Calculating Insulation Needs to Fight Frost Heave by Comparing Freezing Index and Frost Depth, DOW Chemical Company. Available from URL: <http://www.dow.com/PublishedLiterature/dh_01f6/0901b803801f6296.pdf?filepath=styrofoam/pdfs/noreg/178-00754.pdf&fromPage=GetDoc>

[9] American Concrete Institute, “Service-Life Prediction”, ACI 365.1R-00, 2000.

[10] “WL Decommissioning Record Management and Retention”, WLDP-00151-PRO-004 Revision 2, 2007 January.

Appendix A

WL WMA and Bunkers

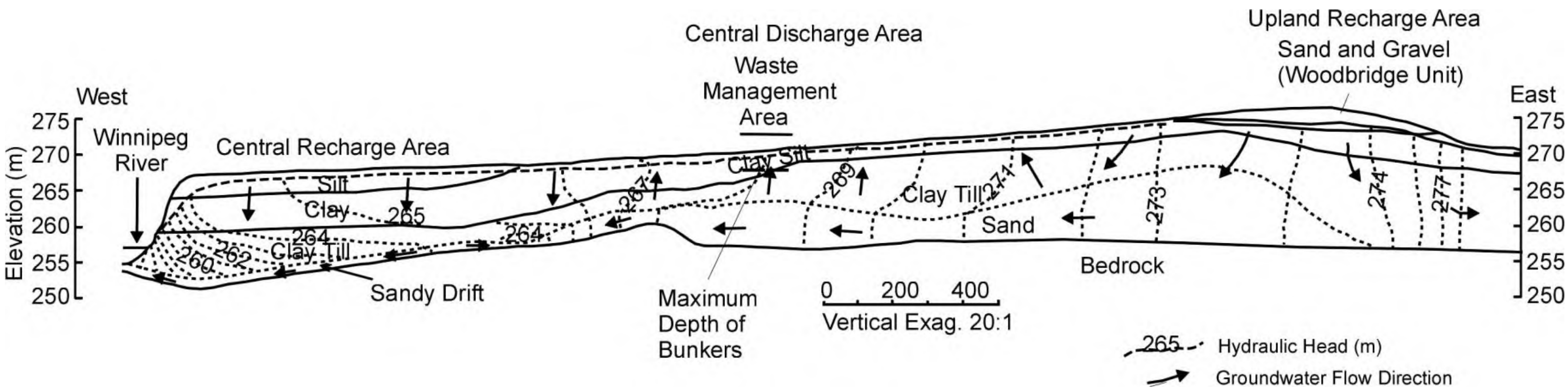

Figure A-1 Stratigraphic Cross Section Showing Location of Waste Management Area and Maximum Depth of Bunkers

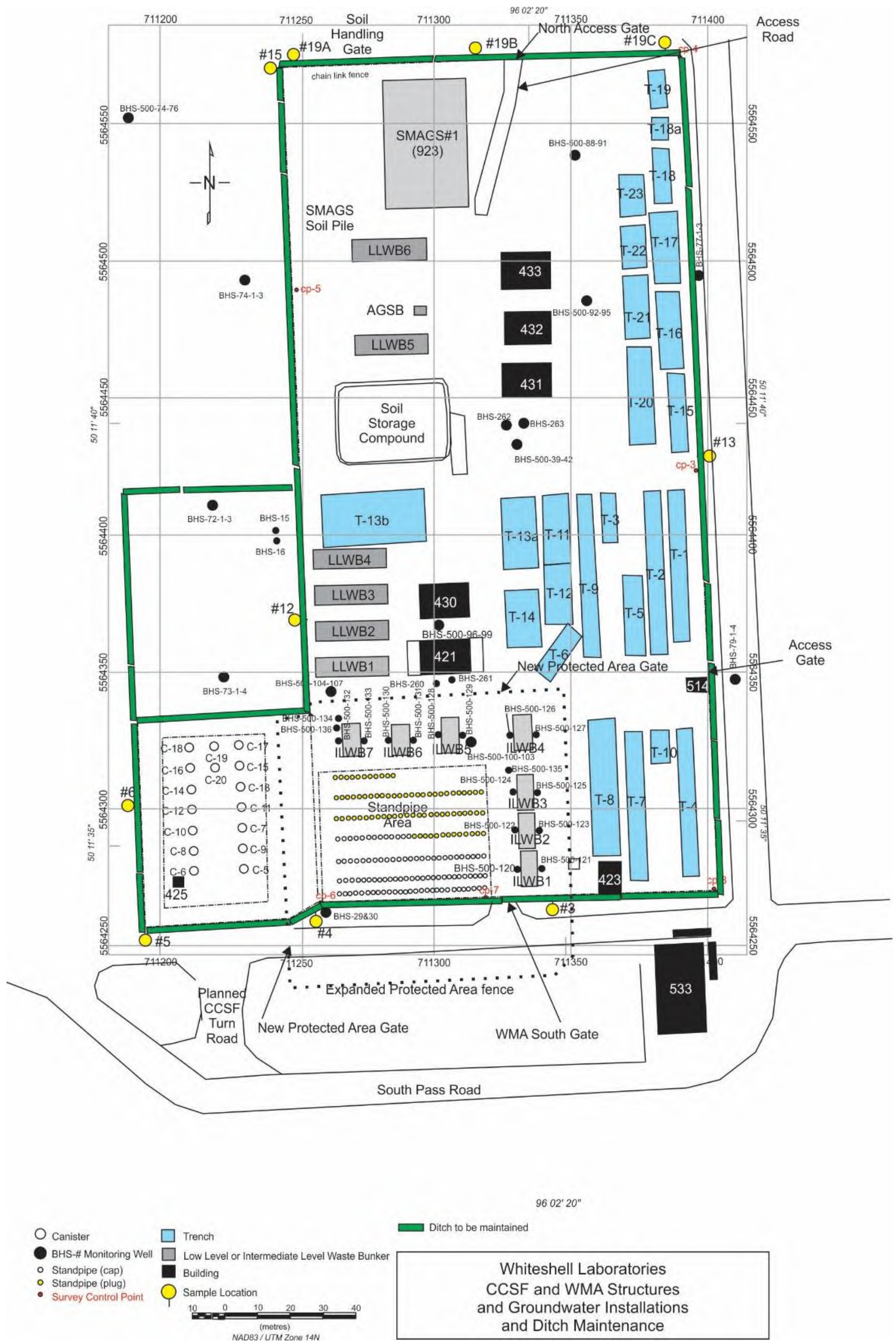

Figure A-2 Location of Bunkers and SMAGS as well as Sampling Wells

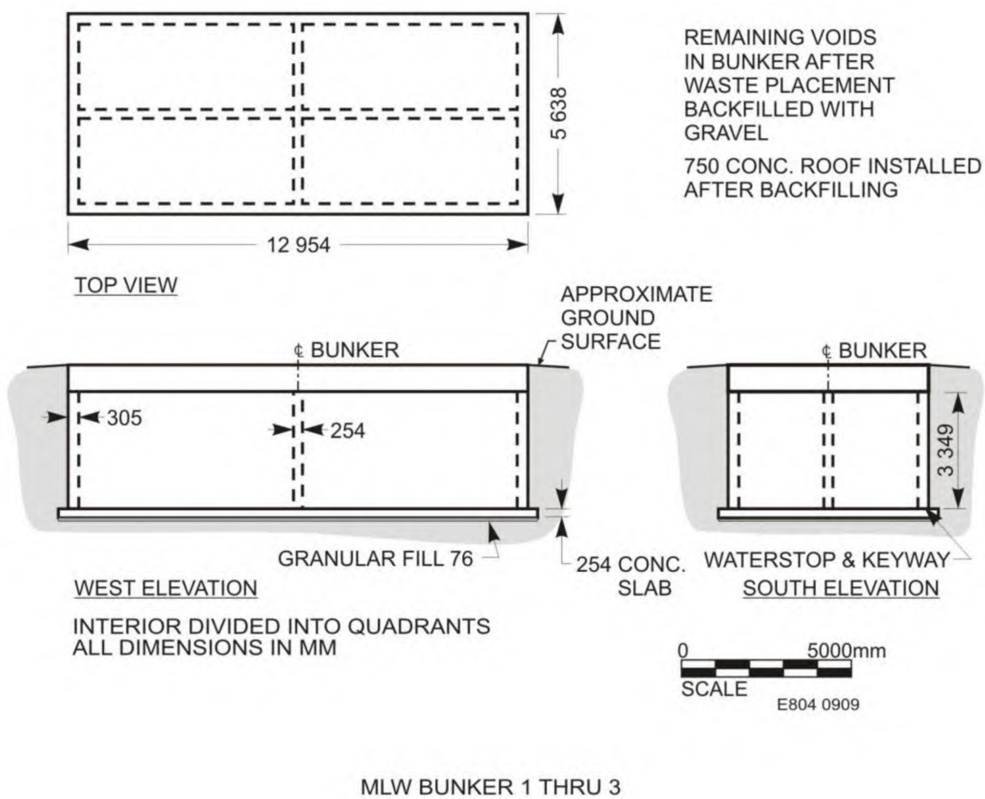

Figure A-3 Sketch of ILW Bunkers 1, 2 and 3 in the WL WMA

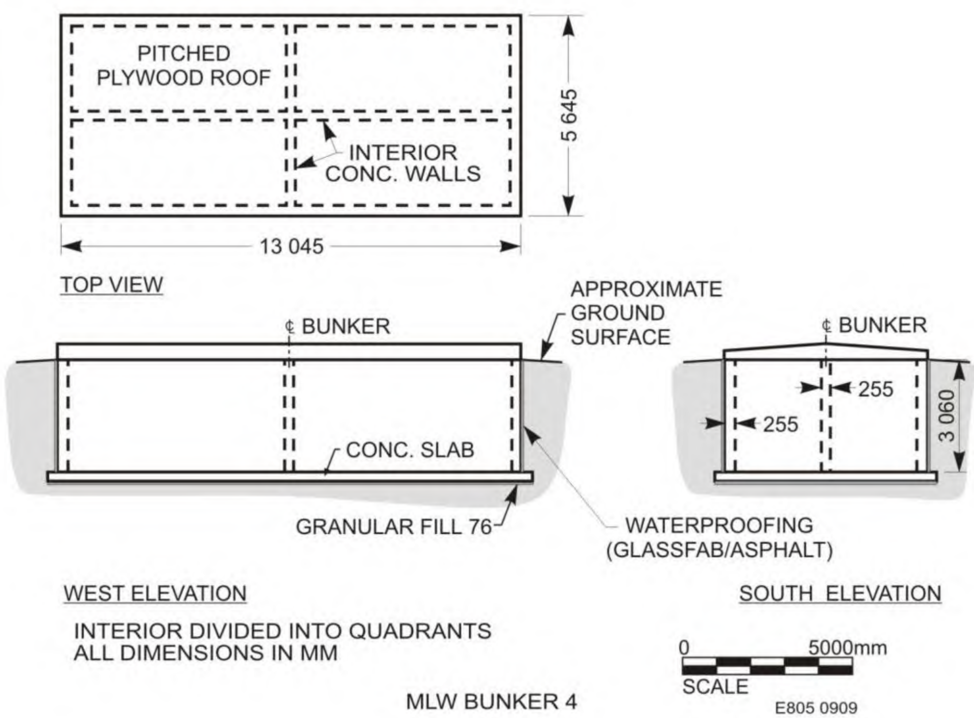

Figure A-4 Sketch of ILW Bunker 4 in the WL WMA

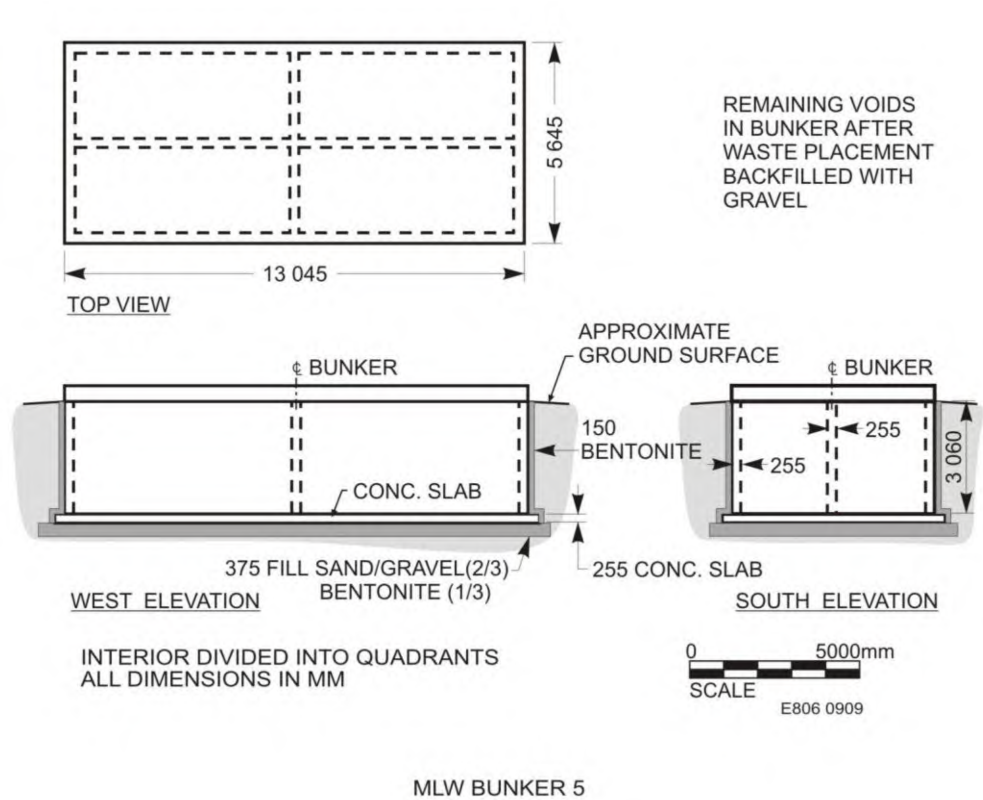

Figure A-5 Sketch of ILW Bunker 5 in the WL WMA

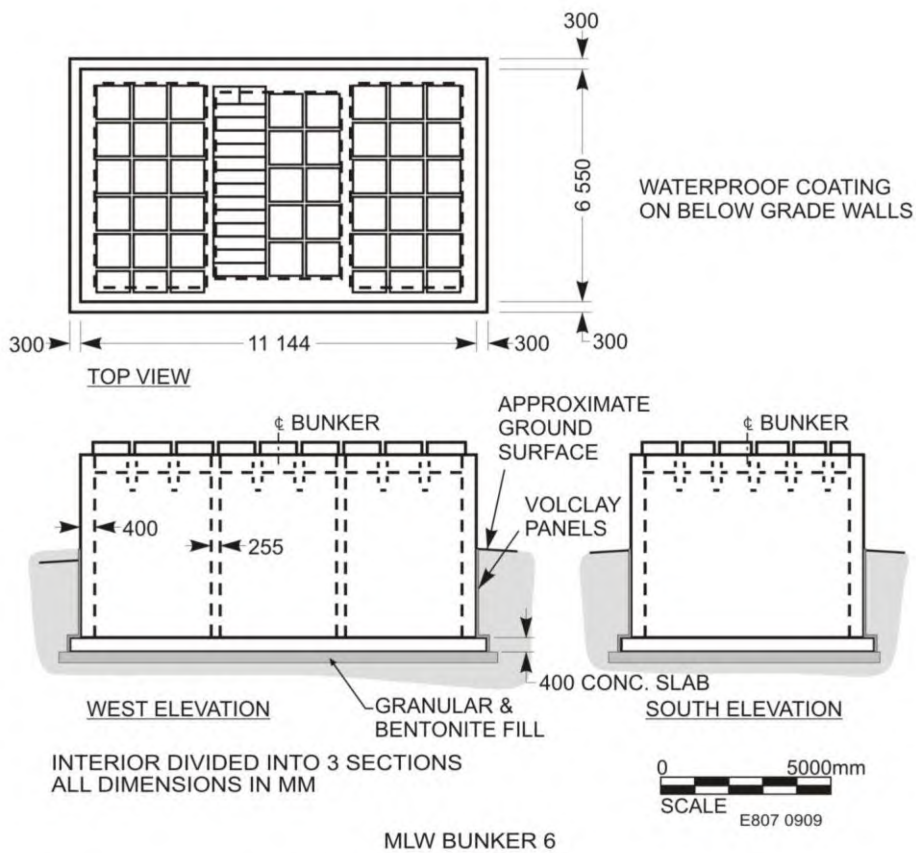

Figure A-6 Sketch of ILW Bunker 6 in the WL WMA

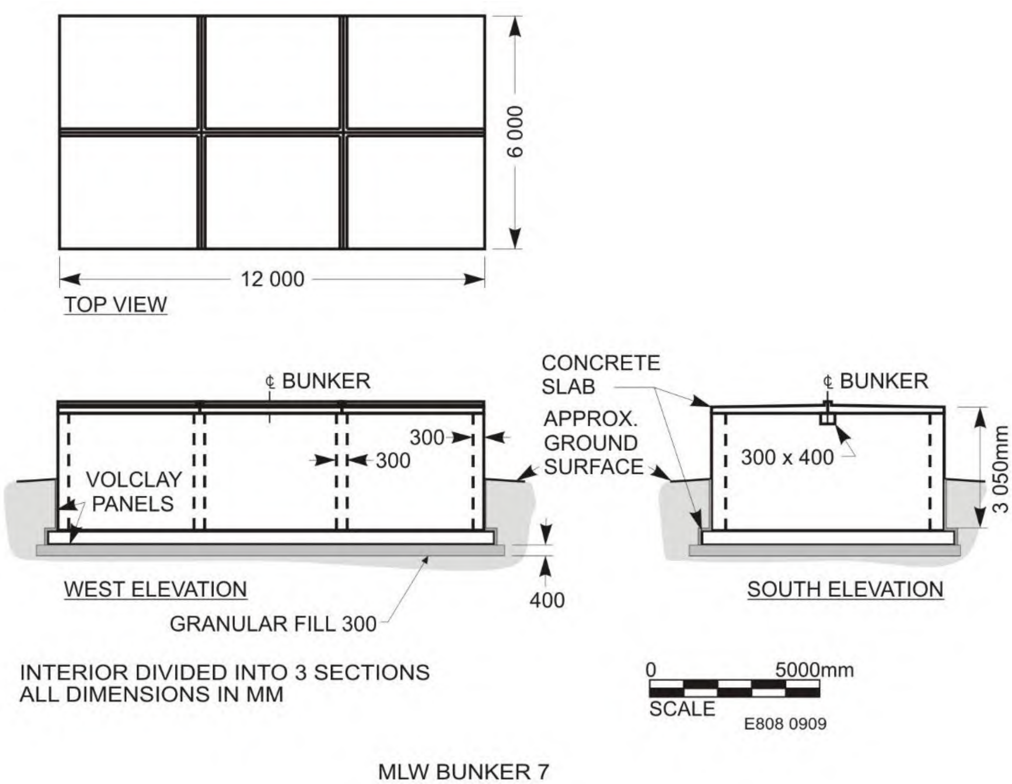

Figure A-7 Sketch of ILW Bunker 7 in the WL WMA

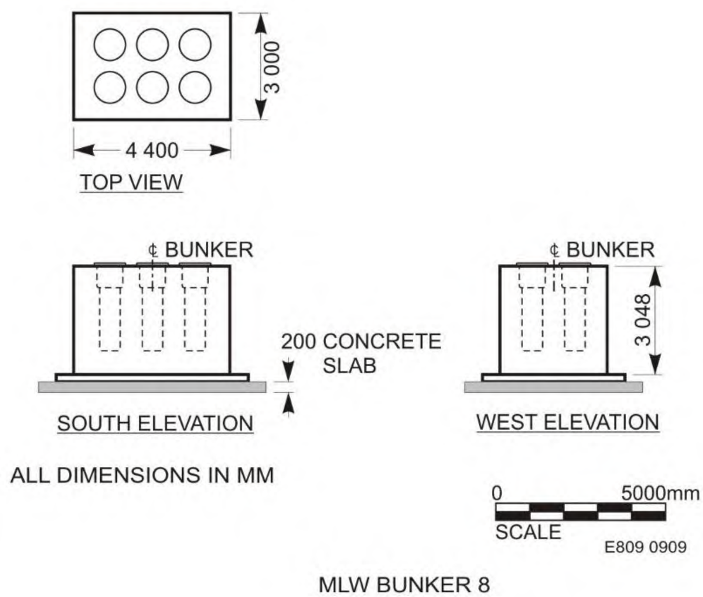

Figure A-8 Sketch of ILW Bunker 8 in the WL WMA

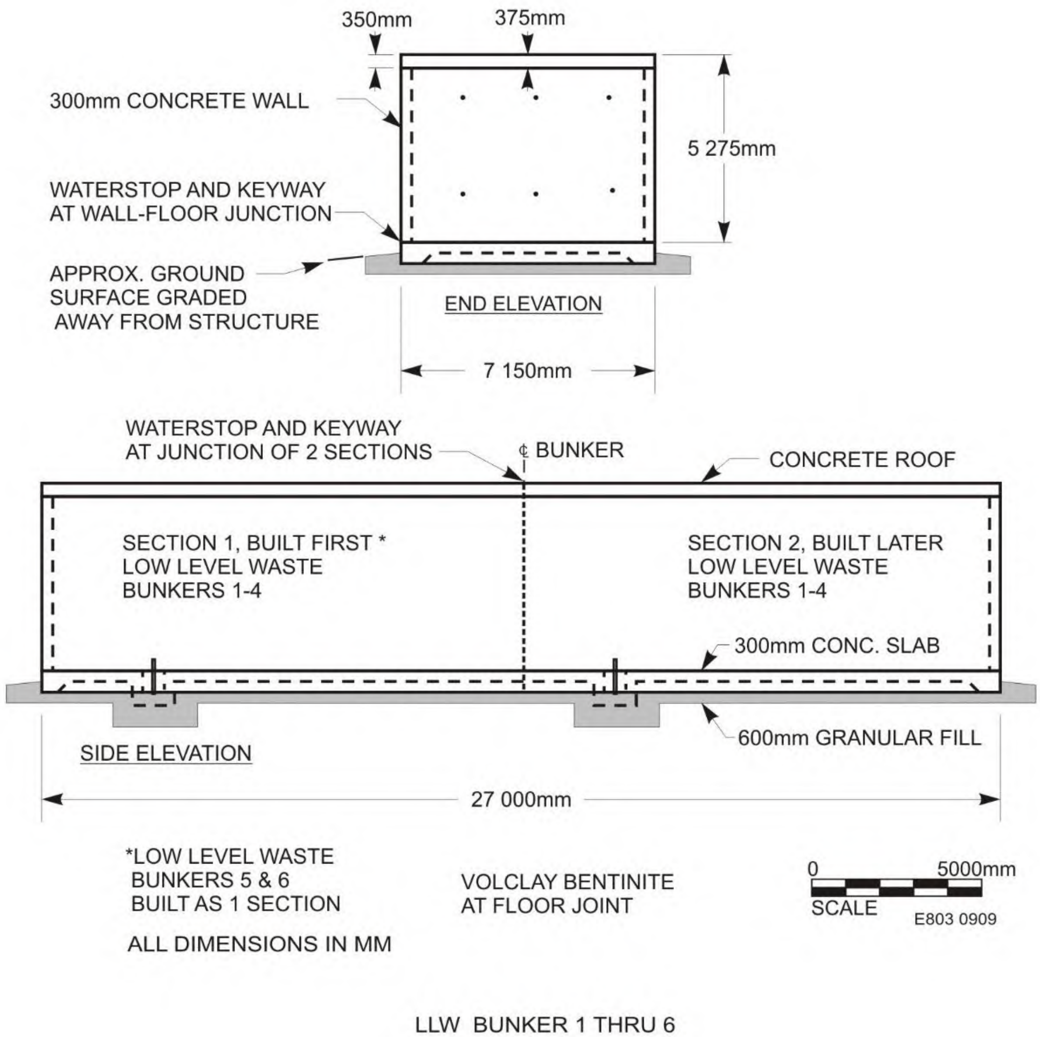

Figure A-9 Sketch of LLW Bunkers in the WL WMA

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

Record of Decision

DEC 19-H4

In the Matter of

Applicant	Canadian Nuclear Laboratories Ltd.
Subject	Application for the Renewal of the Nuclear Research and Test Establishment Decommissioning Licence for Whiteshell Laboratories
Public Hearing Date	October 2-3, 2019
Record of Decision Date	December 19, 2019

Canada

RECORD OF DECISION – DEC 19-H4

Applicant:	Canadian Nuclear Laboratories Ltd
Address/Location:	286 Plant Road Chalk River, Ontario K0J 1J0
Purpose:	Application for the Renewal of the Nuclear Research and Test Establishment Decommissioning Licence for Whiteshell Laboratories
Application received:	November 15, 2018
Date of public hearing:	October 2-3, 2019
Location:	Lac du Bonnet Community Centre, Lions Hall, 25 McArthur Avenue, Lac du Bonnet, Manitoba
Members present:	R. Velshi, Chair T. Berube S. Demeter M. Lacroix
Secretary:	M. Leblanc
Recording Secretary:	C. Moreau
Senior Counsel:	D. Saumure

Applicant Represented By		Document Number
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Intervenors		
See appendix A		
Other Government Representatives		
Environment and Climate Change Canada, represented by N. Ali and D. Kim		

Licence: Renewed

Table of Contents

1.0 INTRODUCTION

1. Canadian Nuclear Laboratories Ltd. (CNL) has applied to the Canadian Nuclear Safety Commission[1] (CNSC) for the renewal of the Nuclear Research and Test Establishment Decommissioning Licence (NRTEDL) for its Whiteshell Laboratories (WL), located in Pinawa, Manitoba. The current licence, NRTEDL-W5-8.05/2019, which expires on December 31, 2019, allows CNL to operate and decommission WL. CNL requested a licence renewal for a period of 10 years.

2. The WL site encompasses an area of approximately 4,375 hectares and includes facilities such as the Whiteshell reactor (WR-1 reactor), shielded facilities, radioactive waste management facilities and structures, a concrete canister storage area and various research laboratories and support buildings. WL operated as a nuclear research facility for approximately 40 years. During this time, the WR-1 reactor operated for a period of 20 years.

3. In February 2019, up to $50,000 in funding to participate in this licensing process was made available to Indigenous groups, not-for-profit organizations and members of the public through the CNSC's Participant Funding Program (PFP). A Funding Review Committee, independent of the CNSC, recommended that up to $63,300 in participant funding be provided to five applicants. These applicants were required, by virtue of being awarded participant funding, to submit a written intervention and make an oral presentation at the public hearing commenting on CNL's application.

4. The Commission wishes to make clear that the scope of CNL's licence renewal application and of this public hearing was the renewal of the WL licence. This hearing did not consider the *in situ* decommissioning of the WR-1 reactor that has been proposed by CNL. The Commission understands that the proposed *in situ* decommissioning of the WR-1 reactor is an important concern for intervenors, as raised in several interventions. Those issues are outside the scope of these proceedings and the Commission will consider the concerns raised by Indigenous peoples, members of the public and other stakeholders regarding the proposed *in situ* decommissioning of the WR-1 reactor, as well as the EA for the proposed decommissioning method, through a future public Commission hearing, that will provide an opportunity for public participation.

<u>Issues</u>

5. In considering the application, the Commission was required to decide:

   a) what environmental assessment review process to apply in relation to this application;

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[1] The *Canadian Nuclear Safety Commission* is referred to as the "CNSC" when referring to the organization and its staff in general, and as the "Commission" when referring to the tribunal component.

b) whether CNL is qualified to carry on the activity that the licence would authorize; and

c) whether, in carrying on that activity, CNL would make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Public Hearing

6. The Commission, in making its decision, considered information presented for a public hearing held on October 2-3, 2019 in Lac du Bonnet, Manitoba. The public hearing was conducted in accordance with the *Canadian Nuclear Safety Commission Rules of Procedure*[2] (the Rules). During the hearing, the Commission considered written submissions and heard oral presentations from CNL (CMD 19-H4.1, CMD 19-H4.1A, CMD 19-H4.1B and CMD 19-H4.1C) and CNSC staff (CMD 19-H4, CMD 19-H4.A, CMD 19-H4.B, CMD 19-H4.C and CMD 19-H4.D). The Commission also considered oral and written submissions from 11 intervenors (see Appendix A for a list of interventions). The hearing was webcast live via the CNSC website, and video archives are available on the CNSC's website.

Request for Ruling

7. On October 2, 2019, the Canadian Environmental Law Association (CELA) filed a ruling request[3] pursuant to Rule 20(1) of the Rules. The Commission acknowledged receipt of the request during the hearing and indicated that the Commission would consider the ruling request during its deliberations.

8. As stated in a previous decision,[4] the Commission has made its Rules and interprets them in light of the direction Parliament gave to the Commission in subsection 20(3) of the NSCA, that it deal with all proceedings "as informally and expeditiously as the circumstances and considerations of fairness permit." In this context, Rule 20 contemplates that a participant in a public hearing may request that the Commission rule on a particular issue. Such a request may be made at any time before the start of a public hearing or during a public hearing. The rule contemplates that the "relevant persons" – those whose interests might be affected by the ruling that is requested – have notice of a request and have an opportunity to present their views on it, before a ruling may be made.

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[2] Statutory Orders and Regulations (SOR)/2000-211.
[3] CMD 19 H4.13, *Request for Ruling from the Canadian Environmental Law Association*, October 2, 2019.
[4] Canadian Nuclear Safety Commission Record of Decision, *Application to Renew the Nuclear Power Reactor Operating Licence for the Pickering Nuclear Generating Station*, issued December 2018.

9. The intervenor requested “that the Commission in its Record of Decision actively support, advance and implement the Winnipeg Nuclear Declaration 2018 in respect to the Right to Nuclear Peace and Freedom from Nuclear Fear.” The Commission determined that consultation with persons whose interests may be affected by the ruling requested was not required for this matter as it was determined that this request was outside the scope of this hearing.

10. Requests for ruling can contribute to the Commission ensuring that it conducts an expeditious and fair hearing. Such requests are always in the context of a particular hearing, and some requests for a ruling on a matter of substance or procedure can contribute to a fair hearing and should be dealt with specifically – a ruling on substance might narrow the scope of a hearing, for example, or might fully address a matter arising in a hearing, or might speak to the limiting of participation in a hearing, as contemplated in paragraph 2(b) of Rule 20. In such circumstances, the potential for specific rulings before or within a hearing is positive, and reliance on the rule, salutary. Requests for rulings are appropriate in respect of matters that either would not otherwise arise in a hearing and a participant feels a ruling would clarify or simplify a matter in some way, or would advance the Commission’s consideration of the subject-matter of the hearing in some way that merits separate treatment outside of or in addition to the flow of the hearing.

11. The Commission, as a quasi-judicial administrative tribunal, renders decisions that are within its legislated mandate and does not take a position on matters such as is contemplated by this ruling request. The Commission notes that Canada is a non-nuclear weapon country and that the Commission, in regulating the peaceful use of nuclear energy and materials, must be confident in its decision that licensees ensure maintenance of national security and measures required to implement international obligations to which Canada has agreed.

2.0 DECISION

12. Based on its consideration of the matter, as described in more detail in the following sections of this *Record of Decision*, the Commission concludes that CNL is qualified to carry on the activity that the licence will authorize. The Commission is of the opinion that, in carrying on that activity, CNL will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed. Therefore,

> the Commission, pursuant to section 24 of the *Nuclear Safety and Control Act*, renews the Nuclear Research and Test Establishment Decommissioning Licence issued to Canadian Nuclear Laboratories Ltd. for its Whiteshell Laboratories located in Pinawa, Manitoba. The renewed licence, NRTEDL-W5-8.00/2024, is valid from January 1, 2020 until December 31, 2024.

13. Although CNL requested a ten-year licence renewal, the Commission considers that a licence for a period of five-year is more appropriate considering all the important activities to be carried out at this specific site in the next couple of years and the concerns raised by some intervenors. The five-year licence period will provide enough time for CNL to submit the Environmental Impact Statement for the proposed *in situ* decommissioning of the WR-1 reactor, which the Commission understands will be available in 2020, and the Safety Analysis Report for the underground low-level waste (LLW) trenches, which the Commission understands will be available by the end of 2023. Indigenous peoples and members of the public are invited to review and comment CNL's performance as part of the regular Regulatory Oversight Report (ROR), as well as during future licensing hearings.

14. The Commission includes in the licence the conditions as recommended by CNSC staff in CMD 19-H4, CMD 19-H4.A, CMD 19-H4.B and CMD 19-H4.C, including licence condition 12.2. The Commission also delegates authority for the purposes of licence condition 3.2, as recommended by CNSC staff.

15. The Commission is satisfied that an environmental assessment (EA) under the *Canadian Environmental Assessment Act, 2012*[5] (CEAA 2012) was not required for the renewal and considers the environmental protection review that was conducted by CNSC staff to be acceptable and thorough.

16. With this decision, the Commission directs CNSC staff to report on the performance of CNL and WL as part of a ROR. CNSC staff shall present this report at a public proceeding of the Commission, where members of the public will be able to participate. The Commission encourages Indigenous groups and members of the public to participate.

17. The Commission notes that CNSC staff can bring any matter to the Commission as applicable. The Commission directs CNSC staff to inform the Commission of any changes made to the Licence Conditions Handbook (LCH) as a component of the ROR.

3.0 ENVIRONMENTAL ASSESSMENT

3.1 Application of the *Canadian Environmental Assessment Act, 2012* and the *Impact Assessment Act*

18. In coming to its decision, the Commission was first required to determine whether an EA under the CEAA 2012 was required.

19. CNL's application was made November 15, 2018. At that time, the CEAA 2012 and its regulations were the environmental assessment regime in place and specified the requirements for EA for nuclear projects. The licence renewal of a facility is not

[5] S.C. 2012, c. 19, s. 52

included on the Designated Project list for an EA, as renewing a licence is not an activity identified in the *Regulations Designating Physical Activities*.[6]

20. The application submitted by CNL is for a licence renewal and CNL is not requesting authorization to conduct new projects or new physical activities.[7] The Commission notes that a licence renewal is not a designated project under CEAA 2012. The Commission recognizes that the decommissioning of the WR-1 reactor triggered an EA under CEAA 2012 that is currently in process, with licensing for that project to be considered at a separate proceeding.

21. The *Impact Assessment Act*[8] (IAA) came into force on August 28, 2019. Under the IAA and the *Physical Activities Regulations*[9] made under it, impact assessments are to be conducted in respect of projects identified as having the greatest potential for adverse environmental effects in areas of federal jurisdiction. Since CNL's application was submitted to the CNSC prior to the coming into force of the IAA, the Commission is satisfied that the IAA does not apply to this licensing application.

22. Based on the information provided for this hearing, the Commission is satisfied that an EA under CEAA 2012 is not required in regard to this licence renewal.

3.2 CNSC Environmental Protection Review

23. The Commission considered the completeness and adequacy of the environmental protection review under the *Nuclear Safety and Control Act*,[10] (NSCA) and its regulations that CNSC staff conducted for this licence renewal. CNSC staff findings included that:

- CNL's environmental protection programs met CNSC regulatory requirements and results from CNL's and from other regional monitoring programs carried out by other levels of government confirmed that the environment and health of persons around the WL site remained protected.
- CNSC staff concluded that the potential risk from physical stressors and radiological and hazardous releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible. As required by the regulation, CNSC staff will verify that CNL conducts a site-wide ERA in accordance with REGDOC-2.9.1, E*nvironmental Principles, Assessments and Protection Measures* [11] and CSA N288.6-12, *Environmental*

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[6] SOR/2012-147
[7] "Projects" as defined in section 66 of CEAA 2012.
[8] S.C. 2019, c. 28, s. 1
[9] SOR/2019-285
[10] Statutes of Canada (S.C.) 1997, chapter (c.) 9.
[11] CNSC Regulatory Document REGDOC-2.9.1, E*nvironmental Principles, Assessments and Protection Measures*, 2016.

Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills[12] during the proposed licensing period.

- The 2017 sampling results from CNSC's Independent Environmental Monitoring Program (IEMP) confirmed that the environment and health of persons around the WL site were protected.

24. Based on the information provided on the record for this hearing, the Commission is satisfied that the environmental protection review conducted by CNSC staff for the WL licence renewal was acceptable and thorough. The Commission notes that the NSCA provides a strong regulatory framework for environmental protection, and the health and safety of persons. The Commission understands that an Environmental Risk Assessment (ERA) is currently underway and expects that the results from this ERA will form part of the information to be filed for the next licence renewal.

3.3 Conclusion on Environmental Assessment

25. Based on the information provided for this hearing, the Commission concludes that the licence renewal is not a designated project under CEAA 2012 and that an EA under CEAA 2012 is not required. Further, the Commission is satisfied that CNL has made, and will continue to make, adequate provision for the protection of the environment throughout the proposed renewed licence period.

26. Following its consideration of the information provided on the record for this hearing, the Commission concludes that an environmental protection review conducted under the NSCA and its regulations was appropriate for this licence renewal application.

4.0 ISSUES AND COMMISSION FINDINGS

27. In making its licensing decision, the Commission considered a number of issues and submissions relating to CNL's qualification to carry out the proposed licensed activities. The Commission also considered the adequacy of the proposed measures for protecting the environment, the health and safety of persons, national security and international obligations to which Canada has agreed.

28. CNL submitted a licence renewal application for WL on November 15, 2018. In its consideration of this matter, the Commission examined the completeness of the application and the adequacy of the information submitted by CNL, as required by the NSCA, the *General Nuclear Safety and Control Regulations*[13] (GNSCR) and other

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[12] N288.6-12, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills,* CSA Group, 2012.

[13] SOR/2000-202.

applicable regulations made under the NSCA. The Commission also examined CNSC staff's assessment of CNL's performance in all 14 safety and control areas (SCAs) and in relation to several other matters of regulatory interest over the current licence period.[14]

4.1 Management System

29. The Commission examined CNL's management system which covers the framework that establishes the processes and programs required to ensure that WL achieve its safety objectives, continuously monitor its performance against these objectives, and foster a healthy safety culture. CNSC staff rated CNL's performance in this SCA as "satisfactory" throughout the current licence period.

30. The Commission assessed the information submitted by CNL and CNSC staff regarding the WL management system. CNSC staff submitted that CNL implemented CSA N286-12, *Management system requirements for nuclear facilities*[15] to all CNL sites in a CNL-wide management system program with Quality Assurance Plans to describe site-specific functions, responsibilities and authorities. CNSC staff also submitted that the WL Decommissioning Quality Assurance Plan met the expectations set in CSA N286-12.

31. The Commission reviewed the information submitted by CNL regarding its organizational structure at WL. CNL described the government owned-contractor operated (GoCo) model that has been in place since 2015. CNL submitted that the organizational structure at WL identified the high-level responsibilities and authorities of the positions associated with its operations, as detailed in its organizational chart.

32. CNSC staff reported that it had no concerns regarding CNL organizational structure and confirmed that it was of the view that CNL's organization was suitable to ensure continued safe operation and compliance with regulatory requirements. CNSC staff also reported that its reviews showed that CNL appropriately documented the roles, responsibilities, accountabilities and authorities in its documentation.

33. The Commission examined the information provided by CNL in regard to facility management at WL. CNL submitted that it operated under eleven corporate policies, providing direction and expectations to management and employees for all business activities performed at WL.

34. CNL submitted that it developed software to support the operating experience process and that the software contained a reporting component for workers to report issues and opportunities for improvement. CNSC staff indicated that CNSC staff routinely

[14] In this Record of Decision, when referring to the "current licence period", the Commission refers to the period including the current one-year licence issued on January 1, 2019, as well as the previous licence, which was valid from December 31, 2008 to December 31, 2018.
[15] N286-12, *Management system requirements for nuclear facilities,* CSA Group, 2012 (R2017).

reviewed the issues raised by CNL's employees and conducted field verifications of the completion of follow-up actions, where appropriate, during on-site inspection activities.

35. CNL provided the Commission with information on its change management program, noting that changes were made according to the Organizational Change Control process.

4.1.1 Safety Culture

36. The Commission assessed the adequacy of CNL's safety culture at WL. CNL reported that a detailed safety culture assessment was executed in the fall of 2012 and that results indicated that, at that time, additional effort was required to ensure that standards and expectations were established and clearly communicated to CNL employees. CNL also reported that it had implemented a corrective action plan to enhance safety culture and described the measures that had been taken, such as the 2013 alignment of CNL's Nuclear Safety Policy with the Institute of Nuclear Power Operators' *Traits of a Healthy Nuclear Safety Culture*.[16]

37. CNL submitted detailed information about its monitoring of safety culture through frequent surveys, including in 2017 and 2018. CNL stated that results from the 2017 and 2018 surveys continued to show that results on safety and security aspects ranked the highest.

38. CNL indicated that attendance at nuclear safety culture courses was required for all of CNL's employees and that the courses were delivered to all new employees during orientation training. CNL added that programs and processes were implemented and maintained to ensure the fostering of a strong safety culture at WL.

39. CNL submitted that it conducted a company-wide safety stand-down on May 30, 2019, after indication that its industrial safety metrics were declining. CNL explained that the safety stand-down was devoted to increased safety awareness, the strengthening of work practices, and identifying emergent safety issues where immediate action would produce quick gains, in addition to recognizing issues where improvements would take longer time. CNSC staff indicated that it assisted the safety stand-down and that it was satisfied with CNL's promotion of health and safety awareness at WL.

40. The Commission is satisfied that CNL had maintained and will continue to maintain a strong safety culture at WL.

[16] Institute of Nuclear Power Operators (INPO), INPO 12-012, *Traits of a Healthy Safety Culture* (Rev. 1), April 2013.

4.1.2 Conclusion on Management System

41. On the basis of the information provided on the record for this hearing, the Commission concludes that CNL has appropriate organization and management structures in place and that the operating performance at WL in the current licence period provides a positive indication of CNL's ability to adequately carry out the activities under the proposed licence.

4.2 Human Performance Management

42. The Commission assessed CNL's human performance management programs which encompass activities that enable effective human performance through the development and implementation of processes that ensure that the WL staff are sufficient in number in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. During the current licence period, CNSC staff rated CNL's performance in this SCA as "satisfactory."

43. The Commission examined the information submitted by CNL regarding the WL human performance program and the improvements put in place by CNL during the current licence period to reduce human performance-related events and errors. CNL provided a list of improvement initiatives developed during the current licence period including the establishment of a Human Performance Steering Committee and the implementation of an Event Free Day Reset program at WL.

44. CNSC staff submitted that compliance inspections during the current licence period included verifications of the training records of employees in safety-related positions and a general verification of CNL's maintenance of a complement of competent and knowledgeable workforce at the WL. CNSC staff reported to the Commission that programs related to CNL's Human Performance Management activities at WL met the CNSC's regulatory requirements.

45. The Commission considered the information submitted by CNL about its personnel training programs. CNL informed the Commission that the application of the systematic approach to training (SAT) was mandatory for all personnel in direct operating positions in CNL nuclear facilities and that CNL's training procedures were aligned with REGDOC-2.2.2, *Personnel Training*, version 2.[17]

46. CNSC staff reported that CNL's program met specifications of REGDOC-2.2.2, version 2. CNSC staff submitted that its compliance verification activities determined that CNL had implemented and maintained appropriate training programs at WL.

47. The Commission assessed the information provided by CNL regarding the fitness for duty program at WL. CNL provided information elements of its fitness for duty program such as pre-employment medical screening for firefighters and drug and/or

[17] CNSC Regulatory Document REGDOC-2.2.2, *Personnel Training*, version 2, 2016.

alcohol testing for post-incident response and investigation.

48. Concerning the implementation of REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*,[18] CNL indicated that it performed a gap analysis in 2017 and presented an implementation plan to CNSC staff. CNSC staff submitted that CNL had revised the scheduling requirements to meet REGDOC-2.2.4 by January 2020.

49. In regard to REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, version 2,[19] CNL informed the Commission that CNL was on track to comply with the specifications of REGDOC-2.2.4, Volume II. CNSC staff submitted that the CNSC's licensees had requested that their implementation dates for this REGDOC be delayed to allow for the discussion of industry-proposed amendments regarding the use of oral fluid testing. CNSC staff will monitor the implementation of REGDOC-2.2.4, Volume II by CNL during the proposed licence period.

50. Based on its consideration of the information presented on the record for this hearing, the Commission concludes that CNL has appropriate programs in place and that current efforts related to human performance management provide a positive indication of CNL's ability to adequately carry out the activities under the proposed licence.

51. The Commission is satisfied that CNL has appropriate training programs in place at WL and that these programs meet the objectives of REGDOC-2.2.2, version 2.

52. The Commission is satisfied that the factors for fitness for duty examined above were adequate and acknowledges the discussion of industry-proposed amendments for REGDOC-2.2.4, Volume II. The Commission expects REGDOC-2.2.4 and REGDOC-2.2.4, Volume II to be implemented in the renewed licence period as detailed in the submissions made for this hearing. The Commission expects updates in this regard via an ROR or other means, as appropriate.

4.3 Operating Performance

53. The Commission examined operating performance at WL, which includes an overall review of the conduct of the licensed activities and the activities that enable effective performance as well as improvement plans and significant future activities at WL. Throughout the current licence period, CNSC staff rated CNL's performance in the operating performance SCA as "satisfactory."

54. CNL submitted that WL were safely operated in accordance with the operating limits and conditions during the current licence period. CNL further reported that its safe operating practices were governed by its Conduct of Operations Program.

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[18] CNSC Regulatory Document, REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*, 2017.
[19] CNSC Regulatory Document REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use*, 2017, version 2.

55. CNSC staff submitted that CNSC compliance verification activities showed that WL were operated safely during the current licence period and that CNL's Conduct of Operations Program was in accordance with CNL's licence requirements for WL.

56. The Commission also reviewed CNL's operating experience (OPEX) program at WL. CNL provided details about its OPEX program, as well as the corrective action program, and noted that its processes included responding to external events and disseminating lessons learned. CNL also reported that, through the OPEX Program, CNL aimed to achieve higher levels of operational safety and performance, and to reduce the significance and occurrence of unplanned events.

57. Asked about the difference between the corrective action program and the OPEX program, the CNL representative explained that the OPEX program reviewed and tracked lessons learned internally or from other entities in the nuclear industry. The CNL representative further explained that the corrective action program was used to identify actions to put in place once issues were identified and to track those issues to closure.

58. Having examined the information submitted for this hearing, the Commission is satisfied that WL were operated and will continue to be operated safely during the proposed licence period.

59. The Commission assessed the information submitted by CNL and CNSC staff regarding CNL's adherence to the reporting requirements of unplanned situations or events at WL. CNL submitted that CNL's reporting procedure document was revised in 2016 to incorporate the additional requirements about reporting to a CNSC Duty Officer, as required by CNSC staff during the licence period.

60. CNSC staff reported that CNL complied with the requirements for reporting unplanned situations or events at the WL site to the CNSC during the current licence period. CNSC staff also reported that CNL would be expected to comply with REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*[20] during the proposed licence period and that this expectation would be added to CNL's LCH should the licence be renewed.

61. Based on the information provided, the Commission is satisfied that CNL met all reporting parameters for reporting unplanned situations or events at WL. The Commission expects CNL to implement REGDOC-3.1.2 in the renewed licence period as presented during this hearing and directs CNSC staff to report progress in future RORs or other means, as appropriate.

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[20] CNSC Regulatory Document REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*, 2018.

62. The Commission considered the adequacy of CNL's documentation and procedures. CNSC staff submitted that CNL maintained a comprehensive suite of procedures across all programs and facilities at WL and had continually updated the facility-specific procedures as needed to support ongoing process improvements at WL. CNSC staff also confirmed that changes to procedures were made in accordance with CNL's change control process.

63. Based on the above information, the Commission concludes that the operating performance at WL during the current licence period provides a positive indication of CNL's ability to carry out the activities under the proposed licence. On the basis of its review of the above information, the Commission is satisfied that CNL will continue to ensure that appropriate operation performance-related programs are in place at WL to ensure the health and safety of persons and the protection of the environment.

4.4 Safety Analysis

64. The Commission assessed safety analysis at WL, which includes a systematic evaluation of the potential hazards associated with the conduct of the licensed activity or the operation of a facility, and considers the effectiveness of preventive measures and strategies in reducing the effects of such hazards. Safety analysis supports the overall safety case for WL. CNSC staff reported that, throughout the current licence period, WL were operated safely and within licence limits, with CNL's performance in this SCA rated as "satisfactory" by CNSC staff.

65. The Commission considered the information provided by CNL about the deterministic analyses that were performed for WL. CNL reported that the Safety Analysis Reports (SARs) demonstrated that the facilities at WL were appropriately designed to meet health, safety, security, environmental and regulatory requirements. CNL added that four facilities at WL had SARs: the Shielded Facilities, the Waste Management Area (WMA), the Concrete Canister Storage Facility (CCSF), and the Active Liquid Waste Treatment Centre.

66. CNSC staff reported that CNL updated the SARs over time as operational requirements changed and that the updates were reviewed by CNSC staff and carried out in accordance with the requirements of the licensing basis.

67. In regard to criticality safety, CNL informed the Commission of its procedures and guidance at WL providing oversight and direction in regard to all activities that involve fissionable materials. CNL reported that it updated its criticality safety documents on a risk-graded approach: upper subcritical limits were documented, criticality hazard identification studies were completed for all nuclear criticality controlled areas at WL and criticality accident mitigation measures were documented. CNL also reported that computer-based nuclear criticality safety awareness training was delivered to all staff as part of the required training.

68. CNSC staff submitted that the only remaining activities involving fissionable material at WL were the storage of used fuel in the CCSF and the WMA's Intermediate-Level Waste (ILW) standpipes, which CNSC staff reported to be of low risk. CNSC staff also reported that CNL implemented and maintained a nuclear criticality safety program compliant with RD-327, *Nuclear Criticality Safety*.[21]

69. On the basis of the information presented, the Commission concludes that the systematic evaluation of the potential hazards and the preparedness for reducing the effects of such hazards is adequate for the operation of the facility and the activities under the proposed licence. The Commission finds that CNL's safety analysis program for WL meets regulatory requirements and that CNL has adequate preventive measures and strategies in place at WL to ensure the protection of workers, members of the public and the environment and that the facilities at WL meet safety requirements. The Commission is also satisfied that CNL is maintaining appropriate programs to ensure criticality safety at WL.

4.5 Physical Design

70. The Commission considered the physical design of facilities at WL, including the activities to design the systems, structures and components to meet and maintain the design basis of the facility. The design basis is the range of conditions, according to established criteria, that the facility must withstand without exceeding authorized limits for the planned operation of safety systems. CNSC staff rated CNL's performance in this SCA as "satisfactory" throughout the current licence period.

71. The Commission examined the physical design and associated activities of the facilities at WL, which is managed by CNL under its Design Authority and Design Engineering Program. CNL submitted information about how its Design Engineering Program complied with CSA N286-12 and CSA N285.0, *General requirements for pressure retaining systems and components in CANDU nuclear power plants*,[22] noting that the program applied to all design activities at WL.

72. CNL submitted information regarding its Configuration Management Program which provides the framework to maintain and control the physical configuration of all structures, systems and components and which applies to all design, operation, decommissioning and maintenance activities at WL. CNL also provided the Commission with information regarding planned improvements and key initiatives for the proposed licence period such as performing a gap analysis for codes and standards and redistributing engineering functions to better leverage experience and knowledge in the workforce.

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[21] CNSC Regulatory Document RD-327, *Nuclear Criticality Safety*, 2010.
[22] N285.0-08, *General requirements for pressure-retaining systems and components in CANDU nuclear power plants*, CSA Group, 2008.

73. CNL reported that the CNL chief nuclear engineer had the responsibility to ensure that staff executing design processes understood their accountabilities and that the chief nuclear engineer had authority over and provided oversight for the execution of the design program.

74. CNSC staff reviewed the design of new facilities, a Shielded Modular Above-Ground Storage Building and a Soil Storage Compound, constructed by CNL to support the on-going decommissioning activities at WL. CNSC staff determined that CNL met regulatory requirements related to the design of its facilities, and the operation of these new facilities remained within the design basis.

75. CNSC staff informed the Commission that, during the proposed licence period, CNL planned to design and construct facilities for the remediation of the 171 standpipes and ILW bunkers. CNSC staff added that the planned work included the removal, characterization, packaging, and shipment of the waste. CNSC staff indicated that CNSC staff will review the design of these facilities prior to their operation.

76. The Commission assessed the information provided by CNL and CNSC staff on the pressure boundary program at WL. CNL submitted that WL pressure boundary program provided assurance that pressure systems and components were in compliance with the applicable codes, standards, and regulatory requirements.

77. CNSC staff submitted that the WL pressure boundary program met regulatory requirements. CNSC staff indicated that CNL was required to update its pressure boundary procedure to include the decommissioning of pressure boundary systems and components. CNSC staff added that it will review the design of new facilities at WL to ensure that they meet pressure boundary requirements.

78. The Commission considered the adequacy of the Fire Protection Program design at WL. CNSC staff indicated that CNL's Fire Protection Program met the *National Building Code of Canada 2010*,[23] the *National Fire Code of Canada 2010*,[24] and CSA N293-12, *Fire protection for nuclear power plants*.[25] CNSC staff informed that, at its request, CNL performed a gap analysis in 2016 against the operational requirements of CSA-N393, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*,[26] and developed and implemented a corrective action plan to address the gaps identified. CNSC staff added that it reviewed the corrective action plan and will verify its implementation during upcoming inspections.

79. On the basis of the information presented, the Commission concludes that CNL continues to implement and maintain an effective design program at WL and that the design of WL is adequate for the operation period included in the proposed licence. The Commission is satisfied with CNSC staff's assessment of the adequacy of the

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[23] IRC-10NBC, *National Building Code of Canada 2010*, National Research Council, 2010.
[24] IRC-10NBF, *National Fire Code of Canada 2010*, National Research Council, 2010.
[25] N293-12, *Fire protection for nuclear power plants*, CSA Group, 2012.
[26] N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substance,* CSA group, 2013.

physical design of WL.

4.6 Fitness for Service

80. Fitness for Service covers activities that are performed to ensure that the systems, structures and components (SSCs) at WL continue to effectively fulfill their intended purpose. CNSC staff rated the CNL's performance in this SCA as "satisfactory" throughout the current licence period.

81. The Commission considered the adequacy of CNL's maintenance programs. CNL provided the Commission with detailed information on preventative and corrective maintenance carried out at nuclear and non-nuclear facilities at WL. CNL reported that maintenance was carried out by qualified workers on safety systems as well as on those aspects of buildings, structures and grounds required to maintain personnel and structural safety, protection of site assets, protection of the environment and support of the closure mission.

82. CNSC staff reported that CNSC staff reviewed CNL's governing documents for the conduct of maintenance at WL and concluded that the program meets regulatory requirements and that SSCs verified during CNSC staff inspections were well maintained. CNSC staff also reported that CNL was compliant with CSA N286-12 in having processes in place for SSC maintenance.

83. CNL indicated that the concrete waste storage structures, the IWL bunkers, at WL were assessed under a Periodic Inspection Plan (PIP) and that the inspections were documented annually, with preventative maintenance and repairs occurring as needed. CNL added that the structural integrity of the CCSF was inspected quarterly, showing no significant cracking or spallation, and that preventative maintenance and repairs were performed as required. CNL also reported that maintenance plan updates would remain on a five-year review cycle in the proposed licence period.

84. CNSC staff reported that, based on its inspections and reviews of CNL's PIP and the CCSF inspection reports submitted by CNL, CNSC staff was of the view that CNL met and will continue to meet the regulatory requirements in regard to structural integrity at WL.

85. In response to a suggestion made in the intervention from the Local Government District of Pinawa regarding the hot cells in the shielded facility, the Commission asked whether it would be possible to retain the five fully functional hot cells at WL. The CNL representative explained that it could be possible to retain the hot cells but new work would be required to achieve this.

86. Based on the information provided on the record for this hearing, the Commission is satisfied with CNL's programs for the inspection and life-cycle management of key safety systems at WL. The Commission concludes that the equipment, as installed at

WL, is fit for service and that appropriate programs are in place to ensure that the equipment remains fit for service throughout the proposed licence period.

4.7 Radiation Protection

87. As part of its evaluation of the adequacy of the measures for protecting the health and safety of persons, the Commission considered the past performance of CNL in the area of radiation protection. The Commission also considered how the WL radiation protection program ensured that both radiation doses to persons and contamination were monitored, controlled and kept as low as reasonably achievable (ALARA), with social and economic factors taken into consideration. Throughout the current licence period, CNSC staff rated CNL's performance in this SCA as "satisfactory."

88. The Commission considered the information provided by CNL and CNSC staff to assess whether the WL radiation protection program satisfied the requirements of the *Radiation Protection Regulations*.[27] CNL informed the Commission that CNL updated its radiation protection program procedural documents in 2017 and 2018 to align with the new management system at CNL.

89. CNSC staff provided the Commission with information about the performance indicators used to monitor the radiation protection program at WL and submitted that CNL met CNSC expectations for the monitoring of the implementation and performance of the radiation protection program at WL. CNSC staff submitted that, throughout the current licence period, CNSC staff compliance inspection demonstrated that CNL had implemented an appropriate and effective radiation program at WL that satisfied regulatory requirements.

4.7.1 Application of ALARA

90. The Commission assessed the information submitted by CNL and CNSC staff regarding the application of ALARA at WL. CNL submitted that the ALARA principle was applied during the planning of radiological work at WL. CNL added that Health Physics and Radiation Protection employees were engaged in ALARA assessments, providing authoritative advice regarding radiation protection matters, preparing radiological safe work documents, providing oversight of the execution of radiation work and in the planning and conduct of radiological clearance surveys.

91. CNSC staff submitted that CNL had a documented ALARA program that identified the methods and processes in place at the WL site to control dose and minimize exposures based on current industry best practices and operating experience. CNSC staff added that its reviews of CNL's radiation protection program showed that CNL carried out ALARA planning for all radiological activities at WL, and that CNL's ALARA program met regulatory requirements.

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[27] SOR/2000-203.

92. CNL provided details about the radiation protection improvement initiatives that were completed during the current licence period, such as documenting the contamination clearance levels used for decommissioning activities at WL. CNL also reported that the implementation of its radiation protection program at WL ensured operation in compliance with CNSC regulations, with no regulatory limits or action levels having being exceeded during the current licence period, and with individual and collective doses remaining ALARA. CNL also reported that weekly and quarterly radiation protection performance reviews were undertaken at WL to identify performance trends and track program corrective actions and improvement initiatives.

93. Based on the information considered for this hearing, the Commission is satisfied that the ALARA concept is adequately applied to all WL activities.

4.7.2 Worker Dose Control

94. The Commission considered information submitted by CNL and CNSC staff about CNL's worker dose control practices at WL, including detailed worker dose data for the current licence period. CNL submitted that all nuclear energy workers (NEWs) and non-NEWs, including site visitors and members of the public, received whole-body doses that were well below regulatory limits.[28] CNL submitted that the highest individual whole body annual dose for WL NEWs during the last 10 years was 1.65 mSv.

95. CNL submitted information about proposed improvements at WL that would further improve worker dose control, such as evaluation and employment of telescoping radiation detectors, high-range probes, and remote monitoring methods for the measurement radiation fields. CNL added that it would re-evaluate the radiological source term hazard in all buildings and facilities planned to be decommissioned to ensure that protection is optimized and exposures remain ALARA.

96. The Commission noted Northwatch's concern regarding an upward trend in doses in 2017 and 2018, but is satisfied that doses to workers remain low and that the small increase does not represent an increased risk to the health and safety of workers.

97. CNL submitted that CNL transferred the majority of WL Dosimetry service activities to the CNSC-licensed Chalk River Laboratories (CRL) dosimetry service. CNL added that WL procedures and processes were updated in 2018 to reflect the change of provider.

98. CNSC staff reported that CNL had effectively implemented its radiation protection program at WL to ensure that doses received by workers remained below regulatory limits. CNSC staff also informed the Commission that CNL operated a CNSC-

[28] The effective dose limits for a NEW is set at is set at 50 mSv in any one year and 100 mSv in five consecutive years, and for pregnant NEWs the dose limit is 4 mSv from the time the pregnancy is declared to the end of the term. The dose limits for non-NEWs, including members of the public, is set at 1 mSv per year.

licensed dosimetry service that was implemented through the radiation protection program and that the dosimetry service met regulatory requirements. CNSC staff added that effective and equivalent doses, along with the effective dose distribution data, demonstrated that CNL was maintaining effective control over worker exposures at WL.

99. CNSC staff informed the Commission that CNL was in the process of revising some of the radiation protection action levels used at WL. CNSC staff added that these new action levels will be subject to CNSC staff review and acceptance.

100. The Commission requested additional information on the type of personal and area dosimetry equipment used at WL. The CNL representative responded that CNL employees wore thermoluminescent dosimeters as well as electronic personal dosimeters. The CNL representative added that trained radiation detection staff also used remote radiation survey meters to monitor the dose rates at job sites. The Commission was satisfied with the information provided on this topic.

101. Based on the information provided for this hearing, the Commission is satisfied that doses to workers at WL are adequately controlled.

4.7.3 Dose to the Public Control and Radiological Hazard Control

102. The Commission considered the effectiveness of CNL's programs to prevent uncontrolled releases of radioactive materials to the public from the WL site. CNL submitted that weekly and quarterly radiation protection performance reviews were undertaken to identify performance trends and track program corrective actions and improvement initiatives. CNL added that radiation doses to the public did not exceed the annual dose limit of 1 mSv per year[29] for the most exposed member of the public.

103. The Commission also assessed CNL's identification and control of existing and potential radiological hazards during work activities at WL. CNL indicated that changes and improvements were planned for the proposed licence period, such as an enhanced air monitoring program for nuclear building demolition.

104. CNSC staff submitted that CNL had effectively controlled the radiological dose to the public. CNSC staff further reported that the maximum effective dose based on all radioactive releases from WL during the last five years was 0.0014 mSv per year in 2014. CNSC staff also submitted that CNL continued to maintain and implement radiation protection program requirements for contamination monitoring at WL such as contamination control, radiation dose rate control, and airborne monitoring and control.

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[29] The regulatory dose limit for a member of the public is 1 mSv (1,000 µSv) per year and the natural background dose is estimated between 2 mSv – 5 mSv (2,000 µSv – 5,000 µSv) per year.

105. Based on the Commission's assessment of the information provided for this hearing, the Commission is satisfied that CNL is adequately controlling radiological doses to the public and will continue to adequately identify and control radiological hazards at WL.

4.7.4 Conclusion on Radiation Protection

106. Based on the information provided on the record for this hearing, the Commission concludes that, given the mitigation measures and safety programs that are in place and will be in place to control radiation hazards, CNL provides for, and will continue to provide for, the adequate protection of the health and safety of persons and the environment throughout the proposed licence period.

107. The Commission is satisfied that CNL's radiation protection program at the WL meets the requirements of the *Radiation Protection Regulations*.

108. The Commission notes the proposed improvements to CNL's radiation protection program for WL and anticipates that these will be carried out in the renewed licence period as presented in the materials submitted for this hearing.

4.8 Conventional Health and Safety

109. The Commission examined the implementation of a conventional health and safety program at WL, which covers the management of workplace safety hazards. The conventional health and safety program is mandated by provincial statutes for all employers and employees to minimize risk to the health and safety of workers posed by conventional (non-radiological) hazards in the workplace. This program includes compliance with applicable labour codes and conventional safety training. Throughout the current licence period, CNSC staff rated the CNL's performance in this SCA as "satisfactory."

110. CNL reported that the WL Site Safety and Health Committee was the principal forum for joint employee/management consultation and development of solutions for safety and health concerns. CNL added that the activities conducted by the committee included the inspection of all WL work locations and participation in incident investigations.

111. CNSC staff submitted that CNL's activities must comply with Part II of the *Canada Labour Code*,[30] its associated regulations,[31] and other applicable federal and provincial health and safety acts and regulations. CNSC staff added that CNSC staff verified CNL safety practices during compliance inspections and that CNSC staff was satisfied with CNL's performance at the WL site in the aspects related to conventional

[30] R.S.C, 1985, c. L-2
[31] SOR/86-304

health and safety.

112. CNL provided the Commission with detailed information regarding its Occupational Health and Safety (OHS) program at WL. CNL reported that contractors hired by CNL in Manitoba were subject to the *Manitoba Workplace Safety & Health Act and Regulation*[32] and that the CNL OHS program also provided oversight of contractors when they were on CNL property and that the contractors were governed by the CNL work permit process. CNL also provided the Commission with details regarding improvement initiatives that had been carried out in respect of the OHS program since 2009 such as a near-miss reporting initiative.

113. CNSC staff reported that CNL actively promoted conventional health and safety to its workforce through the provision of information, training, instructions, and supervision. CNSC staff also reported that CNL's employees were encouraged to report concerns, unsafe conditions, non-compliances or events in order to identify hazards and ensure measures were put in place to prevent injury and illness.

114. CNL reported to the Commission that there had been an overall improvement in the frequency of recordable lost-time injuries for WL site workers, as well as an improvement in the trend for the severity of lost-time accidents.

115. Based on the information presented, the Commission concludes that CNL's conventional health and safety program at WL satisfies regulatory requirements. The Commission also concludes that the health and safety of workers and the public was adequately protected during the operation of the facility for the current licence period and that the health and safety of persons will continue be adequately protected during throughout the proposed licence period.

4.9 Environmental Protection

116. The Commission examined CNL's environmental protection programs at WL, which are intended to identify, control and monitor all releases of radioactive and hazardous substances, and aim to minimize the effects on the environment which may result from the licensed activities. These programs include effluent and emissions control, environmental monitoring and estimated doses to the public. CNSC staff rated CNL's performance in this SCA as "satisfactory" throughout the current licence period.

117. The Commission considered whether the CNL's environmental protection programs adequately met the specifications of REGDOC-2.9.1.

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[32] M.R. 217/2006

4.9.1 Effluent and Emissions Control (Releases)

118. The Commission considered CNL's programs to control the release of effluent and emissions from the WL site to the environment during the current licence period. CNL submitted that its program documentation was being updated to align with CSA N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills,*[33] CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*,[34] CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*[35] and CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities.*[36] CNL also submitted information about radiological emissions from WL, including airborne emissions and liquid releases, noting that they were below derived release limits[37] (DRL) and regulatory limits. CNL also reported that the DRLs for WL had been updated in 2016 and that these were calculated in accordance with CSA N288.l-08, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*.[38]

119. CNSC staff indicated that it accepted CNL's plan and schedule for the implementation of these standards and that it was tracking and monitoring CNL's compliance with its commitments.

120. CNSC staff reported that CNL's environmental monitoring results presented in CNL's annual report demonstrated that radiological releases to the atmosphere and to the Winnipeg River were below their respective DRLs. CNSC staff added that, with the exception of chlorine, hazardous releases to the Winnipeg River were below release limits. CNSC staff explained that total residual chlorine released by WL was not a concern to the health of the Winnipeg River ecosystem because of the river's water flow rate.

121. CNL informed the Commission that federal requirements for the total residual chlorine in wastewater will come into force in 2021 for CNL's lagoon at WL. CNL added that WL will continue to adjust the site's chlorination practices to meet the new requirements.

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[33] N288.4-10, *Environmental monitoring programs at class I nuclear facilities and uranium mines and mills*, CSA Group, 2010 (Reaffirmed 2015).
[34] N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CSA Group, 2011 (Reaffirmed 2016).
[35] N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CSA Group, 2015.
[36] N288.8-17*, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities,* CSA Group, 2017.
[37] The "derived release limit" (DRL) for a particular radionuclide is the release rate that would result in an annual committed effective radiation dose of 1 mSv to the most exposed group of the public (also known as the critical receptor) for that nuclear substance.
[38] N288.1-08, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*, CSA Group, 2008.

122. CNL submitted to the Commission detailed information regarding monitoring results and stated that the levels of radiation and radioactive contaminants in the environment outside the WL site remained low throughout the licence period. CNL added that liquid and airborne effluents were below the DRL and that all emissions of radioactive material from WL throughout the licence period were below CNL's Administrative Levels and Action Levels and well below regulatory limits.

123. CNSC staff reported to the Commission that CNL's monitoring results and CNL's Effluent Verification Monitoring Program, provided through the issuance of CNL's annual report, complied with the applicable regulations and continued to protect the public and the environment.

124. Noting the questions about the former experimental cesium pond raised in the intervention from the Concerned Citizens of Renfrew County and Area (CCRCA), the Commission asked for information. The CNL representative explained that this was a man-made pond injected with cesium-137 in order to study the effects of this radioisotope on microorganisms and to the natural environment. Asked about whether the pond contained any other radioisotopes, the CNL representative added that the pound strictly contained cesium-137. The Commission was satisfied with the information provided.

125. On the basis of the information provided for this hearing, the Commission is satisfied that the CNL has and will continue to have adequate programs in place for the control of effluent and emissions at WL to protect the environment and meet regulatory requirements.

4.9.2 Environmental Management System

126. The Commission assessed the information provided by CNL and CNSC staff about the WL Environmental Management System (EMS). CNL submitted that its EMS was ISO 14001:2015[39] certified and that annual EMS audits were performed to verify the effectiveness of the system and for the promotion of continuous improvement of CNL's environmental performance.

127. CNSC staff submitted that the WL EMS met the specifications of REGDOC-2.9.1 and added that CNL was updating its program to meet REGDOC-2.9.1, version 1.1[40] for implementation in the proposed licence period.

128. Based on the information provided, the Commission is satisfied that CNL has maintained, and will continue to maintain, an adequate EMS at WL.

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[39] CAN/CSA-ISO 14001:2015, Environmental Management Systems – Requirements with Guidance for Use, CSA Group, 2015.

[40] CNSC Regulatory Document REGDOC-2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*, version 1.1, 2017.

4.9.3 Environmental Monitoring

129. The Commission considered information submitted by CNL about the CNL's environmental monitoring program that is designed to demonstrate that emissions from WL are properly controlled. CNL submitted that liquid effluents from WL were monitored for non-radioactive contaminants in order to measure conformance with CNL's internal guidelines for chemical substances in liquid effluents. CNL added that non-radiological monitoring results of liquid effluents and groundwater had been consistent over the licence period and levels of non-radiological contaminant releases from operations at the WL site did not negatively affect the quality of water on-site or on the local environment.

130. Further on CNL's environmental monitoring activities, CNL reported that it complied with the *Species at Risk Act*[41] and the *Migratory Bird Convention Act*[42] and that CNL performed identification of species at risk on the WL site over the current licence period, including acoustic songbird and bat recording studies as well as field sightings identification. CNL added that it completed an alternative habitat project in 2018 to provide barn swallows with an alternative nesting spot as buildings were removed on the WL site.

131. CNSC staff informed that CNSC staff review of CNL's environmental monitoring results for the licence period of 2009 to 2018 showed that monitoring of potential atmospheric effluent exposure pathways did not indicate any significant dose contributions from the operations of the WL site. CNSC staff also informed that the monitoring results indicated that radioactive contaminants in Winnipeg River water remained below allowable levels defined in the *Canadian Drinking Water Guidelines*[43] and that the groundwater monitoring program had demonstrated that there was no significant radioactive parameters (gross beta, gross alpha, tritium and uranium) migration from the waste management facilities.

132. Asked whether CNL adjusted the environmental monitoring frequency based on the onsite activities, the CNL representative explained that CNL performed routine environmental monitoring activities and also conducted enhanced monitoring when specific activities were occurring.

133. Based on the information provided, the Commission is satisfied that CNL has maintained, and will continue to maintain, adequate environmental monitoring at WL.

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[41] SI/2004-48
[42] S.C. 1994, c. 22
[43] *Canadian Drinking Water Guidelines*, https://www.canada.ca/en/healthcanada/services/environmental-workplace-health/water-quality/drinkingwater/canadian-drinking-water-guidelines.html

Independent Environmental Monitoring Program (IEMP)

134. The Commission examined the information provided by CNSC staff in regard to the IEMP. CNSC staff provided detailed results from monitoring carried out in 2017 in publicly accessible areas outside the perimeter of the WL site of collected air, soil, sediment, vegetation, food and water samples. CNSC staff noted that the measured radioactivity in all samples were below CNSC reference levels.[44]

135. The Commission notes the interest of the Sagkeeng First Nation and the Manitoba Metis Federation (MMF) to participate more fully in the IEMP and encourage CNSC staff to consider the benefits of the increased participation.

136. CNSC staff submitted that the IEMP results confirmed that the public and the environment around WL were protected and that there should be no health impacts as a result of WL operations. Furthermore, CNSC staff reported that the IEMP results were consistent with the WL environmental monitoring results.

137. The Commission enquired about the seemingly elevated results of an IEMP sampling at location WL03, located 15 kilometers east of WL. CNSC staff noted that the results were below screening levels which are set well below levels that would be of regulatory concern and, although an outlier, CNSC staff did not investigate this result further. The CNL representative added that the gross alpha reading most likely arose from the natural uranium in the granite of the Canadian Shield.

138. Based on the information submitted by CNSC staff, the Commission is satisfied that that environmental monitoring both within and outside the perimeter of the WL site shows that CNL has and will continue to make adequate provision for the protection of the environment, workers and the public.

4.9.4 Environmental Risk Assessment

139. The Commission examined the information provided by CNSC staff in regard to the Environmental Risk Assessment (ERA) of WL. CNSC staff reported that an updated ERA for the lagoon and landfill areas on the WL site was currently underway for future decommissioning activities. CNSC staff added that, based on the available information from CNL's environmental monitoring results, safety reports submitted annually for the WL site and the CNSC IEMP results, CNSC staff is of the view that risk to human health and the environment at WL could be characterized as low, with an overall trend indicating stable performance.

140. CNSC staff reported that radioactive contaminants in the Winnipeg River were well below the Canadian drinking water guidelines and that dose to members of the public

[44] CNSC reference levels are established based on conservative assumptions about the exposure scenario and using CSA N288.1-14. On this basis, the reference level for a particular radionuclide in a particular medium represents the activity concentration that would result in a dose of 0.1 mSv per year.

from liquid effluents at WL was calculated to be low, at 0.048 μSv/yr. CNSC staff also reported that airborne emissions were negligible, with an estimated public dose of 0.002 μSv/yr.

141. CNSC staff informed the Commission that CNL will conduct a site wide ERA in accordance with REGDOC-2.9.1, version 1.1 and CSA N288.6-12 during the proposed licensing period.

142. Based on the information submitted by CNSC staff, the Commission is satisfied that that environmental monitoring both within and outside the perimeter of the WL site shows that CNL has and will continue to make adequate provision for the protection of the environment, workers and the public.

4.9.5 Protection of the Public

143. The Commission assessed CNL's programs to mitigate risk to members of the public from hazardous substances discharged from WL. CNL submitted that its monitoring activities included the monitoring of airborne and liquid effluent as well as groundwater. CNL informed the Commission that radiation monitoring results verified that the level of contamination outside the WL site due to its operations did not exceed the annual dose limit of 1 mSv per year for any member of the public. Regarding non-radiological contaminants, CNL submitted that monitoring results for those contaminants were consistent over the licence period and did not negatively affect the quality of water on-site or on the local environment.

144. CNL informed the Commission that non-radiological emissions to air dropped significantly, starting in 2013, with the conversion from centralized, fuel oil heating operations to localized electrical or propane heating and the continuing shut-down and demolition of site buildings.

145. Based on the information provided, the Commission is satisfied that CNL's programs to mitigate risk to members of the public from WL operations are adequate.

4.9.6 Conclusion on Environmental Protection

146. Based on the assessment of the application and the information provided on the record at the hearing, the Commission is satisfied that, given the mitigation measures and safety programs that are in place to control hazards, CNL will provide adequate protection to the health and safety of persons and the environment throughout the proposed licence period.

147. The Commission is satisfied that the CNL environmental protection programs adequately meet the specifications of REGDOC-2.9.1 and that CNL is expected to meet the specifications of REGDOC-2.9.1, version 1.1 in the proposed licence period.

148. The Commission notes the interest of the Sagkeeng First Nation and the Manitoba Metis Federation to participate more fully in the IEMP and direct CNSC staff to consider greater participation by interested Indigenous groups, where appropriate.

4.10 Emergency Management and Fire Protection

149. The Commission considered CNL's emergency management and fire protection programs which cover the measures for preparedness and response capabilities implemented by CNL in the event of emergencies and non-routine conditions at WL. This includes nuclear emergency management, conventional emergency response, and fire protection and response. Throughout the current licence period, CNSC staff rated CNL's performance in this SCA as "satisfactory."

150. CNL submitted that the WL Emergency Services Operations Branch fulfilled the Emergency Preparedness and Fire Protection requirements at WL, as well as the Security Program requirements.

4.10.1 Conventional Emergency Management

151. The Commission considered the adequacy of CNL's conventional (non-nuclear) emergency management programs at WL. CNL submitted that all required annual drills and exercises were completed as required during the current licence period with the exception of a major exercise scheduled for 2012 that was deferred to and completed in 2013. CNL added that all emergency preparedness plans and procedures had been updated during the current licence period. CNL further submitted that it was working with the Royal Canadian Mounted Police (RCMP) and that RCMP staff were going to the WL site for familiarisation tours and joint training exercises.

152. CNL reported that WL implemented a new organizational Emergency Operations Centre (EOC) and Incident Management Framework in 2015, adding that this framework was consistent with the industry standard Incident Command System (ICS).

153. CNSC staff informed the Commission that CNL maintained an effective conventional emergency response program and that emergency response personnel were available on site 24 hours a day to respond to any type of emergency. CNSC staff added that training and equipment were maintained for medical response, hazardous materials and other conventional hazards that may be present at WL.

154. Based on the information provided on the record for this hearing, the Commission is satisfied with CNL's programs to manage conventional emergencies at WL.

4.10.2 Nuclear Emergency Management

155. The Commission considered the information submitted by CNL and CNSC staff about nuclear emergency management at WL. CNL informed the Commission regarding nuclear emergency preparedness measures at WL. CNL also provided details regarding the performance of a gap analysis with REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*.[45] CNL added that the corrective actions were agreed upon by WL and the CNSC, and had been completed.

156. CNL reported that the WL Source Term Report had been revised, documenting the current radiological source terms of nuclear facilities at WL and the calculation of on-site and off-site radiation doses to individuals resulting from a hypothetical, accidental release of radioactive material. CNL added that the analysis documented in this report demonstrated that there was no longer a radiological requirement to have a site stay-in siren for the main WL campus and that this finding was accepted by CNSC staff.

157. CNSC staff informed that the WL Site Emergency Response Plan outlined the interfaces with the Manitoba Emergency Plan. CNSC staff evaluated CNL's emergency preparedness by assessing the emergency plan and preparedness program as well as the results of emergency exercises. CNSC staff submitted that CNL has sufficient provisions in place for emergency preparedness and response capabilities to mitigate the effects of accidental releases of nuclear and hazardous substances on the environment and the health and safety of persons.

158. CNL told the Commission that WL was provided a fully stocked Mobile Nuclear Laboratory on behalf of the federal Chemical, Biological, Radiological-Nuclear, and Explosives Research and Technology Initiative headed up by Health Canada. CNL added that the Mobile Nuclear Laboratory and its equipment were maintained in a state of readiness to respond to any off-site emergencies.

159. Asked about CNL's ability to manage medical emergencies at WL, the CNL representative reported that CNL has an onsite medical facility staffed by a registered nurse five days a week during normal shift hours. The CNL representative added that CNL works closely with the Pinawa Hospital during emergency drills and exercises. The CNL representative further added that the regional ambulance service provides transport for injured workers to the local Pinawa Hospital.

160. Further on this topic and in consideration of the interventions from the Local Government District of Pinawa and Northwatch, the Commission enquired whether the town of Pinawa was prepared to manage injuries to workers at WL involving radiological exposure or contamination. The Mayor of Pinawa explained that he had ongoing dialogue with CNL about the radiation protection of employees. The Mayor of Pinawa added that he was satisfied that CNL had the capability of managing radiation-related events. The CNL representative reported that CNL's emergency preparedness organization was working with the local hospitals and authorities to

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[45] CNSC Regulatory Document REGDOC-2.10.1, *Emergency Preparedness and Response*, 2014.

ensure that they are aware of the radiation hazards.

161. Based on the information submitted for this hearing, the Commission is satisfied that CNL has appropriate emergency plans in place to protect the health and safety of persons and the environment in the event of a nuclear emergency at WL.

4.10.3 Fire Protection

162. The Commission examined the adequacy of the WL fire protection program. CNL submitted detailed information regarding fire response improvements and achievements that CNL had implemented since 2009 at WL. CNL reported that improvements included a gap analysis performed in 2016 against the operational requirements of CSA N393-13, *Fire protection for facilities that process, handle, or store nuclear substances*[46] followed by a corrective action plan that was developed and implemented to address the gaps identified. CNL added that third-party reviews were conducted on inspections, testing and maintenance operations and practices of WL facilities to ensure compliance with the *National Fire Code of Canada 2010* and CSA N393-13.

163. CNSC staff submitted that it would verify the implementation of the corrective action plan, resulting form the CSA N393-13 gap analysis, during upcoming inspections. CNSC staff added that CNL's fire response program at the WL site was still meeting regulatory requirements.

164. Based on the information provided, the Commission is satisfied that CNL has an adequate fire protection program in place at WL that meets regulatory requirements.

4.10.4 Conclusion on Emergency Management and Fire Protection

165. Based on the above information provided on the record for this hearing, the Commission concludes that WL nuclear and conventional emergency management preparedness programs and the fire protection measures in place, and that will be in place during the proposed licence period, are adequate to protect the health and safety of persons and the environment.

4.11 Waste Management

166. The Commission assessed CNL's WL site-wide Waste Management Program. Throughout the current licence period, CNSC staff assessed CNL's performance in this SCA, including waste minimization, segregation, characterization and storage programs, as "satisfactory."

[46] N293-13, *Fire protection for facilities that process, handle, or store nuclear substances*, CSA Group, 2013.

167. CNL reported that its waste management program ensured the continued availability of waste storage facilities and storage capacity for waste generated and stored temporarily at WL, and for the capability of the Chalk River Laboratories (CRL) to receive waste from WL.

168. CNL informed the Commission about the achievements and improvements made in the Waste Management Program during the current licence period such as the creation of the WL Waste Management Division and the operation of the Shielded Modular Above-Ground Storage (SMAGS) building to store LLW and ILW.

169. CNSC staff reported that wastes were generated at WL from operational activities and decommissioning projects and that radiologically contaminated waste was either decontaminated to meet clearance criteria where feasible or characterized and sent to the WMA for processing or storage. CNSC staff added that CNL was segregating, packaging, storing, reusing or recycling radioactive, hazardous and conventional wastes in accordance with its Waste Management Program.

170. CNSC staff reported that it evaluated CNL's compliance in the waste management SCA through oversight activities such as desktop reviews and compliance inspections and concluded that CNL's waste management SCA at the WL site met all applicable regulatory requirements.

171. In considering the intervention from CELA, the Commission asked about the characteristics and contents of the WMA standpipes. The CNL representative explained that the standpipes were of various ages of design with different dimensions. The CNL representative added that the 171 standpipes were all around five metres in length with a diameter ranging from a little less than half a metre to a metre. The CNL representative explained that the standpipes contained various materials including cut fuel elements, high efficiency particulate air (HEPA) filters or material coming from the hot cells. On the potential hazards from the standpipes, the CNL representative stated that there exists a potential for flammable gas generation and pyrophoric substances inside the standpipes and that remote-controlled operation of the remediation equipment had been proposed to mitigate these hazards.

172. The Commission asked whether any of the standpipes were under pressure and, if so, how was CNL containing or characterizing the radiological hazard when the standpipes were open. The CNL representative indicated that CNL had characterization data from previous years, as CNL had previously opened 20 of the standpipes and noted very little pressurization. The CNL representative added that a multi-part system with robotic arms was being designed to address possible hazards, including the worst-case hazard of a deflagration within one of the standpipes, and that the system would be designed to contain any releases without offsite impact.

173. In considering the intervention from the MMF, CELA and the CCRCA, the Commission enquired about space availability at CRL for the decommissioning waste coming from WL. CNSC staff submitted that CRL's operating licence allowed CRL

to accept waste from off-site clients providing that there was an identified storage or disposal facility in place.

174. The Commission asked for information on waste characterization and segregation at WL. CNSC staff stated that CNL had established clearance levels of waste in their program documents, aligned with the *Nuclear Substance and Radiation Devices Regulations*.[47] CNSC staff added that the waste was released as clean material if the characterization indicated that the material was below the screening levels.

175. Further on the waste characterization and segregation, the Commission asked for information concerning processes and how it was performed. The CNL representative explained that the waste characterization informed about the appropriate package to use depending on the quantity of radioactivity and other hazardous constituents. The CNL representative added that the quantity of radioactivity determined the level of inspections that happen with that particular package. The Commission was satisfied with the information provided.

176. The Commission enquired about the presence of enriched uranium at the CCSF. The CNL representative stated that most of the fuel at the CCSF was natural uranium, but added that a small quantity was enriched uranium. The CNL representative further stated that CNL performed criticality safety analysis before retrieving, moving, loading and shipping casks containing enriched uranium.

177. Commenting on the absence of a safety analysis report for the LLW trenches in CNL's and CNSC staff submissions, as noted in the interventions from CELA and the CCRCA, the Commission enquired about the reason for including the LLW trenches in the decision-making process when information to determine the adequacy of the safety case was not submitted. CNSC staff explained that *in situ* management for the LLW trenches, included in the safety analysis for the waste management area A, had been approved by the Commission in the 2002 licencing hearing[48] and that an updated safety analysis report needed to be presented to CNSC staff before any further work started on the LLW trenches. The CNL representative indicated that a safety assessment for the LLW trenches will be presented to CNSC staff for approval by 2023.

178. Further on the LLW trenches safety analysis report, the CNL representative stated that CNL would completely remove the contents of the trenches and transfer the content to CRL in the eventuality of CNSC staff not approving the LLW trenches safety analysis report.

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[47] SOR/2000-207

[48] Record of Proceedings, Including Reasons for Decision, *Application for a licence to decommission Whiteshell Laboratories*, issued December 2002.

179. The Commission enquired about the possible implications of the new IAA's requirements when considering the *in situ* decommissioning of the LLW trenches. CNSC staff responded that the *in situ* decommissioning of the LLW trenches was not considered a new activity since it was presented to the Commission at the 2002 WL licence renewal hearing with an EA performed under CEAA 1992.[49] CNSC staff added that CNSC staff would review CNL's safety assessment for the LLW trenches during the proposed licence period and determine what type of environmental review, if needed, would be required.

180. Further on the *in situ* decommissioning of the LLW trenches, the Commission noted that the 2002 WL decommissioning licence application decision stated that the licensee was "*… proposing that some of the low-level radioactive waste currently stored in trenches in the WMF, and a limited area of radioactive contaminated sediment in the Winnipeg River, will remain in place after completion of Phase 3.*"

181. The Commission noted the concern raised by Northwatch about waste inventory and asked for clarification about the level of radioactive waste in the LLW trenches. The CNL representative reported that, as identified in the 2001 *Whiteshell Laboratories Decommissioning Project Comprehensive Study Report*[50] (Comprehensive Study Report), a number of trenches contained material not suitable for *in situ* decommissioning, including WR-1 reactor pressure tubes, and would need to be remediated.

182. Further on the LLW trenches safety analysis, the Commission enquired about whether CNL had a complete characterization of the content of the trenches. The CNL representative informed the Commission that CNL had detailed records of the contents of the trenches and that CNL was currently reviewing the data as part of the safety analysis to identify the trenches that required remediation or were not acceptable for *in situ* decommissioning. The Commission is satisfied that CNL is working on the completion of a safety analysis for the LLW trenches.

183. The Commission invited the Sagkeeng First Nation to describe how it had been engaged by CNL in regard to the LLW trenches decommissioning project. The Sagkeeng First Nation representative explained that the Sagkeeng First Nation had had general discussions with CNL on the *in situ* decommissioning of the LLW trenches and communicated to CNL that the Sagkeeng First Nation was opposed to having radioactive waste left in the ground on its territory. The Sagkeeng First Nation representative added that the Sagkeeng First Nation wanted to be involved in the preparation of the safety analysis for the LLW trenches and not only to review and comment it.

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[49] S.C. 1992, c. 37 (repealed).
[50] AECL, *Draft Whiteshell Laboratories Decommissioning Project Comprehensive Study Report Volume 1: Main Report*, Revision 2, March 2001.

184. On the Indigenous engagement for the LLW trenches decommissioning, CNSC staff indicated that the LLW trenches safety analysis was the subject of engagement activities.

185. The Commission enquired about the possible impact the safety assessment for the LLW trenches could have on the proposed licence and the LCH. CNSC staff confirmed that the current licence would be adequate as long as the safety assessment for the LLW trenches determined that it remained within the licensing basis and that CNL would have to propose a new action course if the safety assessment for the LLW trenches was outside the licensing basis. CNSC staff added that CNSC staff will report to the Commission on changes to the LCH via a ROR, if there was a need for any changes.

186. Based on the above information and consideration of the hearing materials, the Commission is satisfied that CNL has appropriate programs in place to safely manage waste at WL. However, the Commission expects to receive more information concerning the safety analysis for the LLW trenches at the next licence renewal or through other means.

187. The Commission understands that following the submission by CNL of a safety analysis for *in situ* decommissioning of the LLW trenches, CNSC staff will review the documentation against applicable regulatory requirements and the licensing basis. It also understands that should the *in situ* decommissioning safety analysis demonstrates that it is outside the licensing basis, approval by the Commission of any other option would be required.

4.12 Security

188. The Commission examined CNL's security program at WL, which is required to implement and support the security requirements stipulated in the relevant regulations and the licence. This includes compliance with the applicable provisions of the *General Nuclear Safety and Control Regulations*[51] and the *Nuclear Security Regulations*.[52] During the current licence period, CNSC staff rated CNL's performance in this SCA as "satisfactory" for 2009 and 2010, "fully satisfactory" from 2011 to 2013, "satisfactory" from 2014 to 2017 and "below expectations" in 2018.

189. CNL provided the Commission with information on security exercises involving the RCMP carried out by the WL Emergency Services Operations as well as security improvements completed since 2009 such as vehicle denial barriers and card access-authentication at pedestrian access points. CNL added that Nuclear Security Officer

[51] SOR/2000-202.
[52] SOR/2000-209.

fitness-for-duty was managed in accordance with RD-363, *Nuclear Security Officer Medical, Physical and Psychological Fitness.*[53]

190. CNL informed the Commission about security improvements completed since 2009, such as upgrades to the physical security system and security lighting equipment and intrusion systems included in the expansion of the WMA protected area.

191. CNL presented security improvements to be implemented during the next licence period including upgrades to the WL Protected Areas to improve infrastructure and security posture, as well as improvement on communication and security culture.

192. The Commission enquired about the actions taken by CNL as a result of the 2018 "below expectations" rating. CNSC staff stated that it identified the issues to CNL and that CNL had responded appropriately by submitting a corrective action plan to CNSC staff. CNSC staff added that once CNL fully implements the corrective action plan, it will meet all of the regulatory requirements to ensure a satisfactory security program meeting the regulatory requirements.

193. CNSC staff submitted that, in 2018, it identified issues in the security arrangements at WL. CNSC staff added that these issues have been the subject of enforcement actions, including an order, and that CNSC staff accepted CNL proposed corrective actions which aligns with the requirements stated in the order. CNSC staff indicated that it continued to monitor the implementation of these corrective actions.

194. The Commission asked whether CNL would be able to implement the corrective action plan according to schedule. The CNL representative stated that CNL was confident that the security program at WL will achieve a satisfactory rating as anticipated by the corrective action plan. The CNL representative emphasized that the below expectation rating was not as a result of any breach of security at the WL site, nor a result of an attempted breach of security.

195. CNSC staff recommended the addition of a licence condition to the WL licence to strengthen regulatory compliance in the security SCA and to ensure a timely implementation of the security corrective action plan. CNSC staff proposed the following licence condition 12.2: "*The licensee shall complete the implementation of all security arrangements as outlined in the corrective action plan Implementation Plan: Tiered Response Force (TRF) 119-508710-PLA-010, no later than May 1, 2020.*"

196. Asked for how a design basis threat could be defined, the CNL representative explained that design basis threats were the definitions of the different threat profiles that a nuclear facility may encounter. CNSC staff indicated that the definition in the *Nuclear Security Regulations* for a design basis threat was "the characteristics of a potential adversary in respect of which countermeasures are incorporated into the

[53] Canadian Nuclear Safety Commission, Nuclear Security Officer Medical, Physical, and Psychological Fitness, RD-363, 2008.

design and evaluation of a physical protection system."

197. Upon enquiry on the inspection frequency related to security, CNSC staff responded that high-security sites, such as WL, were required to conduct a security exercise every two years to test the contingency plan, which is intended to demonstrate the plan's effectiveness to counter the design basis threat. CNSC staff added that the next scheduled security exercise was scheduled to take place on November 28, 2019.

198. Based on the information provided for this hearing, together with the specific licence condition, the Commission is satisfied that CNL will provide for the implementation of adequate measures in the area of security at WL.

4.13 Safeguards and Non-Proliferation

199. The Commission examined the adequacy of CNL's safeguards program at WL. The CNSC's regulatory mandate includes ensuring conformity with measures required to implement Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* [54] (NPT). Pursuant to the NPT, Canada has entered into a Comprehensive Safeguards Agreement and an Additional Protocol (safeguards agreements) with the International Atomic Energy Agency (IAEA). The objective of these agreements is for the IAEA to provide credible assurance on an annual basis to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no undeclared nuclear material or activities in this country. CNSC staff rated CNL's performance in this SCA as "satisfactory" throughout the current licence period.

200. CNL provided the Commission with information about its Nuclear Materials and Safeguards Management (NM&SM) program, which was designed to meet the specifications of REGDOC- 2.13.1, *Safeguards and Nuclear Material Accountancy*[55] and to be applied to all nuclear material and safeguards management activities performed at CNL facilities. CNL also informed the Commission that classified confidential inventory of nuclear material was placed on a stand-alone server to provide the adequate care and control of information associated with nuclear material inventories. CNL further provided details on how it had implemented Nuclear Materials Accountancy Reporting (NMAR) at WL and how it was submitting reports through the NMAR portal to ensure accurate and efficient nuclear materials reporting and security verification.

201. CNL informed the Commission that it was using a new reporting tool introduced by the IAEA and added that the current plan to retrieve all irradiated fissionable materials from the CCSF and the WMA standpipes and to transfer the materials to CRL for storage will increase the NM&SM workload at WL over the next licensing period.

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[54] *Treaty on the Non-Proliferation of Nuclear Weapons* (1968), IAEA Doc. INFCIRC/140, 729 UNTS 169, entered into force 5 March 1970 (NPT).

[55] CNSC Regulatory Document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*, 2018.

202. CNSC staff reported that CNL had an effective safeguards program that conformed to measures required by the CNSC to meet Canada's international safeguards obligations as well as other measures arising from the NPT. CNSC staff also reported that nuclear material accountancy information submitted by CNL met regulatory requirements and that CNL continued to grant access and assistance to the IAEA for inspection activities at WL.

203. Based on the above information, the Commission is satisfied that CNL has provided for, and will continue to implement adequate measures in the areas of safeguards and non-proliferation at WL that are necessary for maintaining national security and measures necessary for implementing international agreements to which Canada has agreed.

4.14 Packaging and Transport

204. The Commission examined CNL's packaging and transport program at WL. Packaging and transport covers the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility. The licensee must adhere to the *Packaging and Transport of Nuclear Substances Regulations, 2015*[56] and Transport Canada's *Transportation of Dangerous Goods Regulations*[57] (TDG Regulations) for all shipments. During the current licence period, CNSC staff rated CNL's performance in this SCA as "satisfactory."

205. CNL provided information about its Transportation of Dangerous Goods (TDG) program and reported that this program provided an operational framework for the safe transport of all nine classes of dangerous goods in conformance with all applicable legislations, CNL procedures and international standards. CNL added that CNL will implement the new edition of the IAEA safety standard, *Regulations for the Safe Transport of Radioactive Material*,[58] that was released in 2018 and that CNL also planned to implement the new edition of the TDG Regulations expected to be released in the near future by Transport Canada.

206. CNL informed the Commission about recent activities such as the procurement of certified transportation/storage packages, waste handling equipment and associated equipment to facilitate LLW transfer operations and the large-scale waste shipping campaign, resulting in the transportation of approximately 1,500 m^3 of contaminated soil to CRL in 2017, and the remaining 866 m^3 in 2018. CNL also provided information about the continued collaboration with the Nuclear Waste Management Organization for the use of the used fuel transportation package to facilitate high-level waste transportation operations.

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[56] SOR/2015-145.
[57] SOR/2001-286.
[58] International Atomic Energy Agency, SSR-6, *Regulations for the Safe Transport of Radioactive Material*, 2018.

207. CNSC staff submitted that CNSC inspections had shown that CNL's TDG program was effectively implemented and that the transport of nuclear substances to CRL was regularly performed in a safe manner and met regulatory requirements. CNSC staff also noted that CNSC inspectors verified that CNL's personnel involved in transport held valid training certificates.

208. In relation to the intervention from Northwatch, the Commission enquired whether the transportation of nuclear substances was part of the scope of CNSC staff's environmental protection review report. CNSC staff answered that the transportation of radioactive material was not in the scope of the environmental protection review but was reviewed as part of the Comprehensive Study Report conducted in 2001 and in the Packaging and Transport SCA section of CMD 19-H4. CNSC staff added that the Comprehensive Study Report reviewed the transportation of radioactive material in terms of accidents and malfunctions and concluded that they would not result in any significant adverse environmental effects.

209. Upon request for comment about the CCRCA's assertion on radioactive waste shipments made "with no formal governmental approval or consultation", the Atomic Energy of Canada Limited (AECL) representative reported that CNL's decommissioning plans have been reviewed by AECL and accepted by AECL, a crown corporation.

210. In considering the intervention from Northwatch regarding the monitoring activities of the transport of radioactive material, CNSC staff explained that the fundamental concept of safety in the transportation of radioactive material lied within the packaging, and added that the requirements for the performance and the robustness of the package increased with the levels of risk posed by the nuclear substances being transported. CNSC staff also explained that the packaging required certification from the CNSC for the highest level of risk of material being transported.

211. In regard to the intervention from Northwatch, the Commission enquired about statistics on the number of accidents in relation to the transport of nuclear substances. CNSC staff informed that the regulations required to report any dangerous occurrence to the CNSC related to transportation of radioactive material. CNSC staff added that the events were listed in the ROR on the use of nuclear substances and that the number of reportable events was in the tens per year but that packages were not damaged. As an example, CNSC staff stated that it previously happened that a truck carrying a high-risk source caught on fire and the truck melted, however there was no safety-significant impact on the package or to the source.

212. The Commission enquired about how CNSC staff was being informed of road infractions committed by nuclear substance carriers. CNSC staff reported that it had mechanisms in place to discuss issues with regards to transport with provincial authorities. CNSC staff added that CNSC staff was part of a working group committee along with Transport Canada and provincial and territorial transportation committees, which met twice a year to discuss transportation issues. CNSC staff further added that

the citations issued for trucks that were transporting Class 7 material, mentioned in the intervention from Northwatch, had been reviewed by CNSC staff and that after following up with the Ontario's Ministry of Transportation, CNSC staff was of the view that they did not represent a risk to the environment or the health and safety of persons.

213. Asked about the safety and risk analysis based on the mode of transportation, the CNL representative provided that the usability of rail was assessed by CNL but was deemed not financially feasible compared to road transportation.

214. Further on risk assessment analysis of transportation activities, the Commission enquired about whether the proposed accelerated decommissioning timeline, compared to the original decommissioning plan assessed in the Comprehensive Study Report, would increase health and safety risks of radioactive waste transportation compared to the original decommissioning plan. The CNL representative indicated that risk analysis was part of CNL's operating procedures and that the risk for the proposed accelerated decommissioning plan on transportation was determined to be minimal. CNSC staff explained that the *Radiation Protection Regulations* had to be followed regardless of the radioactivity of the material being shipped, and that the dose limits still had to be respected.

215. In relation to a concern raised by Northwatch about driver training and vehicle maintenance, the CNL representative submitted that CNL was using subcontractors for transportation and that CNL assessed transport carriers' safety record as part of CNL's procurement process. The CNL representative added that CNL inspects every trucks and packages before they leave WL and that a more rigorous inspection corresponding with the radiological hazard would be performed on the vehicles before they leave.

216. From a concern raised in the intervention from CCRCA, the Commission enquired about whether it was possible to publicly release information about radioactive shipments made by CNL, taking security considerations into account. The CNL representative stated that CNL had to consider some documents on a case-by-case basis and that CNL was actively trying to add more documents to its external web site

217. In relation to the intervention from Northwatch, the Commission asked about the public's involvement in the certification of packages. CNSC staff indicated that certification decisions were carried out by designated officers with no public participation. CNSC staff added that the IAEA provided the CNSC with an independent review of the packaging design.

218. Asked about whether any intermediate-level liquid waste was to be shipped from WL, the CNL representative answered that CNL did not anticipate any intermediate-level liquid waste shipment. The CNL representative added that CNL intended to stabilize and solidify, in a concrete-like matrix, any liquid waste that would be generated before shipment. The Commission was satisfied with the information provided.

219. The Commission asked about whether CNL would be shipping radioactive waste to facilities other than CRL. The CNL representative stated that CNL used several commercial facilities, both in Canada and the U.S., for the treatment of its waste, adding that those facilities were generally restricted to mixed waste such as organic volatile, organic compounds mixed with tritium or other types of LLW. The CNL representative also stated that the waste were either incinerated, stabilized or macro-encapsulated before being sent back to CNL. The CNL representative further added that the resultant treated waste would be certified to meet Ontario Regulation 347 *General - Waste Management*[59] which allows for shallow land disposal. The Commission was satisfied with the information provided on this matter.

220. Based on the information presented on the record for this hearing, the Commission is satisfied that CNL is meeting, and will continue to meet, regulatory requirements regarding packaging and transport.

4.15 Indigenous Engagement and Public Information

4.15.1 Participant Funding Program

221. The Commission assessed the information provided by CNSC staff regarding public engagement in the licensing process as enhanced by the CNSC's Participant Funding Program (PFP). CNSC staff submitted that, in February 2019, up to $50,000 in funding to participate in this licensing process was made available to Indigenous groups, members of the public and other stakeholders to review CNL's licence renewal application and associated documents, and to provide the Commission with value-added information through topic-specific interventions.

222. A Funding Review Committee, independent of the CNSC, recommended that 5 applicants be provided with up to $63,300 in participant funding. These applicants were required, by virtue of being awarded participant funding, to submit a written intervention and make an oral presentation at the public hearing commenting on CNL's licence renewal application. As such, participant funding was awarded to the following recipients:

- Canadian Environmental Law Association
- Concerned Citizens of Renfrew County and Area
- Manitoba Metis Federation
- Northwatch
- Sagkeeng First Nation

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[59] R.R.O. 1990, Reg. 347: *General - Waste Management.*

223. Based on the information submitted for this hearing, the Commission is satisfied that Indigenous peoples, members of the public and other stakeholders were properly notified of CNL's application and were provided with sufficient information on how to participate in this licence amendment process.

4.15.2 Indigenous Engagement

224. The common law duty to consult with Indigenous peoples applies when the Crown contemplates action that may adversely affect established or potential Indigenous and/or treaty rights. The CNSC, as an agent of the Crown and as Canada's nuclear regulator, recognizes and understands the importance of building relationships and engaging with Canada's Indigenous peoples. The CNSC ensures that its licensing decisions under the NSCA uphold the honour of the Crown and considers Indigenous peoples' potential or established Indigenous and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*.[60] The Crown has discretion as to how it structures consultation, and must prioritize fairness. It is the CNSC's practice to use both the work by CNSC staff and the Commission hearing to fulfil the requirements of the duty to consult.

225. CNL described its ongoing engagement with local Indigenous communities in accordance with REGDOC-3.2.2, *Indigenous Engagement*,[61] noting that CNL was seeking feedback from communities regarding traditional and current uses of the lands surrounding the WL site.

226. CNSC staff provided the Commission with information about ten Indigenous groups that were identified as having a potential interest in WL licence renewal and the CNSC engagement activities that were carried out with the identified groups. CNSC staff submitted that it encouraged communities' participation in this hearing process and also noted that CNL continued to engage with interested Indigenous communities on the licence application and ongoing activities of interest to the communities.

227. CNSC staff submitted that, since the proposed licence renewal did not include any significant modifications to WL, this renewal would not cause adverse impacts to any potential or established Indigenous and/or treaty rights. While CNSC staff expressed the view that no formal duty to consult was engaged by the licence renewal, CNSC staff further submitted that continued engagement with interested Indigenous groups was, and would continue to be a priority for CNSC staff and would be continued throughout the proposed licence period to ensure that the groups received all information requested and to establish, maintain and enhance relationships with the groups.

228. The Commission asked whether CNL and CNSC staff were actively tracking the

[60] *Constitution Act, 1982*, Schedule B to the *Canada Act 1982*, 1982, c. 11 (U.K.).
[61] CNSC Regulatory Document REGDOC-3.2.2, *Indigenous Engagement*, 2016.

engagement activities with the Sagkeeng First Nation, the MMF and other Indigenous peoples. The CNL representative stated that CNL was tracking and reporting annually to the CNSC on its engagement activities, such as First Nations and Métis engagement, public inquiries and website traffic, in order to improve CNL's communications and future engagements. CNSC staff answered that CNSC staff tracked all interactions with Indigenous and Métis communities.

Sagkeeng First Nation

229. The Commission expressed appreciation for the information provided by the Sagkeeng First Nation, and asked about how the Sagkeeng First Nation saw its role and responsibility as a steward of the lands. The Sagkeeng First Nation representative explained that stewards of the land needed to protect the land, the ground and also the water, for hunters to be able to live off the land. The Sagkeeng First Nation representative added that the obligation to be stewards of the land and to protect the land was reflected in their law, their Onakonigawin.

230. The Commission noted that in reading the submission from the Sagkeeng First Nation, the Commission sensed frustration in the engagement process and enquired about how the Sagkeeng First Nation saw engagement occurring for the WL decommissioning. The Sagkeeng First Nation representative explained that the Sagkeeng First Nation would like to be meaningfully engaged in the planning process for activities related to the decommissioning project, in the environmental monitoring during the institutional control period of 200 years or the end-states of the land, as the Sagkeeng First Nation will be using the site after its release.

231. Asked to provide additional information on how CNL engages and plans to engage the Sagkeeng First Nation in the WL decommissioning project and beyond, the CNL representative stated that different opportunities for further engagement would be available for CNL to interact with Indigenous groups during the development of specific execution plans to perform the activities described in the WL detailed decommissioning plan. The CNL representative added that this further engagement would enable CNL to understand and interact with the Indigenous groups and to look for a solution to influence the final implementation of the detailed decommissioning plan (DDP) to alleviate concerns. CNSC staff communicated that regulatory requirements were in place to require CNL to consult during the implementation of the DDP.

232. The Commission considered the recommendations submitted by the Sagkeeng First Nation in its intervention and enquired about whether CNL would engage with the Sagkeeng First Nation in regard to these recommendations. The CNL representative indicated that, prior to this Commission hearing, CNL sent a letter to the Sagkeeng First Nation to proactively address some of its concerns and added that CNL would continue to work with the Sagkeeng First Nation, as needed, to address all of its concerns.

233. Upon request for comment on the Sagkeeng First Nation's assertion about the practice of leaving LLW on-site being inconsistent with international standards, the Sagkeeng First Nation representative stated that leaving irradiated materials of any sorts on the WL site could not be the preferred option when the option of safely transporting the radioactive materials to a purpose-built facility was available. The Sagkeeng First Nation representative added that removal of the radioactive material could be performed safely and that the waste should go to a storage area designed for that purpose, whether in the interim or the long term.

234. In its closing remarks, the Sagkeeng First Nation representative noted that the engagement done by CNL and CNSC staff for this hearing was satisfactory. The Sagkeeng First Nation representative added that CNL and CNSC staff visited the community at numerous occasions as it should have been done in the past. The Commission thanked the Sagkeeng First Nation for their participation at this public hearing.

Manitoba Metis Federation

235. The Commission enquired about the MMF's current involvement in the monitoring of air, land, food and wildlife at WL as well as the MMF's recommendation on the creation of a working group to assist with the design and oversight of a monitoring plan. The MMF representative explained that, through an arrangement with CNL, the MMF had the opportunity to have a Métis monitor on the WL site undertaking work in cooperation with CNL. The MMF representative added that MMF recommended the creation of a Métis technical working group, where the MMF could assist with the design and oversight of the monitoring plan, to increase the MMF's involvement.

236. On the MMF's inclusion in the environmental monitoring process, CNSC staff recognized that the CNSC did not have a structured program for the inclusion of Indigenous groups in its inspections. CNSC staff added that it will look at the feasibility and how to implement a program across all regulated facilities. The CNL representative stated that CNL was currently working on aligning and implementing CSA N288.4, which requires the licensee to consult with and get input from impacted Indigenous groups into its environmental monitoring program.

237. Asked about the MMF's vision of the end-state of WL, the MMF representative told the Commission that the land should allow Métis citizens to eat unlimited amount of non-contaminated food. The MMF representative added that Métis citizens should be able to freely practice traditional harvesting activities in the WL area without fear of contamination, including hunting, fishing and gathering.

238. In its closing remarks, the MMF representative noted that the MMF was concerned about contamination spreading outside WL, due to its location beside the Winnipeg River. The MMF representative also encouraged the Commission to consider the recommendations made by the MMF in its submissions.

239. The Commission wishes to thank MMF for participating in this hearing and for submitting information.

Assessment of Indigenous Engagement

240. The Commission notes that CNL committed to dialogue with all Indigenous groups and was looking forward to sitting down with them face to face and further addressing their concerns and developing a plan and a path forward. The Commission expects CNL to engage with Indigenous groups on the end-state of WL. The Commission also requests that CNSC staff continue to engage and develop relationships with Sagkeeng First Nation, the MMF and other Indigenous groups in Manitoba, and report on progress in the context of the ROR or through other means. The Commission noted that Indigenous traditional knowledge is a type of science and should be taken into consideration to help reduce the fear surrounding the WL decommissioning.

241. Based on the information provided for this hearing, the Commission is satisfied that Indigenous engagement activities carried out for the renewal of the existing licence were adequate.

4.15.3 Public Information

242. The Commission assessed CNL's public information and disclosure program (PIDP) for WL. A public information program is a regulatory requirement for licence applicants and licensed operators of Class I nuclear facilities. Paragraph 3(j) of the *Class I Nuclear Facilities Regulations*[62] requires that licence applications include

> "the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed."

243. The Commission assessed how CNL's PIDP met the specifications of RD/GD-99.3, *Public Information and Disclosure*.[63] CNL provided the Commission with information regarding its Whiteshell Public Liaison Committee and the WL Economic Regeneration Partnership, formed in 2015. CNSC staff submitted that its review of CNL's PIDP found that it met regulatory requirements. CNSC staff also submitted that CNL was encouraged to refine and update its PIDP on a regular basis to meet the changing information needs of CNL's target audiences.

244. In considering the interventions from the Sagkeeng First Nation, the MMF and the CCRCA, the Commission recognized that there was a significant level of concern about the risk from the WL site and the waste generated. The Commission requested

[62] SOR/2000-204.
[63] CNSC Regulatory/Guidance Document RD/GD-99.3, *Public Information and Disclosure*, 2012.

details from CNL on how it was communicating with Indigenous groups and stakeholders about this risk. The CNL representative told the Commission that the first step was to listen and understand the perspective from the Indigenous groups and that this was followed by explaining in simple terms the clean-up program and the benefits for future generations.

245. On the subject of risk perception and the psychosocial issues for the persons living around WL, CNSC staff explained that, under the NSCA, subsection 9(b), the CNSC had to disseminate objective scientific and regulatory information to the public. CNSC staff added that typical engagement activities focussed on understanding what radiation and background radiation were and the effects of the licensee activities. CNSC staff further added that CNL was required to establish communications with its community and address those needs.

246. The Commission asked whether a psychosocial impact assessment had been completed or was contemplated by CNL for the decommissioning of WL. CNSC staff stated that psychosocial impacts of the WL decommissioning project was to be further explored as part of the environmental assessment for the WR-1reactor *in situ* decommissioning project. The Commission suggests that the psychosocial impact assessment of the WL decommissioning project includes the whole WL site and not be limited to the WR-1 reactor.

247. Based on the information presented for this hearing, the Commission is satisfied that CNL, through the PIDP and engagement activities, has adequately communicated and will continue to communicate to the public information about the health, safety and security of persons and the environment and other issues related to WL.

4.15.4 Conclusion on Indigenous Engagement and Public Information

248. Based on the information presented, the Commission is satisfied that, overall, CNL's PIDP meets regulatory requirements and commitments made by CNL will increase the effectiveness of its program and engagement activities in keeping Indigenous groups and the public informed of WL operations. The Commission acknowledges the many best practices already implemented by CNL and encourages its efforts in creating, maintaining and improving its dialogue with the neighbouring communities.

249. The Commission acknowledges the current efforts and commitments made by CNL in relation to Indigenous engagement and CNSC staff's efforts in this regard on behalf of the Commission that go beyond the context of the licence renewal proceeding. Based on the information presented on the record for this hearing, the Commission is satisfied that this licence renewal will not result in changes to WL operations that would cause adverse or new impacts to any potential or established Indigenous and/or treaty rights. The Commission is also of the opinion that the engagement activities taken for the review of the WL licence renewal application have been adequate.[64]

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[64] *Rio Tinto Alcan v. Carrier Sekani Tribal Council,* 2010 SCC 43[2010] 2 S.C.R. 650 at paras 45 and 49.

250. The Commission notes that CNL committed to dialogue with all Indigenous groups and was looking forward to sitting down with them face to face and understanding their concerns and developing a plan and a path forward. Therefore, the Commission expects CNL to engage accordingly with First Nations and Métis groups on the end-state of WL.

251. The Commission request that CNSC staff report on progress made in its engagement activities in Manitoba in the context of future RORs or through other means. The Commission also suggests that the upcoming psychosocial impact assessment of the WL decommissioning project includes the whole WL site and not be limited to the WR-1 reactor.

4.16 Decommissioning Plans and Financial Guarantee

252. The Commission requires that CNL has operational plans for the decommissioning and long-term management of waste produced during the lifespan of WL. In order to ensure that adequate resources are available for safe and secure future decommissioning of the WL site, the Commission requires that an adequate financial guarantee for realization of the planned activities is put in place and maintained in a form acceptable to the Commission throughout the licence period.

253. CNSC staff indicated that CNL's DDP was to contain 12 volumes and that CNL was updating their Volume 1, Program Overview DDP to align with CSA N294-09, *Decommissioning of Facilities Containing Nuclear Substances*[65] and G-219, *Decommissioning Planning for Licensed Activities*.[66]

254. The Commission enquired about how many of the 12 volumes of DDP had already been developed. The CNL representative described the outstanding DDPs, such as one volume for Building 402 and the three parts of the WMA volume. The CNL representative added that CNL submitted one of those volumes to the CNSC for review and was currently working on comment disposition. The CNL representative also mentioned that the two volumes related to the standpipes and the ILW waste needed the design of the remediation equipment and the safety analysis in order to be complete.

255. The Commission enquired about a concern raised by CELA about whether the DDP could be made readily available to members of the public. The CNL representative stated that the document could be provided to the public, if requested, adding that commercially sensitive information would have to be redacted. The Commission noted CELA's recommendation of a public repository of documents to allow public access to documents without having to request them.

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[65] N294-09 (Reaffirmed 2014), *Decommissioning of Facilities Containing Nuclear Substances, Update No.1*, CSA Group, 2014.
[66] CNSC Regulatory Document, G-219, *Decommissioning Planning for Licensed Activities,* Guidance Document, 2000.

256. In relation to the CCRCA's intervention, the Commission enquired about the reasons to proceed with the proposed accelerated decommissioning compared to the original decommissioning plan assessed in the Comprehensive Study Report. The CNL representative explained that lessons learned from the decommissioning industry around the world demonstrated that it was beneficial to take some action in the near term, which can all be achieved safely within the arrangements in place. The CNL representative added that radioactive waste can be retrieved from its less optimal current storage and then sorted, characterized and repackaged. The CNL representative further added that having the radioactive waste concentrated in one location allowed for a concentration of trained personnel in radioactive waste handling.

257. Further on the accelerated decommissioning of WL, CNSC staff stated that the reduced deferment period was still in line with the decommissioning strategy that CNL outlined in their DDP. Concerning the double handling of the radioactive waste required to transfer the waste to a permanent repository once one available, CNSC staff indicated that it was CNSC staff's view that CNL applied ALARA measures for any handling of radioactive waste in a robust manner.

258. The Commission enquired about the safety implications of an accelerated decommissioning compared to the deferred decommissioning assessed in the original Comprehensive Study Report. CNSC staff explained that the irradiated WR-1 reactor components had been placed in the waste areas 30 years ago, reducing the external dose rates from short-lived isotopes by several half-lives. CNSC staff added that a delay of 5 to 10 additional years would not have a significant impact on those dose rates.

259. Further on the risk assessment of the accelerated decommissioning, CNSC staff submitted that in addition to the site-wide decommissioning plan, CNL was required to produce a DDP for each individual building or facility detailing the end-state objectives, an assessment of the doses to workers, as well as assessment of any hazard present on that site. CNSC staff added that CNSC staff reviewed and assessed every DDP before giving an approval.

260. To better understand the effects of the accelerated decommissioning, the Commission requests that CNSC staff provide a systematic assessment of the potential effects on the collective occupational dose of the proposed accelerated decommissioning compared to the deferred decommissioning assessed in the original Comprehensive Study Report. The assessment could be provided during a future ROR or other means.

261. Asked about the scenario where CNL did not decommission the WR-1 reactor within the next 10 years and a proposed licence not allowing decommissioning, CNSC staff indicated that the current licensing basis authorizes the dismantlement and complete decommissioning of the WL site and that it is the *in situ* decommissioning of WR-1 reactor that is not authorized in the proposed licence. CNSC staff added that the responsibility for managing the activities related to decommissioning was on the

licensee and that CNL would have to come to the Commission to propose a different plan.

262. The Commission asked for information about the kind of Institutional Control Program that is or would be in place for the WL site. The CNL representative explained that the program was administered by CNL and not by the province of Manitoba.

263. The Commission considered whether the financial guarantees maintained by CNL for WL were in accordance with G-219 and G-206, *Financial Guarantees for Decommissioning of Licensed Activities*.[67] CNSC staff informed that the CNSC received from the Federal Minister of Natural Resources an expressed commitment stating that AECL will retain ownership of the lands, assets and liabilities associated with CNL's licences, including the WL Licence, and stated that the liabilities of AECL were the liabilities of Her Majesty in Right of Canada.

264. Based on the information considered at this hearing, the Commission concludes that the detailed decommissioning plan and related financial guarantee for WL are acceptable for the purpose of the current application for licence renewal.

4.17 Cost Recovery

265. The Commission examined CNL's standing under the *Cost Recovery Fees Regulations*[68] (CRFR) requirements for WL. Paragraph 24(2)(c) of the NSCA requires that a licence application is accompanied by the prescribed fee, as set out by the CRFR and based on the activities to be licensed.

266. CNL informed the Commission that it was in good standing with regards to the provision of CNSC licensing fees and would continue to pay all fees, as required. CNSC staff reported that after conducting a thorough review of CNL records, CNSC staff had verified that CNL was in good standing with respect to the CRFR requirements, and had paid their cost recovery fees in full.

267. Based on the information submitted by CNL and CNSC staff, the Commission is satisfied that CNL has satisfied the requirements of the CRFR for the purpose of this licence renewal.

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[67] Canadian Nuclear Safety Commission, Regulatory Guide G-206, Financial Guarantees for Decommissioning of Licensed Activities, 2000.

[68] SOR/2003-212.

4.18 Nuclear Liability Insurance

268. The Commission notes that CNL is required to maintain nuclear liability insurance for WL. CNCS staff submitted that CNL maintained nuclear liability insurance in accordance with the *Nuclear Liability Act*[69] (NLA) during the current licence period until December 31, 2016 and since then, under the *Nuclear Liability and Compensation Act*[70] (NLCA) that came into force on January 1, 2017. CNSC staff reported to the Commission that Natural Resources Canada, the federal department responsible for the administration of the NLCA, had confirmed that CNL had satisfied and should continue to satisfy its obligation under the NLCA during the balance of the current licence period and throughout the proposed licence period.

269. Based on the information provided on the record for this hearing, the Commission is satisfied that CNL has satisfied, and will continue to satisfy, the requirements for the maintenance of nuclear liability insurance under the NLCA. The Commission expects annual updates on CNL's status in regard to its requirements under the NLCA in the context of an annual ROR.

4.19 Licence Length and Conditions

270. The Commission considered CNL's application for the renewal of the current WL licence for a period of 10 years. CNSC staff recommended the renewal of the licence for a period of 10 years, until December 31, 2029, submitting that CNL is qualified to carry on the licensed activities authorized by the licence. Several intervenors recommended shorter licence periods, as low as a one-year term.

271. The Commission asked about the rationale for recommending a 10-year licence, compared to the 1-year licence extension granted a year ago and also what had changed during the last year to justify a 10-year licence. The CNL representative explained that, at the time of the last licence renewal, CNL wanted to keep the WR-1 reactor *in situ* decommissioning linked with the licence renewal for efficiency purposes and that CNL believed, at that time, that CNL could disposition CNSC staff's comments on the Environmental Impact Statement for the WR-1 reactor *in situ* decommissioning in a short period of time justifying a one-year renewal. The CNL representative added that as the timeline had been longer than expected, CNL decided to proceed with a 10-year licence renewal request and would seek a licence amendment for the WR-1 reactor *in situ* decommissioning.

272. Further on the rationale for recommending a 10-year licence, CNSC staff indicated that, should a licence amendment for the WR-1 reactor *in situ* decommissioning be granted, CNSC staff would review the Licence Conditions Handbook to look at all the processes and procedures that need to be changed in order to allow for that activity to be conducted safely. CNSC staff added that a licence amendment would be required in

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[69] R.S.C., 1985, c. N-28 (repealed).
[70] S.C. 2015, c. 4, s. 120.

the case of a deviation from what had been approved by the Commission under the licensing basis and the safety case. The Commission noted that several intervenors had concerns about granting a 10-year licence to CNL.

273. In considering the licence period, the Commission enquired about the planned submission date of the Environmental Impact Statement for the *in situ* decommissioning of WR-1 reactor. The CNL representative stated that CNL was in the final stages of preparing the Environmental Impact Statement, responding to information requests, and that CNL anticipated a formal submission to the CNSC around March of 2020.

274. The Commission enquired whether the environmental assessment for the WR-1 reactor *in situ* decommissioning would have an impact on the licence and the Licence Conditions Handbook. CNSC staff stated that the first step would be for the Commission to make decisions under subsection 52(1) of CEAA 2012. CNSC staff added that, should the Commission issue a positive decision allowing the project to move forward, a licence amendment would be required to include the *in situ* decommissioning of WR-1 reactor in the licensing basis. CNSC staff further added that the Licence Conditions Handbook would then be updated to include a section on the *in situ* decommissioning of WR-1 reactor, including compliance verification criteria.

275. In order to provide adequate regulatory oversight of changes that are administrative in nature or less significant and do not require a licence amendment nor Commission approval, CNSC staff recommended that the Commission delegate authority for certain approval or consent, as contemplated in licence condition 3.2, to the following CNSC staff:

- Director, Canadian Nuclear Laboratories Regulatory Program Division
- Director General, Directorate of Nuclear Cycle and Facilities Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

276. Based on the information examined by the Commission during the course of this hearing, the Commission considers that a 5-year licence is more appropriate for WL. Unavailable information on decommissioning approach is to be completed and submitted in the next few years and therefore, the Commission considers that a 5-year licence is justified on the basis of CNL's past performance, the time required to complete the Environmental Impact Statement for the *in situ* decommissioning of the WR-1 reactor, the need for CNSC staff to review the Safety Analysis Report for the underground LLW trenches, and opportunities for Indigenous groups and the public to be involved during the renewed 5-year licence period through RORs or other means.

277. The Commission accepts the licence conditions as recommended by CNSC staff. The Commission also accepts CNSC staff's recommendation regarding the delegation of authority, and notes that it can bring any matter to the Commission as required.

5.0 CONCLUSION

278. The Commission has considered the licence renewal application submitted by the CNL. Based on its consideration of the information submitted, the Commission is satisfied that the application submitted by CNL meets the requirements of the NSCA, the GNSCR and other applicable regulations made under the NSCA.

279. The Commission has also considered the information and submissions of the applicant, CNSC staff and all participants as set out in the material available for reference on the record, as well as the oral and written interventions provided or made by the participants at the hearing.

280. The Commission is satisfied that CNL meets the test set out in subsection 24(4) of the *Nuclear Safety and Control Act*. That is, the Commission is of the opinion that CNL is qualified to carry on the activity that the proposed licence will authorize and that it will make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

281. Therefore, the Commission, pursuant to section 24 of the *Nuclear Safety and Control Act*, renews the Nuclear Research and Test Establishment Licence issued to Canadian Nuclear Laboratories for its Whiteshell Laboratories located in Pinawa, Manitoba. The renewed licence, NRTEL-W5-8.00/2024, is valid from January 1, 2020 until December 31, 2024.

282. The Commission includes in the licence the conditions as recommended by CNSC staff in CMD 19-H4, CMD 19-H4.A, CMD 19-H4.B, CMD 19-H4.C and CMD 19-H4.D, including licence condition 12.2. The Commission also delegates authority for the purposes of licence conditions 3.2, as recommended by CNSC staff.

283. The Commission considers the environmental protection review that was conducted by CNSC staff to be acceptable and thorough. The Commission is satisfied that an EA under CEAA 2012 was not required for the WL licence renewal application and notes that the NSCA provides a strong regulatory framework for environmental protection. Further, the Commission is satisfied that CNL has made, and will continue to make, adequate provision for the protection of the environment and the health of persons throughout the proposed licence period.

284. The Commission wishes to make clear that the proposed licence does not provide for the *in situ* decommissioning of the WR-1 reactor. The Commission states that the concerns raised by Indigenous peoples, members of the public and other government regulators regarding the decommissioning of the WR-1 reactor, as well as the EA for the proposed decommissioning method, will be considered by the Commission at a future public Commission hearing(s).

285. To better understand the effects of the accelerated decommissioning, the Commission request CNSC staff to provide a systematic assessment of the potential effects on the collective occupational dose of the proposed accelerated decommissioning compared to the deferred decommissioning assessed in the original Comprehensive Study Report. The assessment could be provided during a ROR or through other means.

286. The Commission requests that CNSC staff report on progress made in its engagement activities in Manitoba in the context of future RORs or through other means. The Commission also suggests that the psychosocial impact assessment of the WL decommissioning project includes the whole WL site and not be limited to the WR-1 reactor.

287. The Commission notes that CNL committed to dialogue with all Indigenous groups and was looking forward to sitting down with them face to face and understanding their concerns and developing a plan and a path forward. Therefore, the Commission expects CNL to engage with Indigenous groups on the end-state of WL. The Commission also requests that CNSC staff continue to engage and develop relationships with Sagkeeng First Nation, the MMF and other Indigenous groups in Manitoba, and report on progress in the context of the ROR or through other means.

288. The Commission notes that CNSC staff can bring any matter to the Commission that merits its attention. The Commission directs CNSC staff to inform the Commission on an annual basis of any changes made to the Licence Conditions Handbook (LCH).

289. With this decision, the Commission directs CNSC staff to report on the performance of CNL and WL, as part of a ROR. CNSC staff shall present this report at a public proceeding of the Commission, where members of the public will be able to participate.

DEC 1 9 2019

Rumina Velshi
President,
Canadian Nuclear Safety Commission

Date

Appendix A – Intervenors

Intervenors – Oral Presentations	Document Number
Local Government District of Pinawa, represented by B. Skinner	CMD 19-H4.8
Canadian Environmental Law Association, represented by K. Blaise	CMD 19-H4.5 CMD 19-H4.5A
Sagkeen First Nation, represented by D. Henderson, A. Macdonald and C. Shefman	CMD 19-H4.4 CMD 19-H4.4A
Manitoba Métis Federation, represented by M. Riel and J. Langhan	CMD 19-H4.12 CMD 19-H4.12A CMD 19-H4.12B CMD 19-H4.12C
Concerned Citizens of Renfrew County and Area, represented by O. Hendrickson	CMD 19-H4.6 CMD 19-H4.6A
Nortwatch, represented by B. Lloyd	CMD 19-H4.11 CMD 19-H4.11A

Intervenors – Written Interventions	Document Number
Rural Municipality of Alexander	CMD 19-H4.2
R Public Liaison Committee	CMD 19-H4.3
Unions	CMD 19-H4.7
Canadian Nuclear Society	CMD 19-H4.9
North Forge East	CMD 19-H4.10

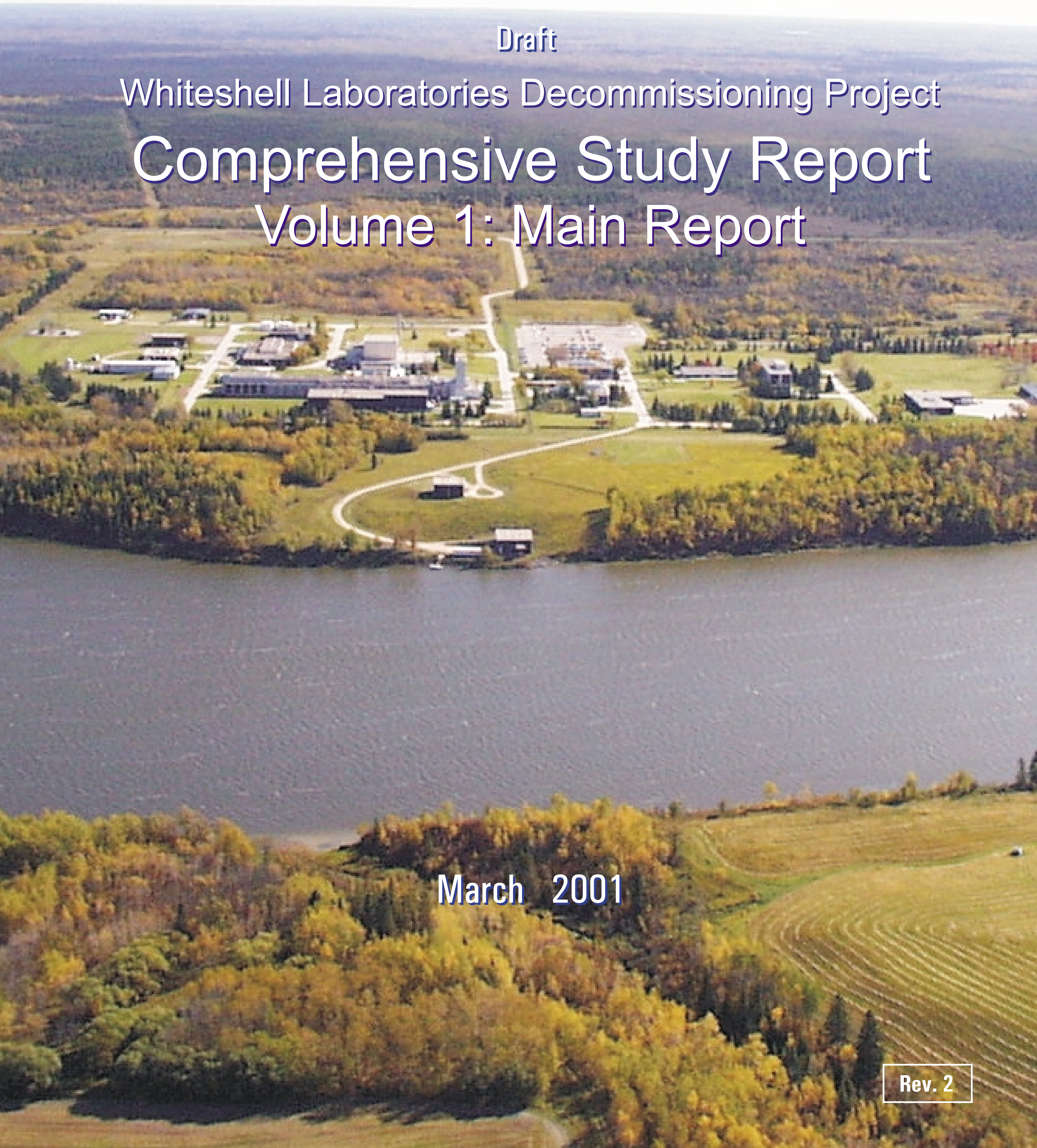
AECL EACL

Draft

Whiteshell Laboratories Decommissioning Project

Comprehensive Study Report

Volume 1: Main Report



March 2001

Rev. 2

CSR PREPARATION TEAM

AECL	Whiteshell Laboratories Pinawa, MB	Project Direction
SENES Consultants Limited	Richmond Hill, ON	Project Management, Environmental Assessment and Technical Input
ECOMatters Inc.	Pinawa, MB	Technical Input
Barbara Connell Advisory Services	Winnipeg, MB	Public Consultation
Wardrop Engineering Inc.	Winnipeg, MB	Environmental Assessment and Technical Input

EXECUTIVE SUMMARY

BACKGROUND

Purpose and Need

Whiteshell Laboratories has provided research facilities for the Canadian nuclear industry since the early 1960's. As a result of the financial impact of the federal government's program review process, Atomic Energy of Canada Limited (AECL) made a business decision in 1997 to discontinue research programs and operations at Whiteshell Laboratories. Because no private sector sponsor was found to assume financial responsibility for the facility, in 1998, the federal government concurred with AECL's decision to decommission the Whiteshell Laboratories. The decommissioning project may proceed only with the prior licensing approval of the Canadian Nuclear Safety Commission (CNSC). Furthermore, and depending on the final conclusions made with respect to the effects on the Winnipeg River, aspects of the project may also be contingent on approvals issued pursuant to the *Fisheries Act***.** In 1999, AECL began to prepare plans for the safe and effective decommissioning of the Whiteshell Laboratories, that would meet the regulatory requirements.

The Canadian Environmental Assessment Act; Responsible Authorities, Procedures and Schedule

Before the responsible federal authorities can permit the Whiteshell Laboratories Decommissioning Project to proceed, a decision must be made on the results of an environmental assessment prepared pursuant to the *Canadian Environmental Assessment Act* (CEAA). Under the Act, the CNSC and the Department of Fisheries and Oceans (DFO) are the Responsible Authorities. The Responsible Authorities determined that a *comprehensive study* under the CEAA was required. A document outlining the scope of the project and assessment was issued in December 1999 following consultation with the public and other federal and provincial government departments. The other expert federal authorities with an interest in the project include Environment Canada, Health Canada, Natural Resources Canada and Western Economic Diversification Canada. A number of departments and agencies of the Province of Manitoba participate through a special Technical Advisory Committee.

As required by the CEAA, a Public Registry was established for the Whiteshell Laboratories Decommissioning Project. This involves the registration of the project on the *Federal Environmental Assessment Index* (FEAI ref. No. 18737) and maintaining public access to all documents related to the environmental assessment. The FEAI can be accessed through the Canadian Environmental Assessment Agency and the CNSC and AECL web sites. The document list, copies of the documents, can be obtained by contacting the CNSC. Manitoba Conservation also established a public registry for the project (File no. 4479.00) with registry locations at the Pinawa Library, Winnipeg Centennial Library and Manitoba Conservation Resource Centre in Winnipeg.

A draft CSR (Rev.1) was submitted to the CNSC in April of 2000. The draft was also made available to the public and distributed to expert federal departments. The comments from the expert departments and responses to these comments are included in Appendix F of the CSR. During the summer and fall of 2000, additional studies were carried out in the Winnipeg River and in the Waste Management Area (WMA) to confirm the appropriateness of the decommissioning proposals for those areas. These studies are presented in Appendices B and C. respectively.

This document (Rev. 2) is now being submitted by the RAs to the public for comment. Following a review of the comments, the RAs will submit the CSR with appropriate addenda and recommendations to the Canadian Environmental Assessment Agency for review and then a decision by the federal Minister of the Environment as to whether the project should be referred back to the responsible authorities for action, or requires further environmental assessment by a mediator or review panel.

SCOPE OF PROJECT

What is included?

The Whiteshell Laboratories Decommissioning Project encompasses all of the site facilities, buildings, infrastructure and land defined as the area affected by nuclear development and operation. Figure ES.1 shows the Licensed Study Area and the Unaffected Lands.

What is not included?

The total area that is under CNSC licence is approximately 4,375 hectares or 10,800 acres. Approximately 3,000 hectares (7,400 acres) of the licensed area is identified as land which was not used for or impacted by nuclear development or operations, and is excluded from the assessment scope.

The Underground Research Laboratory (not licensed by CNSC) and the Whiteshell Irradiator (which is under an CNSC licence held by ACSION) are also excluded.

CONSTRAINT

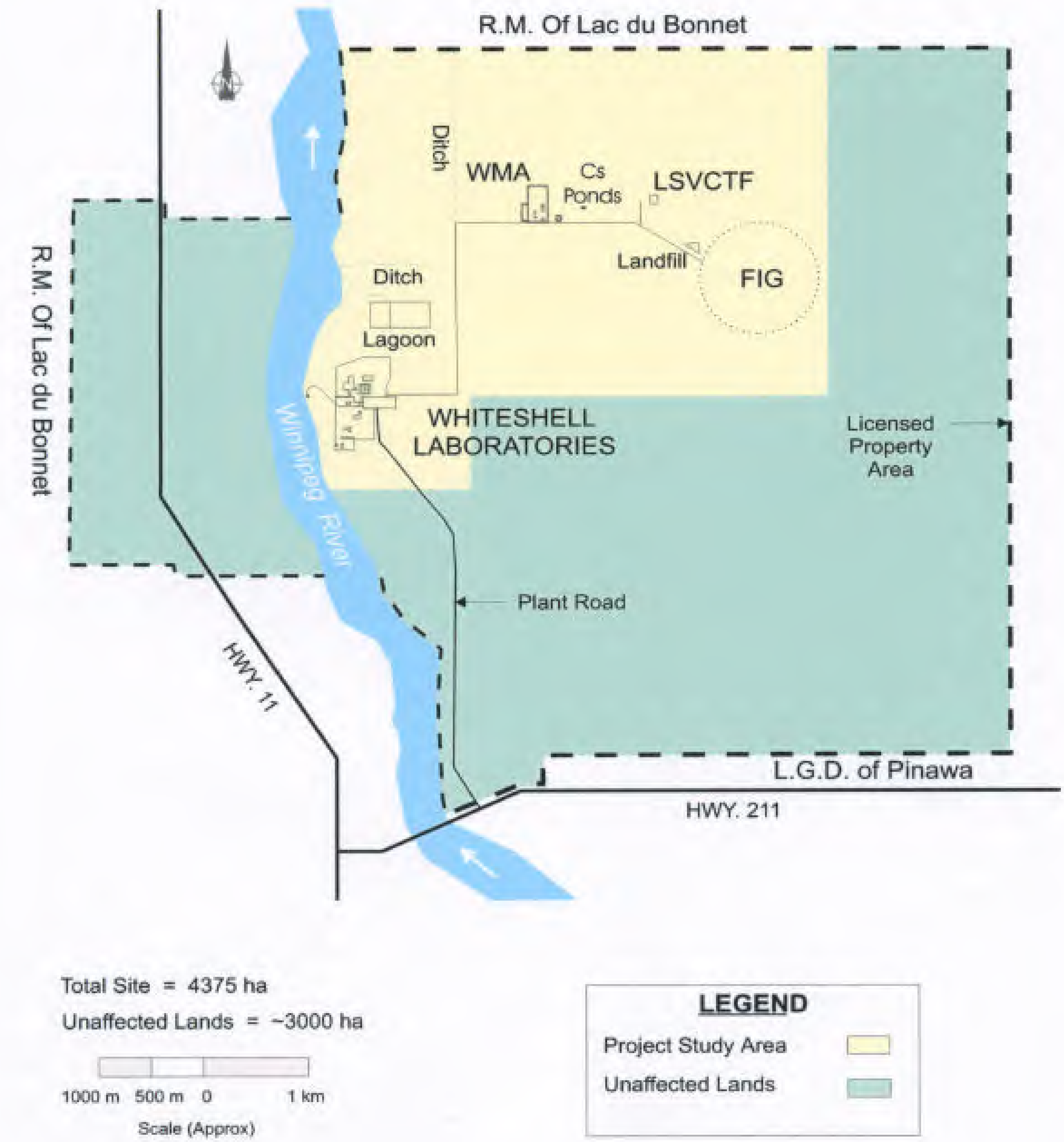
The long-term management of nuclear wastes is contingent upon finding a nationally acceptable solution consistent with federal policy on waste management. At present, no options or sites have been defined or approved that will provide such a solution. The availability of off-site national disposal facilities is essential to completing the decommissioning of the Whiteshell Laboratories' site. Provision of national waste disposal facilities is not within the Whiteshell Laboratories Decommissioning Project scope. Until a national facility is available, the wastes arising from the decommissioning project will remain in other secure interim waste management facilities licensed by the CNSC.

SCOPE OF ASSESSMENT

The environmental assessment of the proposed project includes a consideration of factors detailed in CNSC's Scope of Assessment document and of the following factors identified in the *Canadian Environmental Assessment Act*:

- purpose of the project (Section 1.0);
- alternative means of carrying out the project that are technically and economically feasible (Section 3.0);
- environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative

FIGURE ES.1
PROJECT STUDY AREA



AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out (Section 6.0);

- socio-economic effects caused by a change in the environment due to the project (Section 6.0);
- sustainability of renewable resources (Section 6.0);

- mitigation measures that are technically and economically feasible (Section 6.0);
- significance of the effects (Section 7.0);
- cumulative effects (Section 8.0);
- requirements of a follow-up program (Section 9.0); and
- comments received from the public (Section 10.0).

ALTERNATIVES

CEAA requires that the CSR address alternative means to achieve the decommissioning program. Our review of alternative means indicated that the main difference would be the time period required to complete the decommisssioning program. That is, the same steps and the same activities have to be carried out to achieve decommissioning. It was recognized from the beginning that the public would prefer decommissioning to be carried out in as short a period as possible. The minimum period given the time frame to deliver the decommissioning program and the availability of waste disposal was determined to be 20 years. Three alternatives were analyzed:

- Alternative 1 - End state in a Short time period (20 years).
- Alternative 2 - End state in a Long Time Period (100 years).
- Alternative 3 - End state in a Moderate Time Period (60 years).

Alternative 1 is based on the assumption that an off-site radioactive waste disposal repository would be available within 10 years. This would give time for evaluating wastes and preparing detailed decommissioning programs. Wastes would be removed to disposal throughout the subsequent 10-year time period. Alternative 2 is based on the assumption that the longest time the process necessary to implement a national waste disposal policy could take would be 100 years. Alternative 3 proposes that Whiteshell Laboratories would be decommissioned over an intermediate time frame (approximately 60 years). This time frame is based on the concept that safety and costs can be optimized by taking advantage of natural radioactive decay and by decommissioning buildings as they come to the end of their economic and structural life. It is also based on the assumption that national waste disposal facilities would be available for low-level waste by the year 2025 and high-level waste by 2050.

While it is understood that public preference is for an early decommissioning process, that is, Alternative 1, this approach has two limitations, namely occupational health and safety and costs. The safety issue arises from early handling of highly activated material from WR-1 which currently produces high radiation fields. Working in these fields requires the highest level of local shielded handling facilities as well as expensive and highly automated remote handling. Since an off-site disposal facility is not likely to be available within the 20-year time frame, the highly radioactive wastes from the disassembly of the reactor, and the low and intermediate-level wastes from the other site nuclear facilities would also have to be accommodated in interim storage facilities. This means additional safety risks to workers (double the amount of handling) and associated cost increases of between $50M and $130M.

Alternatives 2 and 3 avoid some of these problems. The likelihood that a national waste disposal facility is established is greatly improved. Postponing the dismantling of WR-1 for fifty years following shut-down provides a thousand-fold decrease in radiation fields. The risk of environmental problems developing over the deferment period is minimized since the site will remain under CNSC license and a follow up/monitoring program will be in place throughout the implementation period.

Alternative 2 is inferior to Alternative 3 providing that national waste facilities become available within the planning time frames of Alternative 3. The decrease in radioactivity resulting from a longer period of natural radioactivity decay in Alternative 2 does not significantly enhance worker safety. In addition, most of the buildings housing nuclear facilities will have gone beyond their economic and structural lives and will have to undergo extensive replacement increasing the costs of Alternative 2. Alternative 3 also reduces the amount of waste ultimately requiring disposal and produces more benign environmental effects than Alternative 2. Table ES.1 summarizes the incremental costs of Alternatives 1 and 2 as compared with the Alternative 3. The table shows that Alternative 3 is the least cost option - $50 to $130 million less expensive than Alternative 1 and $108 million less expensive than Alternative 2. Alternative 3 therefore is chosen as the reference alternative.

Table ES.1
Comparison of Costs for Decommissioning Alternatives

Alternative	**Time Frame (Years)**	**Base Cost ($M)**	**$M Reductions Provided by Option**	**$M Additional Costs of Option**	**$M Total Incremental Cost of Option**
1	20	reference project cost	-40	90 – 170	50 to 130
2	100	reference project cost	0	108	108
3	60	reference project cost	0	0	0

The basic rationale for decommissioning Whiteshell Laboratories is to move site waste only when off-site disposal is available or when the safety of managing wastes in existing facilities is compromised. For analytical purposes, based on technical, economic, public and environmental considerations, Alternative 3 was identified as the preferred alternative. It should be noted that if off-site waste disposal becomes available earlier, all site facilities except those which provide radioactivity decay benefits (e.g. WR-1 and some WMA wastes) could be decommissioned earlier. On the other hand, should off-site waste disposal availability take longer than assumed, the contingency would be to revert to Alternative 2.

Decommissioning Options within the Preferred Alternative

The general strategy is to remove facilities entirely from the site. For two project components, it was determined that the most environmentally sound and cost-effective solution was in-situ disposal, in other words, managing the wastes in the existing location. These two cases were the river sediments and Low Level Waste (LLW) in trenches in the Waste Management Area. In the case of the river sediments, after extensive sediment surveys, it was shown that even if the contaminants detected near the outfall to the Winnipeg River were somehow exposed or resuspended there was no risk to human or ecological health (see Appendix B). Analyses were also carried out for the waste in the trenches (see Appendix C). These analyses indicated that there has been no significant transport of contaminants beyond the trench boundaries. The analysis concluded that there was no likelihood that contaminants could move beyond the boundary of the Waste Management Area before the period of institutional control (now estimated at 200 years) is complete. These conclusions are based on the following observations:

1. The trenches were deliberately located in a water discharge area. This means that water moves upward preventing contaminants from migrating down into the sand aquifer overlying the bedrock and eventually reaching the Winnipeg River.
2. The clay soils around the trenches dramatically inhibit the movement of contaminants.
3. Under the most conservative assumptions the decay period for the dominant radionuclides (^{90}Sr and ^{137}Cs) in the trenches is shorter than the time it would take to migrate to the boundary of the WMA.

During the course of the decommissioning program, there will be additional monitoring and analysis to verify these findings. During Phase 3, a supplementary environmental assessment and safety analysis will be conducted to support the final in-situ end state.

PROJECT DESCRIPTION

Facilities

The following facilities will be decommissioned.

Table ES.2
Facilities to be Decommissioned

Nuclear Facilities	Radioisotope Facilities	General Infrastructure
• Shielded Facilities • Van de Graaff Accelerator • Neutron Generator • Active Liquid Waste Treatment Centre • Whiteshell Reactor -1 • Concrete Canister Storage Facility • Waste Management Area	• Building 300 • Decontamination Centre • Building 402	• Non-nuclear Buildings • Landfill • Sewage Lagoon • Buried Services • Contaminated Lands ("Affected Lands")

Phasing

The proposed Whiteshell Laboratories Decommissioning Project will be implemented through a phased approach (See Figure ES.2) preceded by operational shut down work. The activities planned in each phase are:

- ***Phase 1*** *(approximately 5 years)* – activities directed toward nuclear and radioisotope buildings and facilities to place them in a safe, secure, interim end state. The Van de Graaff Accelerator and the Neutron Generator will be completely decommissioned.

- ***Phase 2*** *(approximately 10 years)* – regular monitoring and surveillance of all buildings and facilities. Most project activity will be focussed on the Waste Management Area. Most waste management facilities will be placed in a passive operational state and interim processing, handling and storage facilities, required during monitoring and surveillance and decommissioning project activities, will be established.

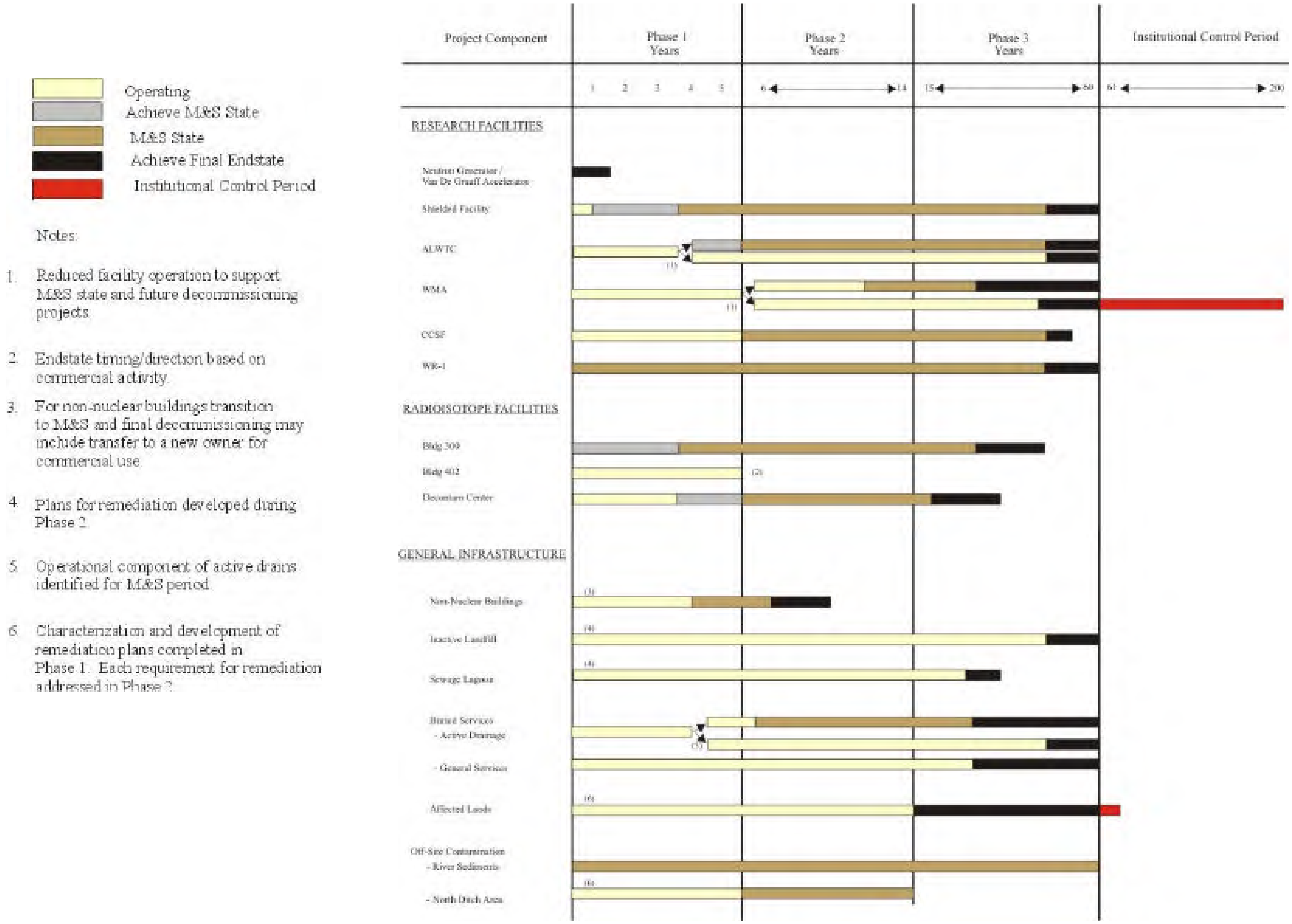
- ***Phase 3*** *(approximately 45 years)* – activities directed to bringing the site to a final end state that will fulfil all pertinent regulatory and national policy requirements. The timing and sequence of decommissioning activities will be determined largely by the availability of disposal facilities and by the age and condition of engineered structures and buildings.

Following the completion of Phase 3, part of the site, namely, the Waste Management Area, will remain under institutional control for an additional 200 year period.

Management of Waste

The decommissioning program essentially is a process of managing the Whiteshell Laboratories' site waste. The inventory of stored waste from Whiteshell Laboratories includes approximately 21,000 m^3 of low-level radioactive waste, approximately 1,400 m^3 of medium level radioactive waste and approximately 28 metric tonnes of irradiated reactor fuel. The decommissioning program will produce an additional approximately 12,000 m^3 of low-level radioactive waste, approximately 1,400 m^3 of medium level radioactive waste and approximately 50,000 m^3 of deminimis (below regulatory concern) waste. TFRE / Amine radioactive liquid waste stored at the site will be processed to a solid waste form. The result of the decommissioning program will be an end state where all wastes are dispositioned to off site disposal facilities or, in the case of river sediments and the LLW trenches, to management in-situ.

Figure ES.2
Whiteshell Laboratories Decommissioning Project Component Timelines



THE ENVIRONMENT

The Site

The Whiteshell Laboratories' site is located on the east bank of the Winnipeg River approximately 100 km east northeast of Winnipeg. The site lies approximately 267 m above sea level within a broad zone where prairie grassland to the southwest merges with boreal forest to the northeast. It is on the western edge of the Precambrian Shield and is surrounded by cleared land, which supports agriculture, interspersed with peat bog. Forty-three percent of the site is forested or leased farmland.

Environmental Indicators and how effects can be transmitted at Whiteshell Laboratories

The following are some key characteristics of the site:

- ***Radioactive Emissions:*** The estimated dose to the most exposed members of the public (assumed to be living at the site boundary) is a negligible percentage of the typical background radiation dose in Canada.

- ***Air Quality:*** Indicators of air quality in the area range from 0 to 17% of provincial and/or federal standards for non-radiological contaminants. Air in the area may be described as "very clean".

- ***Soils and Groundwater:*** Groundwater in the area is generally regarded as "potable". The water tends to move toward the Winnipeg River except at the Waste Management Area which is a water discharge zone where water tends to flow upward to the surface. The site consists of overburden soils (derived from glacial deposits) overlying Precambrian bedrock. Silt, silty clay, fine sand and clay till dominate the Local and Project Study Areas.

- ***Surface Water and the Winnipeg River:*** In general, most surface water from the site flows to the Winnipeg River. Water quality in the Winnipeg River is good and radioactivity is well within the Maximum Acceptable Concentrations for radioactivity in drinking water in Canada, as specified by Health Canada. Appendix B shows that concentrations of radioactivity in the sediments near the outfall present no risk to human or ecological health.

- ***Terrestrial Biota:*** There are many types of vegetation, some of which are rare in the area but common elsewhere in Manitoba. There may be more than 50 species of mammals living on the site but none of them are considered "rare or endangered." The white tailed deer is quite common. The local study area ***may*** support several endangered birds including peregrine falcon, burrowing owl, piping plover and loggerhead shrike. ***Vulnerable*** species in the area may include the least bittern, short-eared Owl, Caspian tern and red-headed Woodpecker.

- ***Aquatic Biota:*** The Winnipeg River has a wide variety of fish species including walleye, pike, red and white sucker, whitefish and the "at risk" and protected sturgeon. There is no significant aquatic vegetation on the site.

- ***Socio-Economics:*** The area around Whiteshell Laboratories has a population of about 18,000. Although Whiteshell Laboratories employed as many as 1,100 people at its peak, it currently employs about 350. When shut down is complete employment will decrease to approximately 30. Other industries now provide the bulk of employment in the area. Traditional employers are mining and forest products but the percentage of employment in the retail trade and tourism is growing.

- ***Land and Resource Use:*** The area supports farming, hunting and fishing and a growing recreational industry based on these activities, as well as swimming and a growing cottage community. The Winnipeg River is particularly important to all these activities.

Valued Ecological and Social Components

Valued Ecological Components (VECs) and Valued Social Components (VSCs) are a way of focussing on potential environmental effects. These components are protected by law or regulation; recognized by the scientific communities as important within the ecosystem; and/or recognized by the public as being important due to their social importance, commercial economic value or role in maintaining quality of life within the community. The following VECs and VSCs were identified in the assessment:

- The Winnipeg River and its Shoreline.
- Sturgeon, Walleye, Northern Pike and Mooneye.
- Whitetail Deer and Moose.
- Gullies and Ravines.
- Coniferous Forest.
- Habitat Diversity.
- The Sport Fishery.
- Provincial Park and Natural Forest Areas.
- The Model Forest.
- The Field Irradiator Gamma (FIG).

EFFECTS OF THE PROJECT ON THE ENVIRONMENT

Approach

Residual effects were determined through a review of decommissioning activities and interactions with environmental components.

Contaminant migration pathways were evaluated and possible receptors along the pathways identified. Where mitigation measures were required they were applied to determine the net residual effect. Special attention was paid to the geographical extent of the effect e.g. the area around the activity, the Project Study Area or the Local or Regional Study Areas (see Figure ES.3).

Residual Effects

In general, there will be an improvement to the environment as a result of the decommissioning program. This is because:

- the achievement of operational shutdown will continue to reduce emissions, ultimately emissions will fall to zero;
- decay of any material on the site will continue;
- there will be no new sources of contaminants; and
- the site will ultimately be restored to a natural condition.

Accordingly, there will be some effects although they will be generally small and in many cases, undetectable. In that regard it should be noted that releases to the environment are not continuous and they are controlled (so that effects are minimal from the start). It should also be noted that the site will remain under license which means that monitoring subject to CNSC review will continue for the entire program. Certain parts of the site will be under institutional control for as long as 200 years.

The following is a summary of residual, but not necessarily significant effects that may be associated with the program.

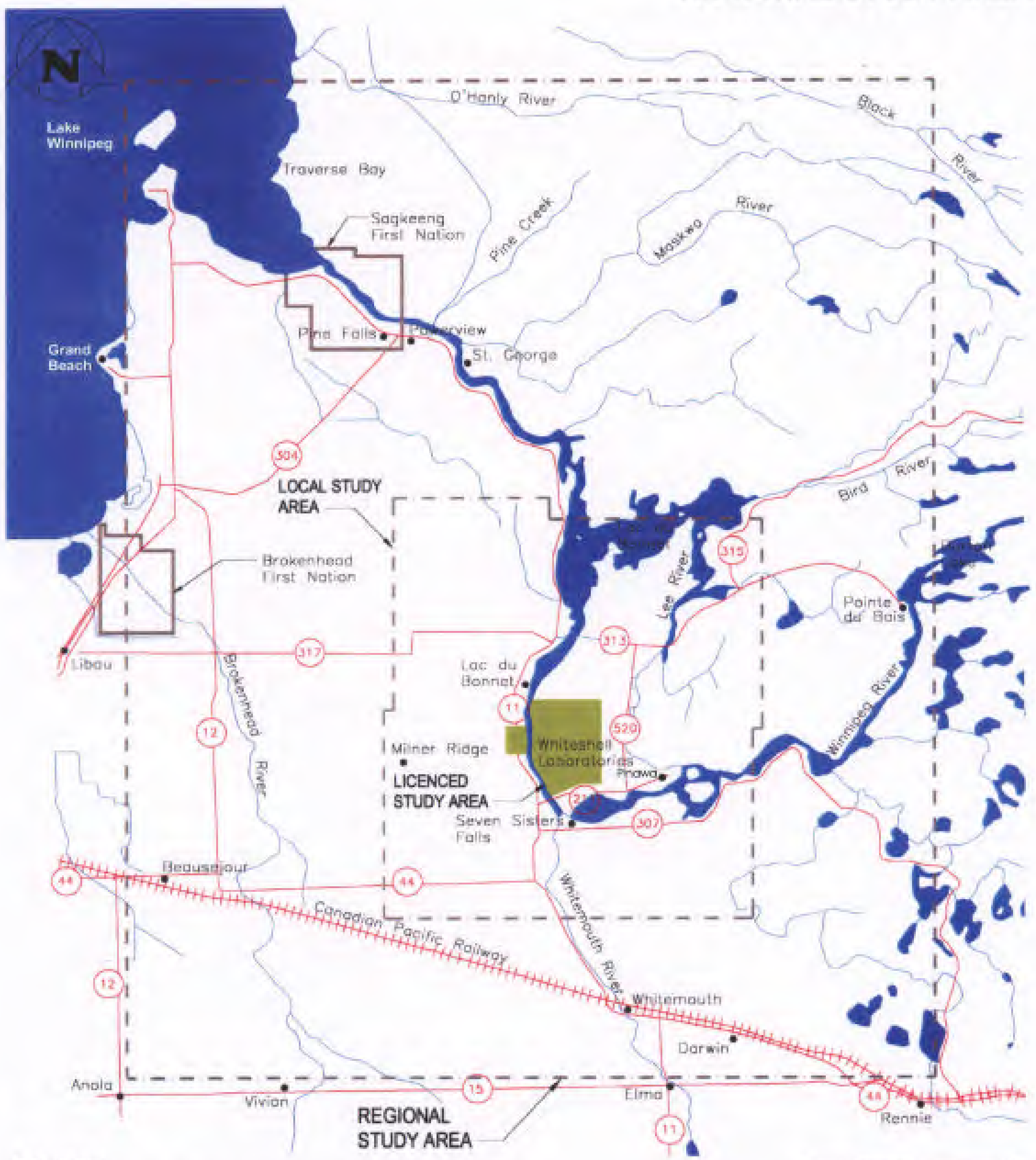
Air Quality and Noise

Air quality issues were related to most decommissioning activities including decontamination, building demolition and site remediation. Air quality effects ranged from the release of very small amounts of radioactive airborne particulates to nuisance dust and noise. Several observations may be made:

- airborne radioactive emissions are controlled to be below permissible Derived Release Limits (DRL). The target for total emissions is a small fraction of the DRL. HEPA filters effectively control radioactive particulates. Where greater control is required, additional HEPA filters can be added. The result is that the release of radioactive particulates is negligible;

FIGURE ES.3

REGIONAL STUDY AREA



SOURCE:
PROVINCE OF MANITOBA 1 : 1 000 000
TOPOGRAPHIC BASE MAP UNIVERSAL
TRANSVERSE MERCATOR PROJECTION
ZONE 14 NORTH AMERICAN DATUM 1983

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

- radioactive materials will be removed from all structures through a decontamination process. HEPA filters used during decontamination will remove a high level of radioactively contaminated dust (99.97%). As a result virtually no radioactivity will be released during the decontamination process;
- experience at other sites suggests that from time to time nuisance dust will be generated. Recent work (Watson and Chow 1999) suggests that the fine fraction (PM_{10}) of fugitive dust, generated by construction-type activities, will remain in the lowest 2 m of the atmosphere and that the local deposition losses and impaction losses (trees) will reduce the amount transported beyond 50 metres by over 90%;
- under extremely windy conditions, when there is a possibility that emissions may leave the site, decommissioning activities will be curtailed; and
- the preservation of the dense tree coverage across the site provides a natural noise barrier between site activities and potential noise receptors within the Project Study Area. Vibration effects would likely only be of concern within the Project Study Area to adjacent buildings and structures.

The assessment has concluded that the spatial extent of the residual effects from emissions to the air and noise will be limited to the Project Study Area.

Surface Water (Hydrology)

Residual effects on surface water, particularly the Winnipeg River, were identified from discharges from the Active Liquid Waste Treatment Centre and the sewage lagoon. These discharges, currently well below applicable standards, will gradually diminish to almost zero by the time decommissioning is complete. The discharges that will occur will be controlled so that there will be some, but very small, residual effects on the River.

Soil and Groundwater (Geology and Hydrology)

Small amounts of contamination may remain in the soils where leaks have occurred around buried services and where active buildings or facilities, such as the Shielded Facilities have been removed. Very small amounts of leachate from these sources as well from the Inactive landfill may migrate into the groundwater. The main area of concern was the LLW to be managed in-situ in the Waste Management Area. As noted in the discussion in alternative methods, it was determined that the likelihood of contaminant transport beyond the Waste Management Area was extremely low and no effects on groundwater were anticipated from in-situ disposal of the trenches. Monitoring of this area will continue well beyond the decommissioning program until the beginning of the 23rd century. The analysis concluded that effects on groundwater would be limited to the Waste Management Area.

Terrestrial Biota

No effects were identified on terrestrial biota and it is expected that natural vegetation will re-establish itself.

Aquatic Biota

The only potential effects were related to the possibility of exposure of aquatic biota to the Winnipeg River contaminated sediments. An ecological risk assessment (Appendix B) indicated that even under the most unfavourable assumptions, there would be no effect on aquatic biota.

Worker Health and Safety

Workers are exposed to radiation during many of the decommissioning activities. Adherence to AECL's radiation protection and occupational health and safety programs will ensure that exposures are controlled and kept within regulated limits. Furthermore, the application of the radiation protection program ensures that exposures are justified and kept as low as reasonably achievable (ALARA), social and economic factors taken into account. No residual effects on worker health and safety are anticipated.

Public Health

No residual effects on public health are expected. The main risk is associated with possible contamination of the Winnipeg River as a water supply. This risk is minimized through control of releases to ensure that there is no effect. The risk analysis described in Appendix B has indicated that there is no risk to human health from contaminated sediments. There is a possibility of radiation exposure from accidents associated with the transport of radioactive waste off-site. Approaches to ensuring the safety of radioactive transport have been developed and include contingencies for accidents and spills.

Physical and Cultural Heritage / Archaeology

Physical and cultural heritage refers to use by First Nations and others of the land over time. In particular, these groups have used the area and especially the Winnipeg River for hunting, fishing and many other traditional activities. The concern is the possible loss of buried artifacts. To avoid such losses, archaeologists will be present during any significant shoreline excavations. Effects can therefore be prevented.

Land and Resource Use

A residual effect is the long-term restriction on land use. The amount of land likely to be involved is very small, relative to the large area of the site.

Socio-Economics

Because there are not likely to be any effects on the biophysical environment, effects on the area's socio-economic conditions are unlikely.

Aboriginal Interests

Activities of specific interest to aboriginal communities are associated with historical and current uses of the Winnipeg River, the disturbance of sacred lands and artifacts. No particularly valuable historical site has been identified in the Project Study Area and First Nations will be kept apprised of any findings during excavations as well as being kept abreast of the decommissioning activities as the project proceeds. This process will ensure that aboriginal interests are not affected.

EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The assessment reviewed the effects of non-routine events including floods, tornadoes, earthquakes and fire. The assessment concluded that if such events were to occur, AECL's existing contingency plans and emergency preparedness plans will be implemented and the effect on the project will be adequately controlled.

ACCIDENTS AND MALFUNCTIONS

These events include equipment failure, fire, explosion, spills and leaks, loss of services and off-site transportation accidents. The assessment confirmed that all of the accidents and malfunctions reviewed have avoidance and contingency plans in order to mitigate potential environmental effects. Mitigation measures to reduce the potential hazards during decommissioning will be developed in the decommissioning plans for individual facilities. Accident mitigation is based on prevention, early detection, remediation and accommodation. AECL is committed to having the necessary trained staff available for these purposes.

ASSESSMENT OF SIGNIFICANCE

The significance of residual effects was assessed using a two-step approach. Step one involved a comparison with specific criteria such as contravening a standard; displacing or endangering a designated environmental feature; or adversely affecting an established treaty and/or aboriginal right. For those effects that met the criteria of the first step, their significance was determined in a second step using a scoring system addressing factors such as magnitude, duration, occurrence, geographical extent and reversibility. No effect was considered significant using either level of evaluation and the analysis determined that the Whiteshell Laboratories Decommissioning Project was not likely to cause significant adverse environmental effects.

CUMULATIVE EFFECTS

Cumulative effects are changes to the environment that are caused by an action (this project) in combination with other past, present and future human actions (other projects or activities in the area).

A total of 30 actions/physical works were identified of which 10 were considered to have the potential to interact with the project.

The effects analysis indicated that the only VEC that could be affected was the Winnipeg River. In all cases, either small amounts of effluent were involved or the discharge points were remote from the stretch of the Winnipeg River affected by the Decommissioning Project. Hence, no cumulative effects were identified.

FOLLOW-UP

The purpose of follow-up is to:

- optimize the monitoring and surveillance program;
- confirm that appropriate mitigation measures are implemented;
- develop appropriate responses to unforeseen effects; and
- identify effects of the project that may not have been predicted.

Follow-up activities include monitoring, surveillance, inspection, data collection, analysis, evaluation, and reporting.

Components of the follow-up program include:

- the preparation of detailed decommissioning plans for each nuclear facility. Each plan addresses environmental control issues and describes control procedures;
- the maintenance of existing site and effluent verification monitoring programs throughout the decommissioning program;
- program updates to meet new requirements identified from implementing the monitoring and surveillance program;
- additional wells and monitoring around the WMA, sewage lagoon and inactive landfill
- the maintenance of regular reporting procedures; and
- support for and co-operation with any independent Public Advisory Committee that may be created to assist the Whiteshell Laboratories Decommissioning Project.

In addition to the above, independent audits can be conducted by the AECL Safety Review Committee and by the CNSC.

PUBLIC CONSULTATION

A public consultation program was designed and implemented to solicit public comments on the Whiteshell Laboratories Decommissioning Project. The program sought the involvement of the stakeholders, First Nations, and interested members of the public that would endure throughout and beyond the entire decommissioning program. Public consultation activities undertaken are shown below:

Activities	1999	2000
Key-person Interviews	July – September	
Interviews (VECs/VSCs)	July – August	
Newsletter	October	June
Letter to Contact List	October	June
Open House	October	
Information Sessions	October	June
Follow-Up Presentation	November	

This approach reached a large a number of people in the area. For example:

- the newsletter was sent out to 7,627 post boxes in the Regional Study Area;
- 121 people attended the open house at Whiteshell;
- another 43 people attended information sessions;
- contacts have been made with the Sagkeeng First Nation, Brokenhead Ojibway First Nation, Treaty 3 First Nations and the Manitoba Metis Federation;
- a communication protocol has been established with the Sagkeeng First Nation, and
- presentations were made to interest groups, local Councils, the Community Leaders Group, the TAC and others.

A number of issues were raised with respect to the project. All of these issues have been addressed in the Comprehensive Study Report.

COMMITMENT

AECL, as holder of the Whiteshell Laboratories' site licence, is committed to:

- conducting all decommissioning activities to ensure health and safety of workers, the public and protection of the environment;
- ensuring that the funding to meet the Whiteshell Laboratories decommissioning requirements is identified as a component of the segregated appropriation for decommissioning from the Treasury Board;
- meeting all applicable regulatory, safety and environmental requirements throughout the decommissioning process;
- retaining key individuals to develop and initiate its decommissioning program. AECL is committed to maintaining required resources on its decommissioning team;
- maintaining fully trained and qualified staff to meet security requirements;
- maintaining an environmental monitoring program for as long as wastes requiring management remain at the site;
- the involvement of local communities in the environmental monitoring program;
- implementing mitigation measures for project activities where an evaluation of decommissioning activities has determined the need for mitigation;
- maintaining monitoring and surveillance programs for all nuclear facilities and affected lands until the final end state is achieved; and

- an ongoing communication program with area communities and other stakeholders and supports the establishment of a Public Advisory Committee during the decommissioning program.

CONCLUSIONS

The following conclusions may be drawn from the Comprehensive Study Report:

- the Whiteshell Laboratories Decommissioning Project is not likely to cause significant adverse environmental effects taking into account the mitigation measures recommended in the report;
- the cumulative effects analysis indicates that there are not likely to be any cumulative effects associated with the project; and
- public concerns raised to date about the project have been addressed in the CSR (Section 10.0).

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GLOSSARY

Active

Active signifies radioactive. It does not indicate whether the facility is operational.

Active Area

The Whiteshell Laboratories (WL) active area (Figure 2.2) includes all WL nuclear and radioisotope facilities. The CCSF and WMA are included as a part of the active area.

Active Drain Lines

Active drain lines are pipes which transfer contaminated liquids from laboratories, hot cells and buildings to the ALWTC collection tanks. A typical drain configuration consists of a drain in a fumehood or sink, a drainage pipe, a tank, a pump and a double pipeline (pipe within a pipe) to the ALWTC.

Active Ventilation

Active ventilation is the exhaust system used to remove air which may contain radioactive particles from a structure such as a laboratory, hot cells, or vented enclosures. A typical configuration in a radioisotope or nuclear facility consists of a lab fume hood, ductwork, a HEPA filter bank, an exhaust fan and an exhaust stack.

AECL

Atomic Energy of Canada Limited, a Crown corporation set up by the Canadian government in 1952 to develop peaceful uses of nuclear energy. AECL develops, markets, sells and builds CANDU power reactors and research reactors and provides engineering and other technical services to nuclear utilities.

Affected Lands

The Affected Lands (Figure 2.1) is defined as the lands where nuclear development, or operations, or supporting activities were conducted. As well, lands potentially impacted by such activities are included as being “Affected”.

Air Kerma

Air kerma is an approximation of dose from gamma radiation.

Alpha Radiation

The least penetrating but most strongly ionizing of the three principal forms of radiation from radioactive materials. It is halted by the outer layer of skin cells in human skin.

ALARA

As Low As Reasonably Achievable. ALARA refers to radiation exposures that are kept as far below regulatory limits as possible, taking into account current technology and the costs of improvement related to three areas: the benefits and risks to the environment and public health and safety; societal and socio-economic factors; and the use of radioactive materials for public benefit, such as in research, medical diagnosis and the production of electricity by nuclear power.

Amine Tank

A tank in the WMA containing radioactive liquid waste from an experiment in which an irradiated CANDU natural uranium fuel bundle was dissolved.

Background Radiation

Radiation that occurs in the natural environment, including cosmic rays and radiation from naturally occurring radioactive elements.

Bequerel (Bq)

The standard international unit of radioactivity equal to 1 radioactive disintegration per second. 37 billion becquerels is equal to 1 curie (Ci).

CANDU

A nuclear power reactor developed in Canada. The term stands for Canadian Deuterium Uranium. The moderator is deuterium or heavy water and the fuel source is natural uranium.

Canister

A steel-lined concrete structure used to store spent nuclear fuel.

Characterization Survey

A radiological survey carried out to characterize radiation hazards and estimate the level of radiation. See interim end state survey definitions.

CEAA

The *Canadian Environmental Assessment Act (CEAA)* sets out responsibilities and procedures for the environmental assessment of projects involving the federal government. The Act applies to projects for which the federal government holds decision-making authority whether as proponent, land administrator, source of funding, or regulator. It was proclaimed on January 19, 1995. The Canadian Environmental Assessment Agency administers the *Act*.

CNSC

The Canadian Nuclear Safety Commission (CNSC) is the federal regulatory body which regulates the use of nuclear energy and nuclear substances to protect health, safety and security and the environment and to respect Canada's international commitments on the peaceful use of nuclear energy. Parliament passed the Nuclear Safety and Control Act in 1997, updating the older Atomic Energy Control Act (1946) and paving the way for the former Atomic Energy Control Board (AECB) to become the CNSC on May 31, 2000.

Comprehensive Study Report (CSR)

An environmental assessment report prepared under the *Canadian Environmental Assessment Act*. A comprehensive study is required for projects listed in the Comprehensive Studies Regulations under the *Act*.

Controlled Area

An area controlled in accordance with Radiation Protection practices. The controlled area is often referred to as the active area.

Critical Group

For a given radionuclide and source, a uniform or generic group of people whose location, age, habits, diet etc cause them to receive doses higher than the average received by people in all other groups in the exposed population.

Curie (Ci)

A unit used to measure the level of radioactive decay. One curie equals 37 billion disintegrations per second, or approximately the radioactivity of one gram of radium.

Deferment Period

A period of monitoring and surveillance when no significant decommissioning work is in progress.

Deminimis Waste

Waste which has activity levels below regulatory requirements for unrestricted release. This material is releasable to an off-site landfill or is recyclable.

Detailed Decommissioning Plans (DDP)

A plan to decontaminate/remediate redundant nuclear facilities to a condition which establishes a final end state that fulfills all pertinent regulatory and national policy requirements.

Duration

The time period over an environmental effect will last.

Environmental Effect

A change in the natural and / or social environment that occurs as a result of project activities.

Final End State

The target final condition of the decommissioned site. Normally this is the state achieved when release from regulatory control or establishment of continuing controls is approved.

Fission

The break-up of the nucleus of an atom into two major fragments, plus smaller fragments and free neutrons, when the nucleus is struck by a slow-moving free neutron.

Fixation (Fixing)

The process of stabilizing contamination through methods such as the application of spray or brushed-on paint or paint-like products. Fixation is done to ensure that any loose surface contamination is stabilized for a long period.

Flask

A CNSC approved containment system for transfer of radioactive materials. It is commonly used for transport of radioactive material from one licensed facility to another licensed facility.

Fuel (Nuclear)

Fissionable material used to power a nuclear reactor.

Gamma radiation

Radiation with the greatest penetrating power but least ionizing of the three principal forms of radiation. Gamma radiation can completely penetrate and damage all body organs.

Geographical Extent

The area over, or throughout which, the environmental effects are likely to occur.

Gray (Gy)

Standard International unit for absorbed radiation dose, equal to the absorption of one joule of radiation energy per kilogram of material.

Hazard

A source of danger to worker health and safety or the environment. Typical conventional industrial hazards include PCB's, asbestos, dust, propane and lead-based coatings. Typical radiological hazards include radiation sources, samples, contaminated materials and irradiated fuel.

HEPA Filters

High Efficiency Particulate Air filters used to filter radioactive dusts from the air.

HLW

High Level Waste comprises irradiated reactor fuel and metals from nuclear reactor core components.

HVAC

This refers to the Heating, Ventilation and Air Conditioning systems. At Whiteshell the heating system includes the powerhouse, district heating distribution system and building heating coils. Typical ventilation for most buildings includes supply and exhaust air duct work and ventilation fans. Air conditioning includes the B100 chiller, distribution lines and the building coils.

Hydrocarbon

An organic compound containing carbon and hydrogen.

Inactive

Not radioactive: as with "active" this does not mean that the facility is non-operational.

Inactive (Supervised) Area

The inactive area boundary is shown in Figure 2.1. The inactive area is generally the support infrastructure that has not been directly impacted by nuclear operations and is considered free of radioactive contamination.

In-Situ

A term referring to the management of radioactive material, waste or a facility in its existing location.

Interim End State

A temporary end state achieved to place a facility in safe monitoring and surveillance until final decommissioning is implemented.

Interim End State Survey

Radiological characterization done to identify hazards and estimate the level of radiation. This would be a documented detailed survey. It would include a review of historic information, gridded surveying, swipe sampling and photographic documentation.

Institutional Control

Institutional controls are requirements placed on AECL by the CNSC to ensure long-term safety from residual contamination of a decommissioned facility.

Isopleth

Line drawn on a diagram, delineating areas with similar ranges of numerical value for a parameter of interest.

Leachate

The water that percolates through a porous medium such as soil and transports any salts or other dissolvable materials which may be found in the soil.

LLW

Low-level (radioactive) Waste is generated from laboratories and the nuclear fuel cycle as well as the nuclear fuel cycle. It comprises paper, rags, tools, clothing, filters etc. which contain small amounts of mostly short-lived radioactivity. It is not dangerous to handle, but must be disposed of more carefully than normal garbage.

Loss of Function

Inability to use the environmental component in a way that serves its ecological role.

Magnitude

Size or degree of the impact compared to existing environmental conditions.

Mitigation

Measures applied to prevent or minimize harm that would otherwise occur to the environment or workers or the public. For example, the use of respirators by workers to eliminate ingestion of airborne contamination is mitigation.

MLW

Medium (or intermediate) level Waste contains higher amounts of radioactivity and may require special shielding. It typically comprises resins, chemical sludges and reactor components, as well as contaminated materials from reactor decommissioning.

Moderator

Moderators are used to lower ("moderate") the energies of the neutrons emitted by fissioning uranium atoms, to increase their probability of hitting another uranium atom to cause further fissioning. Graphite and light water are frequently used as moderators. CANDU reactors use heavy water as the moderator.

Monitoring and Surveillance

Monitoring and surveillance (M&S) is applied to a facility that has been decommissioned to an interim end state but has not been demolished. M&S includes radiological surveying, and inspection and maintenance of building and facility systems.

Natural End State

A state in which lands are released for unconditional public use by the CNSC and where radiation levels approximate background levels in the area.

Occurrence

The rate of recurrence of the environmental effect.

Operational Shutdown

Shutdown operations involve the closing of operations and the removal of unfixed items including furniture, chemicals and laboratory apparatus otherwise necessary to the normal operation of the facility.

Outer (Uncontrolled) Area

The outer area at Whiteshell Laboratories consists of the balance of the property outside the active and inactive areas. There should be no radiation hazards within the outer area, except while material or waste is being transported to the WMA or off-site.

Passive Operating State

This condition is instituted when a facility or system is placed in an operating state where the inventory of radiological or other hazards is managed and controlled, but no new operations are carried out involving additional inventory.

Phase

For the purposes of the Whiteshell decommissioning program, phases are time periods. For Whiteshell Laboratories, there are three proposed phases spanning a time period of sixty years and at the end of the third phase, decommissioning will be complete.

Public Registry

The public registry is a physical and electronic repository of all public information on the CSR. The maintenance of the public registry is the responsibility of the Responsible Authorities (RAs).

Radiation

Radiation refers to energy that is given off by atoms when they move or change state. It can take the form of electromagnetic waves, such as heat, light, x-rays or gamma rays and streams of particles such as alpha particles, beta particles, neutrons and protons.

Radioactive

The condition of a material exhibiting the spontaneous decay of an unstable atomic nucleus into a stable or unstable nucleus.

Radioisotopes

Atoms of chemical elements may have many isotopes (different forms) with different atomic numbers and different atomic weights. If an isotope is radioactive, it is sometimes referred to as a radioisotope.

Refurbishment

Refurbishment involves repairs and replacement of building system components integral to maintenance of a building envelope and the maintenance of its original use.

Rem

A unit of dose equivalent and effective dose equivalent. It is the non-SI unit that has been superseded by sievert. It is equal to 0.01 Sv.

Remediation

Corrective measures that are applied to reduce or eliminate an effect after an incident has occurred. For example, containing and cleaning up a spill is remediation. Remediation techniques are also used to return an uncontaminated site to a natural state.

Renewable Resources

Resources that can naturally regenerate such as forests or fisheries. With effective use and management, these resources can be harvested today while maintaining viability for continued use in the future.

Responsible Authority (RA)

The federal agency or department that is responsible under the *Canadian Environmental Assessment Act* for ensuring that the environmental assessment is conducted in accordance with the requirements of the *Act*.

Reversibility

The degree to which the effect can or will be reversed (usually measured in time it will take to restore the environment).

Roentgen (R)

A unit of exposure equal to 2.58 x 10-4 Ci/kg.

Sediment

Particulate matter that has been transported by wind, water or ice and subsequently deposited.

Scoping Survey

A radiological survey carried out to identify hazards and to estimate the level of radiation to establish safe work practices. Only a moderate amount of detail and effort are required for a scoping survey.

Scope of Environmental Assessment

The subjects identified by the RA to be addressed in the CSR.

Shutdown Operations

See Operational Shutdown.

Sievert (Sv)

A Standard International unit of measurement that is used to describe the absorption of radiation by the human body.

Site Remediation

Refers to cleaning and removal of contaminants from the soil. A remediated site has no contaminants above specified release levels.

Site Restoration

Involves returning a site insofar as is possible to its unperturbed or pre-development condition and may include re-vegetation.

Stabilization

Stabilization is a part of the remediation process. It typically refers to placement of a piece of ground into a state where it will not be affected by erosion or other physical influences.

Standpipe

Standpipes consist of vertically reinforced concrete containers lined with carbon steel pipe and covered with a concrete shielding plug. Smaller standpipe units are 0.6 m I.D. and 1.0 m O.D. with 0.5 m extension above the ground surface. Larger units are about 0.9 m I.D. and 1.3 m I.D. Older units have no steel liners. Standpipes are used to store fuel, MLW and HEPA filters.

Storm Drain System

This network of catch basins, pipes and an outfall is used to drain surface water from the site into the Winnipeg River.

Sump

A pit, depression or other structure in which water collects before being bailed or pumped out.

TLD - Thermoluminescence Dosimeter

A crystalline material, which, when heated after being exposed to radiation, emits light in proportion to the radiation dose previously received. TLD's are used to measure direct dose received by workers.

Trench

Holes of varying lengths and widths, typically 4 m in depth excavated in the WMA until about 1985 and used for storage of low-level radioactive waste.

Tritium

A radioactive isotope of hydrogen with two neutrons and one proton in the nucleus. It is both naturally occurring and produced in nuclear reactors. As well, significant amounts were generated by nuclear weapons testing in the 1950's and 60's. Its uses include biomedical research and self-illuminating devices. It has a radioactive half-life of 12.33 years.

Unaffected Land

The Unaffected Land (Figure 2.1) is the portion of the site that was not used for or impacted by nuclear operations.

Unrestricted Release

A term used to apply to buildings or real estate which the CNSC has certified as no longer requiring radiological controls.

ACRONYMS

AAF	Active Area Fence
AECL	Atomic Energy of Canada Limited
AES	Atmosphere Environment Service
ALARA	As Low As Reasonably Achievable
ALWTC	Active Liquid Waste Treatment Centre
ARMS	Ambient Radiation Monitoring Stations
CANDU	Canadian Nuclear Reactor (CANadian DeUterium)
CAP	Canister Area Perimeter
CCSF	Concrete Canister Storage Facilities
CEAA	Canadian Environmental Assessment Act
CNSC	Canadian Nuclear Safety Commission
CSR	Comprehensive Study Report
DDP	Detailed Decommissioning Plan
DFO	Department of Fisheries and Oceans
DIAND	Department of Indian Affairs and Northern Development
DRLs	Derived Release Limit
EA	Environmental Assessment
EDAW	Economic Development Authority of Whiteshell
FA	Federal Authority
FEAI	Federal Environmental Assessment Index
FIG	Field Irradiator Gamma
HEPA	High Efficiency Particulate Air
HCF	Hot Cell Facility
HLW	High Level Waste
IAEA	International Atomic Energy Agency
ICRP	International Committee on Radiation Protection
IFTF	Immobilized Fuel Test Facility
LGD	Local Government District
LLD	Lower Limit of Detection

LLLW	Low Level Liquid Waste
LLW	Low Level Waste
LSVCTF	Large Scale Vented Combustion Test Facility
M	Million as in millions of dollars
MAC	Maximum Acceptable Concentrations
MLLW	Medium Level Liquid Waste
MLW	Medium Level Waste
M&S	Monitoring and Surveillance
NO_x	Nitrogen Oxides
NRTE	Nuclear Research & Test Establishment
OCR	Organic Cooled Reactor
PCB	Polychlorinated Biphenyl
PM_{10}	Particulate Matter less than 10 microns diameter
$PM_{2.5}$	Particulate Matter less than 2.5 microns in diameter
QA	Quality Assurance
RA	Responsible Authority
RM	Rural Municipality
SF	Shielded Facility, includes the hot cell area and the IFTF
SO_2	Sulphur Dioxide
TAC	Technical Advisory Committee
TLD	Thermoluminescent Lithium fluoride Dosimeter
TSP	Total Suspended Particulate
VEC	Valued Ecosystem Component
VOC	Volatile Organic Compound
VSC	Valued Social Component
WMA	Waste Management Area
WR-1	Whiteshell Reactor-1 (organically-cooled)
ZEUS	Zoological Environment Under Stress

1.0 INTRODUCTION

1.1 BACKGROUND

Atomic Energy of Canada Limited (AECL) was established in 1952 by the Canadian government for the purposes of developing peaceful uses of nuclear energy. AECL has a staff of more than 3500 and has its head office and design and engineering centre in Mississauga, Ontario and major research laboratories in Chalk River, Ontario along with branch offices worldwide. It also has facilities at the Whiteshell Laboratories near Pinawa, Manitoba, in Montreal, Quebec and an office in Ottawa, Ontario.

Whiteshell Laboratories was established at Pinawa, Manitoba (Figure 1.1) in the early 1960s to carry out nuclear research and development activities for higher temperature versions of the Canada Deuterium Uranium (CANDU) reactor. The initial focus of research was the Whiteshell Reactor-1 (WR-1) and Organic Cooled Reactor (OCR), which began operation in 1965. The OCR program was discontinued in the early 1970s in favour of the heavy-water-cooled CANDU system. WR-1 continued to operate until 1985 in support of AECL research programs. Other programs carried out at Whiteshell Laboratories included the Nuclear Fuel Waste Management Program, SLOWPOKE Demonstration Reactor Project and various accelerator activities. Whiteshell Laboratories has a range of nuclear facilities that provided support for these and other research and development programs.

As a result of the financial impact of the federal government's program review process, AECL made a business decision in 1997 to discontinue research programs and operations at Whiteshell Laboratories. AECL and the federal government attempted unsuccessfully to find an alternative private sector sponsor that would assume the financial responsibility for site operations, facilities and programs. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of Whiteshell Laboratories. Planning is now in progress to achieve the transition from an operational state at Whiteshell Laboratories, in support of AECL's business, to a shutdown and decommissioned state that meets regulatory requirements for a licensed nuclear site.

1.2 PROJECT OVERVIEW

The Whiteshell Laboratories' decommissioning program encompasses all of the site buildings and facilities except for unaffected lands (land not used for or impacted by nuclear development or operations), where early release may be requested to meet commercialization or privatization objectives. The first task is to achieve operational shutdown of redundant nuclear research facilities. This shutdown has been initiated and will include operational cleanup and safe shutdown of redundant facilities, preparation and submission to the Canadian Nuclear Safety Commission (CNSC) of Detailed Decommissioning Plans (DDP) for approval, and preparation and submission of an environmental assessment report (i.e. this report). The Active Liquid Waste Treatment Centre (ALWTC) as well as the Waste Management Facilities, Concrete Canister Storage Facility (CCSF) and Waste Management Area (WMA), will remain in operation throughout the operational shutdown period and for the first phase of decommissioning.

The primary objective of the decommissioning program is to leave the site in a safe and environmentally sound manner. The implementation plan for the decommissioning program is highly dependent upon a number of factors. The most important is the availability of disposal facilities which dictates the time frame within which the Whiteshell Laboratories decommissioning program can be carried out to achieve a final end state (see Section 2.3.2).

1.3 PROJECT NEED AND PURPOSE

1.3.1 Need

As a result of the federal government's program review process that significantly reduced funding to nuclear research in Canada, AECL subsequently made a business decision to discontinue research programs and operations at the Whiteshell Laboratories. This closure requires a change in the nature of the licence by the CNSC to reflect the transition from Site Operations to Site Decommissioning.

1.3.2 Purpose

The purpose of the project is to safely and effectively transform the Whiteshell Laboratories from an operational state that supports AECL's business, to a shutdown and decommissioned state that meets regulatory requirements for the unrestricted release of a decommissioned nuclear site.

1.4 REGULATORY REQUIREMENTS

Whiteshell Laboratories Decommissioning Project will be required to comply with applicable federal and provincial environmental legislation and adhere to relevant environmental policies, guidelines and standards.

1.4.1 Federal Government

The Whiteshell Laboratories is owned and operated by the Crown (AECL) and is therefore subject to federal environmental legislation. The three most applicable Acts and regulations are as follows:

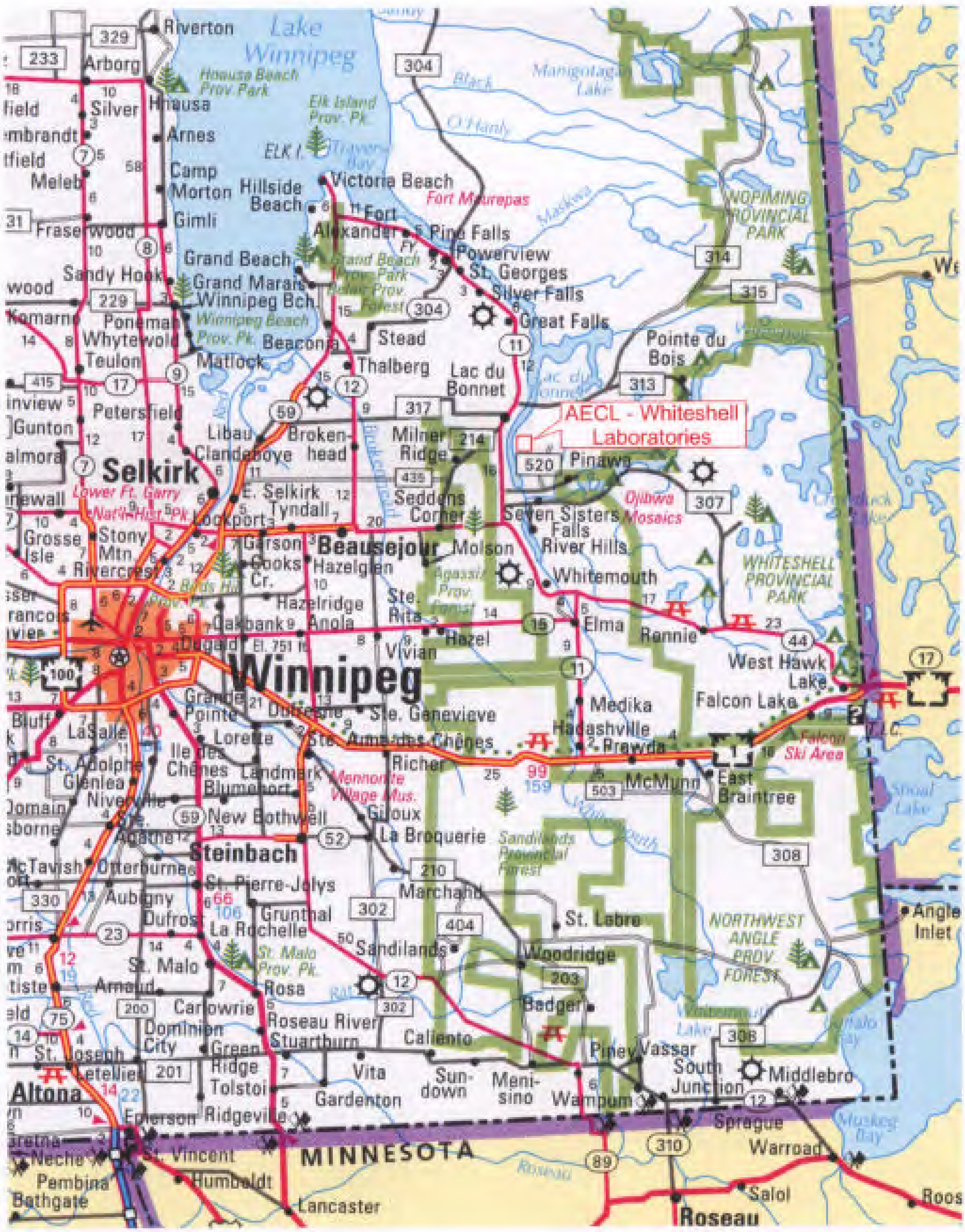
1.4.1.1 Nuclear Safety Control Act

The *Nuclear Safety and Control Act (NSCA)* took effect on May 31, 2000 and replaced the *Atomic Energy Control Act*. The CNSC regulates the use of nuclear energy and materials in Canada to protect human health, safety, security and the environment, and to respect Canada's international commitments on the peaceful uses of nuclear energy. The mandate of the CNSC has evolved from national security concerns to the control of the health, safety and environmental consequences of nuclear activities.

With the *Nuclear Safety and Control Act* taking effect, the Atomic Energy Control Board became the Canadian Nuclear Safety Commission. Relevant regulations under the *Nuclear Safety and Control Act* include:

FIGURE 1.1

LOCATION OF AECL - WHITESHELL LABORATORIES



- General Nuclear Safety and Control Regulations.
- Radiation Protection Regulations.
- Class I Nuclear Facilities Regulations.
- Nuclear Substances and Radiation Devices Regulations.
- Packaging and Transport of Nuclear Substance Regulations.
- Nuclear Security Regulations.

The document *Decommissioning Planning for Licensed Activities*, Regulatory Guide G-219, describes the CNSC's requirements concerning the planning of decommissioning activities.

1.4.1.2 Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act (CEAA)* establishes the process to assess the environmental effects of projects requiring federal actions or decisions. *CEAA* is designed to ensure that the environmental effects of projects are considered as early as possible in a project's planning stage. Application of *CEAA* to the Whiteshell Laboratories Decommissioning Project is discussed below.

Whiteshell Laboratories Decommissioning Project

Decommissioning of the Whiteshell Laboratories is an activity in relation to a physical work (i.e. a project) under *CEAA* and is subject to environmental assessment requirements of the *CEAA*. Where *CEAA* applies, the responsible authority must make a decision on the results of an environmental assessment before it can exercise a power, function or duty of a type set out in section 5 of the *CEAA*, such as issuing a prescribed regulatory approval, or providing federal funds or lands that would allow the project to proceed.

Proponent

The proponent of the Whiteshell Laboratories Decommissioning Project is AECL.

Section 5 Trigger

The amendment to the Whiteshell Laboratories licence to allow for decommissioning of the Whiteshell Laboratories will be made under subsection 24(2) of the *NCSA*.

With the advent of the NSCA, consequential amendments to the regulations under the *CEAA* will be needed to replace references to the *Atomic Energy Control Act* and its regulations by appropriate references to the provisions of the NSCA. Until these amendments are put in place, Section 44 of the Interpretation Act deems references to the former legislation to be references to the analogous provisions of the NSCA.

In this case, the former provision authorizing the licence amendment was subsection 27(1) of the Atomic Energy Control Regulations, which was listed as a *CEAA* trigger under the Law List Regulations. Reading the NSCA in analogous fashion, the present renewal is a trigger for the *CEAA* under the Law List Regulations.

Furthermore, should the assessment determine that the project is likely to harmfully alter, disrupt or destroy fish habitat, an authorization under section 35(2) of the *Fisheries Act* may be required. The granting of such an approval is also prescribed in the *CEAA* Law List Regulations as a trigger for an environmental assessment.

Responsible Authority

The Responsible Authorities (RAs) for the Whiteshell Laboratories Decommissioning Project are the CNSC and the Department of Fisheries and Oceans (DFO). The Canadian nuclear industry is monitored and regulated by the CNSC, a federal nuclear control agency, answerable to the Canadian Parliament. DFO's interest lies in possible effects on the Winnipeg River. There are no other RAs for the project.

Environmental Assessment Track

Decommissioning of the Whiteshell Laboratories has been determined by the CNSC to require a Comprehensive Study environmental assessment under *CEAA*. Decommissioning of the WR-1 nuclear reactor, which is included in the project scope, is referenced under Part VI, Section 19, Subsection (d) of the Comprehensive Study List Regulations of *CEAA*. The environmental assessment is required to address Section 16 (1) and (2) factors under the *Act*.

Expert Federal Authorities

Pursuant to the Federal Co-ordination Regulations under the *CEAA*, the following expert federal authorities likely to have an interest in the decommissioning project include:

- Environment Canada.
- Health Canada.
- Natural Resources Canada.
- Western Economic Diversification Canada.

Public Registries

The CNSC, as the lead RA, established and maintains a public registry for the Whiteshell Laboratories Decommissioning Project in accordance with *CEAA* requirements. This involves the registration of the project on the Federal Environmental Assessment Index (FEAI reference no. 18737) and maintaining public access to all documents related to the environmental assessment. The FEAI can be accessed through the *CEAA*, CNSC and AECL web sites. Manitoba Conservation also established a public registry for the project (File no. 4479.00) with registry locations at the Pinawa Library, Winnipeg Centennial Library and Manitoba Conservation Resource Centre in Winnipeg.

1.4.1.3 Fisheries Act

The *Fisheries Act* is administered by the Ministers of Fisheries and Oceans. The *Fisheries Act* regulates the protection of fishes and fish habitat and prohibits deposition of deleterious substances into waters frequented by fish. Disturbance to or alteration of fish habitat in the Winnipeg River may require issuance of an authorization under the *Fisheries Act*.

1.4.2 Provincial Government

The Manitoba Conservation Department has been notified of the federal environmental assessment to be conducted for this project. Decommissioning of the Whiteshell Laboratories is not considered by Manitoba Conservation to be a development under the *Manitoba Environment Act*. However, under the Canada-Manitoba Agreement for Environmental Assessment Harmonization, information on the decommissioning project has been provided to Manitoba Conservation by the Canadian Environmental Assessment Agency, and provincial technical staff have been invited to participate in the technical review of the assessment. Manitoba Conservation has formed a Technical Advisory Committee (TAC) to maintain awareness of the environmental and socio-economic implications of the decommissioning activities and to provide advice to the Director and the Minister of Manitoba Conservation.

There are some restrictions on the storage of radioactive waste in Manitoba. *The Manitoba High Level Radiation Waste Act* limits the interim or permanent storage of radioactive wastes to those produced from research conducted in Manitoba.

Decommissioned lands released for unrestricted use will be transferred to the Manitoba provincial government and will be subject to provincial legislation. Developments proposed for these lands that are listed in the Classes of Development Regulations under the *Manitoba Environment Act* require licensing under that *Act*. Environmental assessments will be required for listed developments.

1.5 AECL COMMITMENTS

AECL, as holder of the Whiteshell Laboratories site licence, has made the following commitments:

- AECL is committed to conducting all decommissioning activities to ensure health and safety of workers, the public and protection of the environment.
- AECL is committed to ensuring that the funding to meet the Whiteshell Laboratories decommissioning requirements is identified as a component of the segregated appropriation for decommissioning from the Treasury Board.
- AECL is committed to meeting all applicable regulatory, safety and environmental requirements throughout the decommissioning process.
- AECL has retained key individuals to develop and initiate its decommissioning program. AECL is committed to maintaining required resources on its decommissioning team.
- AECL is committed to maintaining fully trained and qualified staff to meet security requirements.
- AECL is committed to maintaining an environmental monitoring program for as long as wastes requiring management remain at the site.

- AECL is committed to the involvement of local communities in the environmental monitoring program.
- AECL will implement mitigation measures for project activities where an evaluation of decommissioning activities has determined the need for mitigation.
- AECL is committed to maintaining monitoring and surveillance programs for all nuclear facilities and affected lands until the final end state is achieved.
- AECL is committed to an ongoing communication program with area communities and other stakeholders and supports the establishment of a Public Advisory Committee during the decommissioning program.

1.6 SCHEDULE

1.6.1 Comprehensive Study Report

The technical work supporting the preparation of the draft Comprehensive Study Report (CSR) was completed in December 1999. From January through March 2000 the document underwent project team review and review by the AECL Safety Review Committee. Following a technical review of the draft report by the CNSC, Federal Authorities and Manitoba Conservation, the CSR was revised to address technical comments. Written comments from the public were requested and incorporated into the draft report as appropriate. The final Comprehensive Study Report is then submitted to the Canadian Environmental Assessment Agency for further public review. In turn, the Agency makes a recommendation regarding approval of the CSR to the Minister of the Environment.

1.6.2 Decommissioning

The initial requirement for Whiteshell Laboratories is to achieve operational shutdown of redundant research facilities, prepare a submission of detailed decommissioning plans to the CNSC for approval and prepare the comprehensive study environmental assessment report. On completion of operational shutdown, AECL will need to have resolved any revisions to the licensing structure for the site and have received approval of the detailed decommissioning plans taking into account mitigation measures and follow-up requirements of the environmental assessment.

1.7 LICENSING

The Whiteshell Laboratories are currently regulated under CNSC Operating Licence NRTEOL-2.00-2002. This licence contains conditions for operation of nuclear and other related facilities. Decommissioning of any facilities at the Whiteshell Laboratories will require the prior approval of the CNSC. The future licensing strategy includes revocation of the current Operating Licence and the issuance of a Decommissioning Licence that will allow decommissioning and designated operating activities to proceed.

1.8 PLANNING RESPONSIBILITIES (AECL)

Detailed planning and execution of the decommissioning program is carried out by AECL's Facilities and Nuclear Operations Unit. The organization implementing the decommissioning plan consists of a Program Manager, Licensing Manager, Decommissioning Operations Manager, Project Team Leaders and representatives from key AECL support functions. Once decommissioning of a facility is implemented, responsibility for safety of that facility is transferred from the Facility Authority to the Decommissioning Authority.

1.9 REPORT ORGANIZATION

The Comprehensive Study Report is organized into the following sections:

1.0 – Introduction: Provides an overview of the Whiteshell Laboratories Decommissioning Project, describes the need and purpose for the project, outlines regulatory requirements and AECL's commitments, presents the schedule for the Comprehensive Study Report and for decommissioning licensing requirements and responsibilities.

2.0 – Scope of Assessment: Discusses the scope of the project and assessment, identifies issues to be addressed in the Comprehensive Study Report and describes spatial and temporal boundaries for the environmental assessment.

3.0 – Alternatives: Discusses alternative means of carrying out the project and presents a preferred alternative.

4.0 – Project Description: Describes Whiteshell Laboratories' site and associated buildings and facilities, describes the proposed decommissioning project, and presents the approach for decommissioning.

5.0 – Description of Existing Environment: Describes the biophysical and socio-economic environment in which the decommissioning project will be carried out and identifies Valued Ecosystem Components and Social Components to be assessed.

6.0 – Assessment of Environmental Effects and Mitigation: Evaluates environmental and socio-economic effects by environmental component for the preferred alternative including effects of accidents and malfunctions and effects of the environment on the project. Mitigation measures to address any adverse environmental effects are outlined and a statement of residual effects is presented.

7.0 – Significance of Residual Effects: Analyzes significance of residual environmental effects for the Whiteshell Laboratories Decommissioning Project.

8.0 – Cumulative Environmental Effects: Assesses environmental effects of decommissioning project in conjunction with effects from other activities in the area.

9.0 – Follow-up Program: Describes the follow-up program for the decommissioning project including monitoring, surveillance and inspection, as well as responsibilities for implementation and reporting.

10.0 – Public Consultation: Outlines the public consultation program developed for the Whiteshell Laboratories Decommissioning Project, describes public and First Nation consultations carried out and discusses issues raised and responses provided.

11.0 – Conclusions: Discusses the acceptability of residual environmental effects, identifies outstanding issues and proposes actions to address them.

2.0 SCOPE OF PROJECT AND ASSESSMENT

The scope of the project, and scope of the assessment were defined by the CNSC in accordance with Sections 15 and 16 of *CEAA* (Appendix A).

2.1 SCOPE OF THE PROJECT

The scope of the project refers to the various components of the proposed undertaking that will be considered as the project for the purposes of the environmental assessment. The project is the decommissioning of the Whiteshell Laboratories, which includes the following nuclear facilities (listed in Appendices A and C of the site licence NRTEOL-2.00-2002):

- Shielded Facility.
- Concrete Canister Storage Facility.
- Waste Management Area.
- Active Liquid Waste Treatment Centre.
- Van de Graaff Accelerator.
- Neutron Generator.
- Whiteshell Reactor (WR-1).

All buildings and infrastructure on the site are included in the project.

Land under CNSC licence, identified as being affected or potentially affected by nuclear development and/or operations, is also included in the project scope. Land which is not connected or associated with any nuclear development or operations and which is not linked to the decommissioning project is not within the scope of the project. This includes a large portion of land currently under the CNSC licence. The approximately 4375 ha (10,800 acres) currently under CNSC licence, was originally selected to provide an appropriate exclusion zone when the WR-1 reactor and site facilities were in full operation. The use of this area for that purpose is no longer required. The Project Study Area map (Figure 2.1) defines the boundaries between the decommissioning project and the licensed project study areas.

Decommissioning activities consist of the dismantling and/or decontamination and refurbishment of all structures, infrastructure and services and the remediation of all lands in the project area, except for 8 ha where continued management of radioactive waste under CNSC licence is proposed to continue in the future. Decommissioning is intended to render the aforementioned facilities, buildings and lands to a condition acceptable for release from CNSC licensed control. The project also includes on-site sorting, segregation, decontamination and interim storage of all materials either currently in storage, or arising from decommissioning activities. Areas where waste management activities are proposed to continue will remain under a CNSC licence and will not be released for unrestricted use.

The project does not include the Underground Research Laboratory (not licensed by CNSC), nor does it include the Whiteshell Irradiator (which is under a CNSC licence held by ACSION).

The CSR does not include the analysis of environmental effects from investigations to identify, delineate or evaluate potential existing contamination that is required to maintain site safety and conduct the environmental assessment. It also does not include the various operations, monitoring and surveillance activities currently authorized under the operating licence.

The long-term management of nuclear wastes is contingent upon finding a nationally acceptable solution consistent with federal policy on waste management. No options or sites have been defined or approved that will provide such a solution. Consequently, it is not possible to examine long-term waste management alternatives as part of the scope of the Whiteshell Laboratories Decommissioning Project.

2.2 SCOPE OF THE ASSESSMENT

The environmental assessment of the proposed project includes a consideration of factors detailed in the CNSC's Scope of Assessment document (CNSC 1999) and of the following factors identified in paragraphs 16(1)(a) to (d) and 16(2)(a) to (d) of *CEAA*:

- purpose of the project;
- alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternatives;
- environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- socio-economic effects caused by a change in the environment due to the project;
- significance of the effects;
- comments from the public that are received in accordance with *CEAA* and its regulations, during the scoping, conduct and review of the environmental assessment;
- measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;
- requirements of a follow-up program in respect of the project; and
- sustainability of renewable resources, including effects on the capacity of renewable resources that are likely to be affected by the project.

In accordance with subsection 16(1)(e) of the *CEAA*, the assessment also includes a consideration of the following matters considered relevant by the CNSC:

- description of the decommissioning project;
- description of the existing environment which may reasonably be expected to be affected by the project; and
- program for consultation with the community and other stakeholders on the project, and for addressing issues raised by the public that are within the scope of this assessment.

2.3 BOUNDARIES

2.3.1 Spatial

The environmental assessment of the proposed Whiteshell Laboratories Decommissioning Project was conducted based on four geographic study areas as follows.

2.3.1.1 Project Study Area

The Project Study Area encompasses all facilities, buildings and infrastructure, including lands, that are directly connected or associated with the decommissioning project as described under the scope of the project (Figure 2.1). This area includes the active and controlled areas as well as the Waste Management Area and Concrete Canister Storage Facility.

2.3.1.2 AECL Licensed Study Area

The Licensed Study Area is the area within the property boundaries of Whiteshell Laboratories (Figure 2.2). The property is located approximately 10 km west of Pinawa and north of Highway 211, and includes lands on both the east and west side of the Winnipeg River. The property covers 4375 ha. The eastern area's southern boundary starts just north of Highway 211 and the property line extends north for about 7.1 km. Across the river, Highway 11 passes through the centre of the western area, which is directly across from the hub of the facility's buildings and stretches 3.5 km along the riverbank. The majority of the Whiteshell Laboratories facilities fall within a 40 ha area, adjacent to the east shore of the Winnipeg River. The lagoon is 300 m north of the main laboratory. The Waste Management Area (WMA), Large Scale Vented Combustion Test Facility (LSVCTF), landfill, and Field Irradiator Gamma (FIG) areas fall between 1 and 3 km north-east of the main area of buildings.

2.3.1.3 Local Study Area

The Local Study Area includes the Rural Municipality of Lac du Bonnet, the Local Government District of Pinawa and the north part of the Rural Municipality of Whitemouth (Figure 2.2). The area includes the communities of Pinawa, Seven Sisters Falls, River Hills, McArthur Falls, and Lac du Bonnet. It includes a north-south reach of the Winnipeg River, the Pinawa Channel and the Underground Research Laboratory.

2.3.1.4 Regional Study Area

The Regional Study Area is the area approximately bounded by the east-west extension of Highway 15 in the south, Traverse Bay of Lake Winnipeg in the north, Highway 12 north of Anola to Grand Beach in the west and north of Rennie to Pointe du Bois in the east (Figure 2.3). The area includes the Local Study Area communities, as well as Beausejour, Pine Falls, Great Falls and Whitemouth, and Sagkeeng and Brokenhead First Nations. It includes parts of Whiteshell and Nopiming Provincial Park, Grand Beach Provincial Park, and a portion of the Winnipeg River watershed.

2.3.2 Temporal

The time frame for the environmental assessment is dependent on the duration of the decommissioning program, as well as the subsequent period of control over the wastes and facilities proposed to remain on site prior to transfer to a permanent disposal facility or other nationally acceptable long-term solution to the management of radioactive wastes.

The implementation plan for the decommissioning program is highly dependent on a number of key factors, namely:

- identification, characterization and safety assessments for site hazards;
- development of detailed plans and procedures;
- waste management policy and structure which allows definition of a suitable end-state; specifically, availability of waste disposal or suitable storage alternatives;
- satisfactory completion of the regulatory approvals process, including an environmental assessment; and
- implementation and control of the decommissioning process.

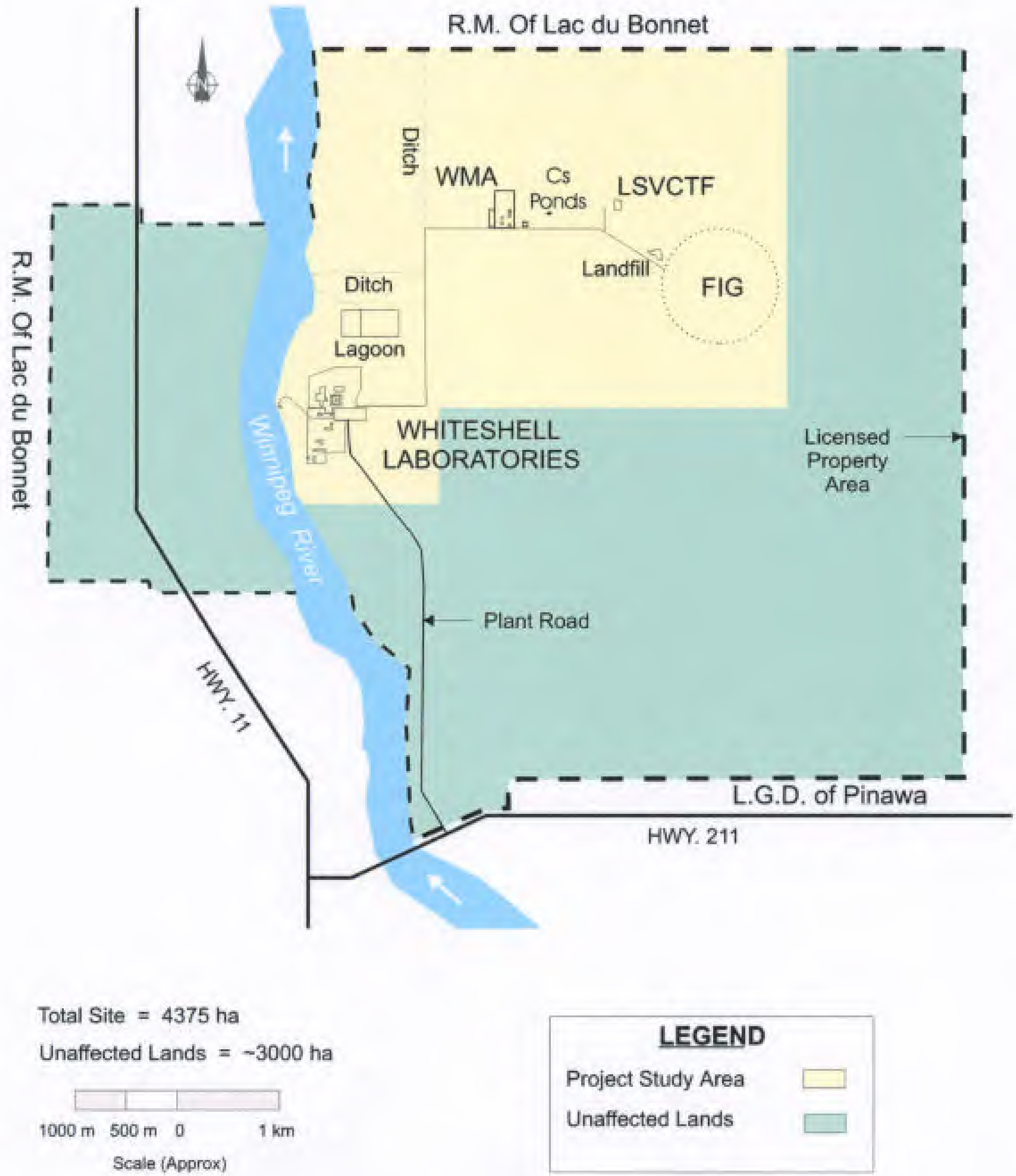
These factors dictate the time frame within which the decommissioning program can be carried out to achieve a final end-state. Many project components must be addressed in a sequential manner since support facilities (waste management areas, decontamination facilities, site service infrastructure) are required to remain in operation to support the initial decommissioning activities. This requires optimization of resources/project teams to develop the hazards characterizations, plans and approvals necessary to implement the project in a sequential manner. Since disposal is not available, the remaining life cycle of the existing buildings and infrastructure is taken into account to control liabilities/hazards for an interim period.

Depending on the alternative selected for decommissioning, the time frame for the project ranges from 20 years to 100 years.

In addition to the time frame of the project as described above, the temporal boundaries of the assessment were considered to be flexible to ensure that the duration of any significant effects beyond the project time frame would be fully characterized.

FIGURE 2.1

PROJECT STUDY AREA



AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

FIGURE 2.2

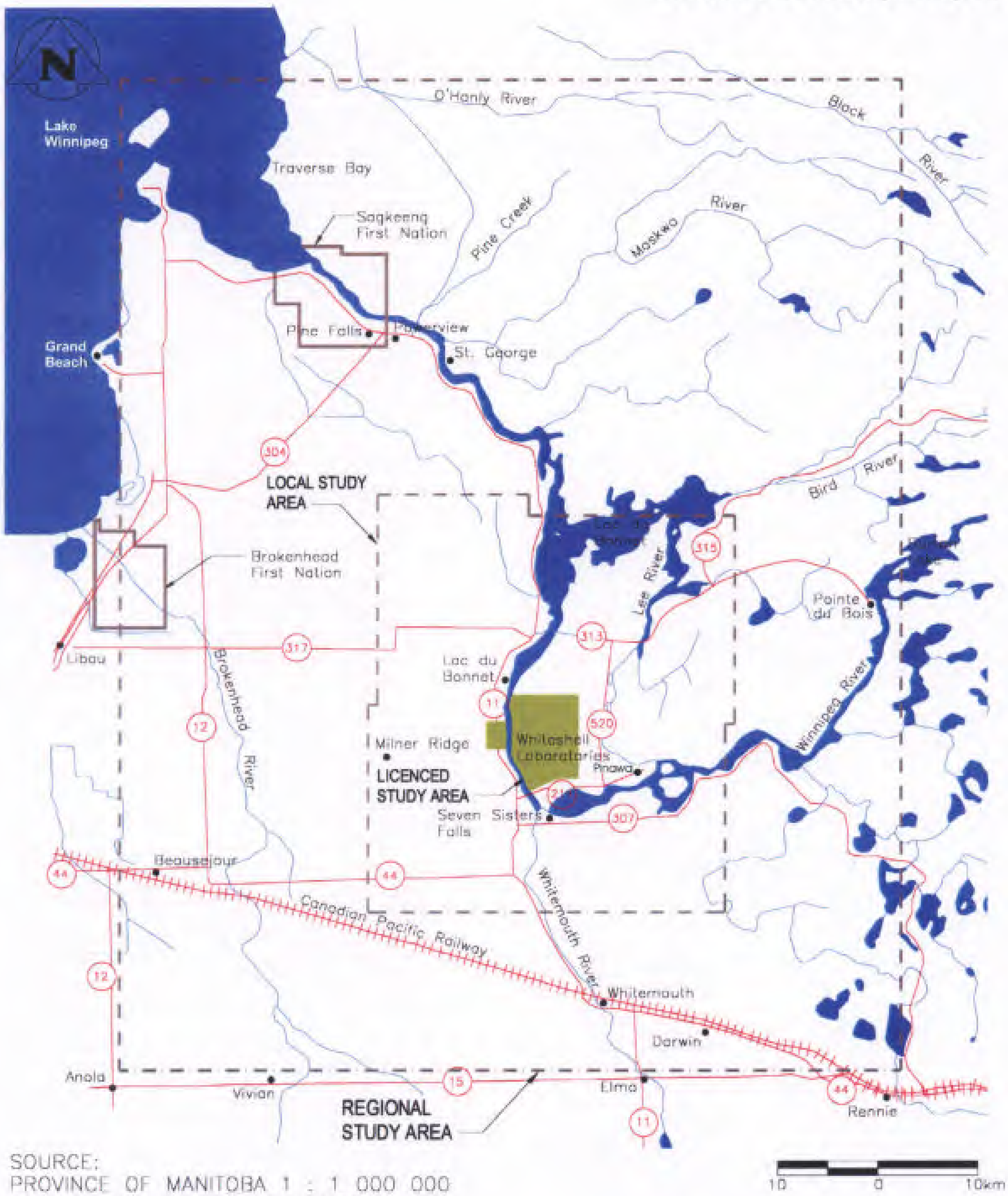
LOCAL STUDY AREA

SOURCE:
PROVINCE OF MANITOBA 1 : 1 000 000
TOPOGRAPHIC BASE MAP UNIVERSAL
TRANSVERSE MERCATOR PROJECTION
ZONE 14 NORTH AMERICAN DATUM 1983

AECL EACL

FIGURE 2.3

REGIONAL STUDY AREA



SOURCE:
PROVINCE OF MANITOBA 1 : 1 000 000
TOPOGRAPHIC BASE MAP UNIVERSAL
TRANSVERSE MERCATOR PROJECTION
ZONE 14 NORTH AMERICAN DATUM 1983

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

3.0 ALTERNATIVES

3.1 INTRODUCTION

CEAA identifies two types of alternatives which can be considered in an environmental assessment; these are "alternatives to" the project and "alternative means" of carrying out the project. Alternatives to the project are functionally different ways to meet the need and achieve the project purpose. "Alternative means" of carrying out the project are methods of a similar technical character or methods that are functionally the same. They illustrate the variety of ways a project can be undertaken and refer to such factors as location, technologies, designs, and economic feasibility.

Since shutdown facilities cannot remain in a monitoring state indefinitely, their ultimate decommissioning is unavoidable. Moreover, the CNSC's regulatory policy on decommissioning imposes obligations on the licensee to retire facilities permanently in the interest of health, safety, security and protection of the environment. Therefore, decommissioning of the Whiteshell Laboratories is necessary and there is no alternative to that undertaking. Thus, only alternative means of carrying out the project have been assessed in this study. The primary difference between alternative means is the implementation time for individual phases. The only difference in delivery is in the optimization of individual project components which are described in Section 4.0.

3.2 ALTERNATIVE MEANS OF CARRYING OUT THE PROJECT

Public input in the local area indicated interest in a rapid (5 years or less) decommissioning program for Whiteshell Laboratories. This approach was not considered for further assessment, since it was deemed to be unrealistic in terms of the time frame to deliver the decommissioning program, optimization of resources and the availability of waste disposal (Helbrecht 1999). Consequently three alternative means were established and evaluated for economic and technical feasibility, public concern and environmental effects.

- Alternative 1 - End state in a Short time period (20 years).
- Alternative 2 - End State in a Long Time Period (100 years).
- Alternative 3 - End-state in a Moderate Time Period (60 years).

All alternatives include a period of waste storage on site with transfer to an off-site waste disposal facility when it becomes available. The establishment of an off-site waste disposal facility is not within the scope of this project. Table 3.1 provides criteria for assessing alternatives.

Table 3.1
Criteria for Assessing Alternatives

Criteria	Definitions
Economic Feasibility	How does each alternative compare in relation to the cost of the project activity? Economic Feasibility Good, Moderate, or Poor
Technical Feasibility	Are off-site waste disposal facilities available? Are there different occupational safety risks associated with each alternative? Technical Feasibility – Yes, No or Undetermined
Public Concern	Is there public concern for each alternative? Public Concern – High, Medium or Low
Environmental Effects	What are the likely environmental effects associated with each alternative? Include the time for which the alternative to the project will satisfy the need and purpose of the project. Environmental Effects – Adverse, Beneficial or Undetermined

Source: Canadian Environmental Assessment Agency 1998.

An outline of each of the alternative means is provided in Sections 3.2.1 to 3.2.3.

3.2.1 Alternative 1 - End State in a Short Time Period

This alternative proposes that Whiteshell Laboratories be decommissioned over a relatively short time period (approximately 20 years). The time frame provides sufficient time to meet characterization, safety assessment and planning/approval requirements needed to implement the project work. Twenty years would allow time to assess wastes and to differentiate the wastes that can be managed in-situ at the site from those that will require removal to disposal or alternate storage.

The approach assumes that a radioactive waste disposal repository would be available within 10 years. The Whiteshell Laboratories' facilities would initially be decommissioned to a safe monitoring and surveillance state. Once waste disposal facilities are available, the final decommissioning phase would be completed. The waste would be removed to disposal throughout the subsequent 10-year time period.

This alternative presents substantial risks in that waste disposal facilities which are outside the control of the Whiteshell Laboratories management program, may not be available.

3.2.2 Alternative 2 – End State in a Long Time Period

This alternative proposes decommissioning of Whiteshell Laboratories over as long a period as necessary to implement national waste disposal policies. The assumption is that the longest this process would take is 100 years. As in Alternative 1, the initial work would involve placing site facilities in a secure monitoring and surveillance state. It is likely that all waste disposal requirements could be optimized as part of the national program. Implementation would occur in three phases followed by an institutional control period:

Phase 1 – Activities directed toward nuclear and radioisotope buildings and facilities in order to place them in a safe, secure, interim end state. The Van de Graaff Accelerator and the Neutron Generator would be completely decommissioned. Phase 1 would be completed in approximately six years.

Phase 2 – Regular monitoring and surveillance of all buildings and facilities project activity would be focussed on the Waste Management Area (WMA). Most waste management facilities would be placed in a passive operational state and interim processing, handling and storage facilities, required during monitoring and surveillance and decommissioning project activities, would be established. Phase 2 would be followed by a deferment period of approximately 45 years during which site monitoring and surveillance would be maintained.

Phase 3 – Activities directed to bringing the site to a final end state that would fulfil all pertinent regulatory and national policy requirements. Phase 3 would involve decommissioning to a final end-state within 100 years. The site would be decommissioned to an unrestricted release state except for some parts of the Waste Management Area which would be disposed of in-situ. Some infrastructure refurbishment and rebuilding may be required to maintain the facilities under monitoring and surveillance for the 45 year deferment period and beyond, resulting in increased volumes of rubble during the final decommissioning.

Institutional Control Period – The three phases of decommissioning activities will be followed by a period of institutional control where the performance of the remaining in-situ disposal components (low-level waste trenches) are monitored and controlled. The institutional control activities are designed to demonstrate that the in-situ components perform in the manner predicted in the related safety assessments and to ensure that there is no development or intrusion into affected areas until the hazards have been reduced to acceptable levels. For Whiteshell Laboratories, this period is expected to extend for approximately 200 years beyond the physical project work.

3.2.3 Alternative 3 - End State in a Moderate Time Period

This alternative proposes that Whiteshell Laboratories be decommissioned over an intermediate time frame (approximately 60 years). The time frame is based on the concept that safety and costs can be optimized by taking advantage of natural radioactive decay and by decommissioning buildings as they come to the end of their economic and structural life. It is also based on the assumption that national waste disposal facilities would be available for low-level waste by 2025 and high level waste by 2050. Decommissioning would be carried out in three phases.

The phasing for Alternative 3 is identical to that for Alternative 2 with the following exceptions:

- the deferment period following Phase 2 would be eliminated;
- Phase 3 decommissioning would be carried out over the period 2015 to 2060; and
- the timing and sequence of decommissioning activities would be determined largely by the availability of disposal facilities and by the age and condition of engineered structures and buildings.

This alternative has the advantage of presenting a feasible approach that is planned in accordance with assumptions for disposal space for Whiteshell Laboratories waste. The approach also achieves maximum cost-efficiency since it capitalizes on existing engineered services and building envelopes to (i) monitor liabilities in the interim, and (ii) schedule final decommissioning for individual facilities based on the expected life span of structures. It also minimizes the production of new waste from refurbishment or construction required to maintain facilities over a lengthy deferment period.

If off-site waste disposal becomes available earlier, all site facilities except those which provide radioactivity decay benefits (e.g. WR-1 and some WMA wastes) could be decommissioned earlier. On the other hand, should offsite waste disposal availability take longer than assumed, the contingency would be to revert to Alternative 2.

3.3 COMPARISON OF ALTERNATIVES

Results of a comparative evaluation of economic feasibility, technical feasibility and public concern are summarized in Table 3.2. The qualitative terms "high", "medium" and "low" are applied to public concerns; "good", "moderate", and "poor" are applied to economic feasibility. Technical feasibility is expressed as either feasible (Yes) or not feasible (No). The relative environmental effects of the three alternatives are evaluated and compared in Section 3.4.2.

Table 3.2
Comparison of Alternative Means of Carrying Out the Project

Alternatives	**Criteria**		
	Economic Feasibility	**Technical Feasibility**	**Public Concern**
Alternative 1 **End-State in a Short Time Period**	***Poor*** Very high decommissioning costs Property maintenance costs low.	***No*** Off-site disposal facility unlikely to be available. Shorter time for radioactivity decay results in high occupational safety risk.	***Low*** Meets public request to clean-up site as soon as possible. Maximizes availability of land for re-development.
Alternative 2 **End-State in a Long Time Period**	***Moderate*** Reduced decommissioning costs High site maintenance costs Increased waste handling costs.	***Yes*** Off-site waste disposal most likely to be available. Longest time for radioactive decay. Lowest occupational safety risk.	***High*** Wastes remain on site for long period - Perceived safety issues. Delays availability of some site land of redevelopment.
Alternative 3 **End-State in a Moderate Time Period**	***Good*** Lowest decommissioning costs Moderate site maintenance costs Lowest waste handling costs.	***Yes*** Off-site waste disposal likely to be available Sufficient time for radioactive decay Low occupational safety risk.	***High*** Wastes remain on site for long period - Perceived safety issues Delays availability of some site land for redevelopment

The main difference between the three alternative means of decommissioning the Whiteshell Laboratories is the time involved. The steps to completing decommissioning of the site and the proposed end-state are virtually the same for the three alternatives considered. It is understood that the public preference is for an early and complete decommissioning, that is, Alternative 1. That approach appears to have two limitations. One relates to the short period for deriving benefits from natural radioactive decay; the other to the unavailability of a site or facilities for disposal of radioactive wastes. Alternatives 2 and 3 offer longer time frames to complete the project, allowing optimization of radioactivity decay and the avoidance of double handling by moving wastes directly to disposal facilities.

It should be noted that although WR-1 is used as the example for the safety and cost discussion relative to project implementation, the same argument can be made for intermediate-level wastes stored in engineered facilities at the Waste Management Area and for decommissioning waste arising from other nuclear facilities. This constitutes an additional volume of ~ 2800 m^3 of waste which was produced through the WR-1 experimental program. This waste has the same characteristics as the WR-1 decommissioning waste and presents similar benefits from optimization of radioactivity decay.

At shutdown in 1985, radiation fields of reactor vault components in WR-1 were approximately 500 Gy/h (50,000 R/h). The radiation levels were estimated by activation calculations based on the irradiation history of the reactor and were verified through direct measurements taken in representative fuel channel locations (McIlwain 1992). The radiation fields resulted from the activation of the main reactor core materials, the stainless steel calandria, the mild steel of the reactor thermal shield and from the stainless steel ozhenite and zirconium-niobium fuel channels.

There are varying degrees of benefit from natural radioactivity decay dependent on the proposed handling and disposition of individual component materials. For example, the most significant decay from fuel channels has already been achieved during the first 15 years following shutdown. On average, the radioactivity decays by a factor of over 1,000 commencing at shutdown through a deferment period of ~ 50 years. Approximately one-tenth of that decay has already been achieved. However, the reactor thermal shield and the stainless steel calandria vessel radiation levels will decrease by an additional factor of about 100 by 2050. These two components are particularly important from a decay benefit perspective since handling these materials to disposal is extremely labour intensive. The material must be segmented to remove it from the core. Therefore, the radiation levels at the time the work is implemented are critical in controlling the project cost and in managing worker doses. The availability of disposal facilities is also a critical factor to consider. Without a disposal facility double handling occurs resulting in additional dose to workers since materials are initially transferred to storage facilities and ultimately to disposal.

Figures 3.1, 3.2 and 3.3 show the decay curves for the core component materials. The reference material (McIlwain 1992) provides additional detail on the radioactivity decay characteristics.

The main benefit of a radioactivity decay period is provided through the decay of the shorter half-life radioisotopes ^{60}Co, ^{55}Fe, ^{54}Mn, ^{125}Sn, and ^{125m}Te. After about 50 years, the radiation fields in the reactor vault are dominated by the long-lived radioisotopes, ^{94}Nb, ^{63}Ni, ^{14}C and there is limited benefit to further deferment.

It is important to note that the reactor vault is a highly shielded structure which provides a high integrity storage location for the activated components until waste disposal is developed in Canada. In fact there are currently no available storage structures in Canada which can accommodate the activated WR-1 vault components. Consequently the best storage location for the fuel channels is the reactor vault until optimum decay is achieved for the entire activated inventory. Radiation fields outside the reactor vault are generally low (< 10 mrem/hr) and are easily manageable during the monitoring and surveillance period.

Handling of the highly radioactive materials places economic and safety limitations on the implementation of the decommissioning program. Although doable, removal of highly radioactive material prior to optimizing radioactive decay, dramatically increases the cost to maintain worker safety. The additional shielding and remote handling required is estimated to add between $40M and $80M to the reference project cost.

Similarly, the unavailability of disposal facilities impacts cost and worker safety. To provide interim storage space requires the construction of high integrity shielded facilities estimated to add between $20M and $40 M to the reference cost of the decommissioning project. The double handling to move materials to disposal adds an additional $10M to $20M to the reference cost of the project and contributes to significant additional dose to workers.

Figure 3.1
Decay Curves to the Stainless Steel Calandria Vessel and The Mild Steel Radial Thermal Shield (per kg Steel)
(Reactor shutdown in 1985)

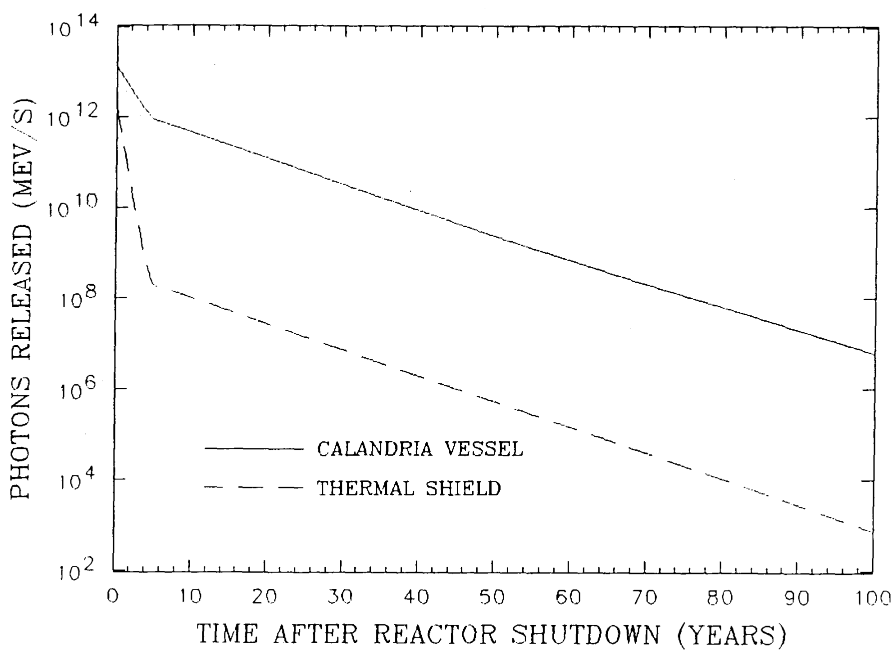


Figure 3.2
Decay Curves for the Steel Fuel Channels and the Steel Calandria Vessel (per kilogram)
(Reactor shutdown in 1985)

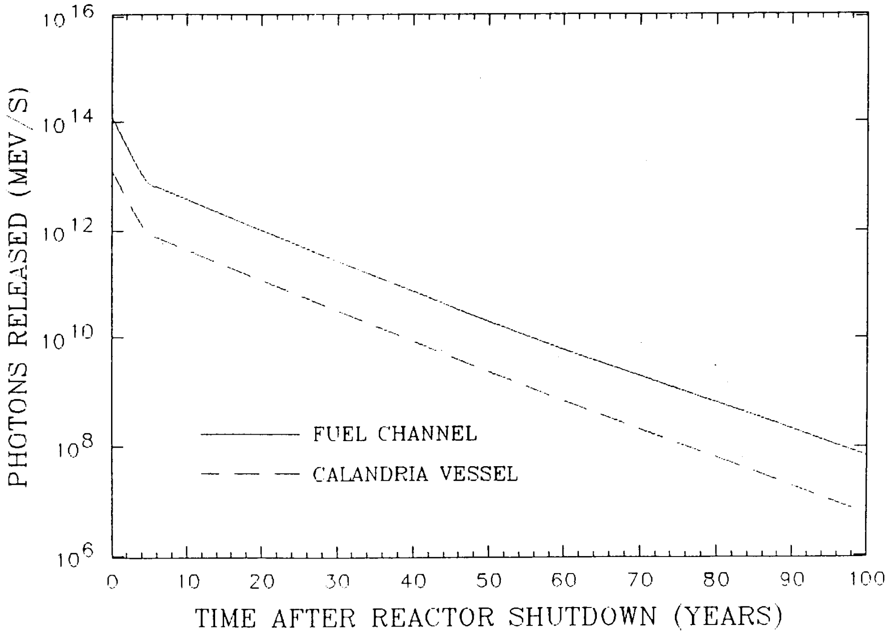
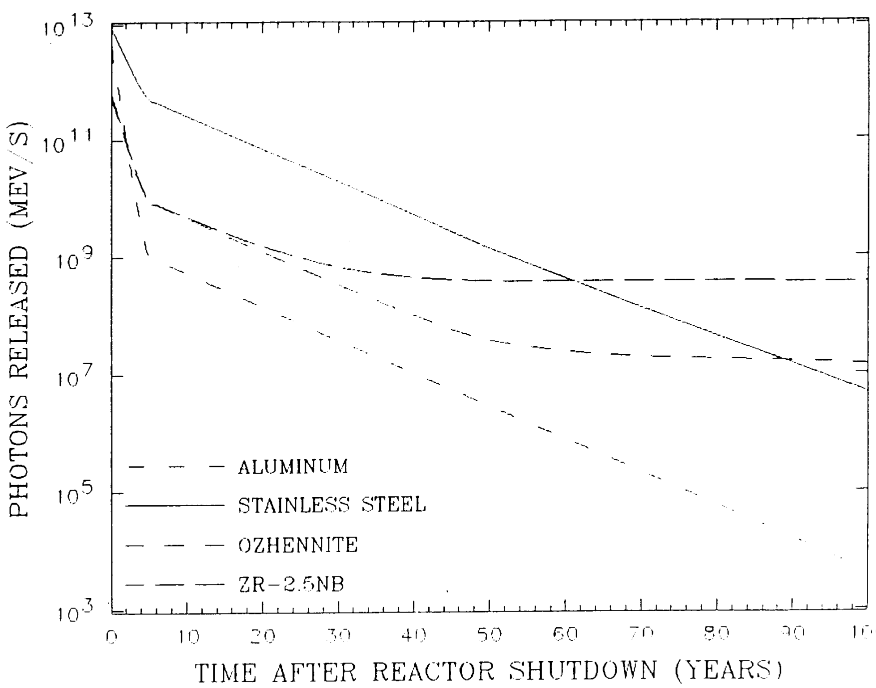


Figure 3.3
Decay Curves for the Fuel Channel and Calandria Tubes (per centimetre height)
(Reactor shutdown in 1985)



The management of the irradiated fuel inventory currently stored in concrete canisters at Whiteshell Laboratories until disposal facilities become available also provides an economic benefit. The canister life safely extends to at least 2050. Although, handling equipment does exist to allow transfer to another location, the construction of replacement interim storage and the associated double handling would add approximately $20M to $30M to the reference project cost.

Alternative 3, (60 years) is the reference option and represents the baseline project cost. Alternative 1 (20 years) would incur the highest overall additional cost to complete the project. Although the M & S cost (approximately $2M/a) would be lower by ~ $40M, the remote handling and interim storage costs would increase the reference project cost in the range of $90M to $170M for an overall increase of between $50M and $130M.

Alternative 2 (100 years), would incur no additional cost for interim storage or remote handling beyond those already estimated in the reference option because there is limited benefit from additional radioactivity decay. However, the M & S costs (approximately $2M/a) would be higher by ~ $80M because of the increased project time frame. As well, most buildings housing nuclear facilities on the site would have exceeded their economic and structural life span and would require extensive replacement. This would add ~ $28M to overall project cost (estimated at about $2000/m^2 for the basic building footprint space of 14,000 m^2 occupied by nuclear facilities). The rebuilding would also increase the amount of waste which ultimately requires disposal. The cost of Alternative 2 is higher than the reference alternative by at least $108M. A cost comparison for the three alternatives is presented in Table 3.3.

The three alternatives involve virtually identical decommissioning steps. As a result, the main differences relate to overall project cost and the greater risk to worker health and safety associated with the dismantling of WR-1 before radioactivity levels have been lowered naturally over time.

Table 3.3

Comparison of Costs for Decommissioning Alternatives

Alternative	Time Frame (Years)	Base Cost ($M)	$M Reductions Provided by Option	$M Additional Costs of Option	$M Total Incremental Cost of Option
1	20	reference project cost	-40	90 – 170	50 to 130
2	100	reference project cost	0	108	108
3	60	reference project cost	0	0	0

The foregoing discussion indicates that Alternative 3 provides the best worker dose optimization and is the lowest cost approach. This approach is summarized as follows:

1. The achievement of a monitoring and surveillance state for the site nuclear facilities within 6 years of project implementation.
2. Monitoring and surveillance of the nuclear facilities with decommissioning activities scheduled to coincide with the end of building structural life and the expected availability of national disposal facilities.

3. Movement of wastes only when off-site disposal is available or when safety in existing structures is compromised.
4. In-situ management for selected low-level waste trenches in the Waste Management Area.

3.4 COMPARATIVE EVALUATION OF ENVIRONMENTAL EFFECTS OF ALTERNATIVES

3.4.1 Overview of Environmental Effects of the Three Alternatives

The focus on environmental effects addresses the likely differences between alternatives. The effects analysis of the preferred alternative is given in Section 6.0. In general, the same activities occur for all three alternatives so any difference would relate either to:

- changes in the intensity of the activity; or
- the risk of leaving a potential contaminant in-situ.

Two comments can be made:

- Notwithstanding the different time frames of the three alternatives, decommissioning still occurs over a lengthy period – at least 20 years. As a result, the intensity of any activity is not likely to be much different between alternatives. Overlap of activities is unlikely.
- Institutional control remains in effect throughout the decommissioning period – whatever alternative is chosen and will include monitoring activities (see Section 9.5). As a result, risk of undetected contaminant migration from the Study Area will be very low for all alternatives.

The following provides a qualitative comparison of the environmental effects of the three alternatives:

Air Quality and Noise

No differences in air quality effects are anticipated for the three alternatives.

Groundwater

The potential for groundwater contamination relates to in-situ disposal. Any permanent in-situ disposal must be safe for all time. In that context, the time differences between alternatives are insignificant and the differences in environmental effects probably not measurable. The potential for groundwater impact is discussed in Appendix C.1. The conclusion, at least for the decommissioning period, was that there is little likelihood of contaminant migration. As a result, there will be no difference between alternatives.

Surface Water

Effects from all three alternatives should be essentially the same. Alternative 1 may result in slightly higher effluent emissions to the river due to the short project duration. However, for all three alternatives, effluent emissions are expected to be lower than in the past when Whiteshell Laboratories was operating.

Aquatic Biota

The effect from all three alternatives should be essentially the same. The risk to aquatic biota is related to the release of contaminants to the Winnipeg River. Alternative 1 may result in the higher effluent emissions. However, for all three alternatives, effluent emissions are expected to be lower than in the past when Whiteshell Laboratories was operating.

Socio-Economics

There has been public pressure to have the site released for other uses as soon as possible. Alternative 1 will achieve this sooner than Alternative 3 while Alternative 2 takes the longest time.

Worker Health and Safety

The prime worker health and safety concern is the decommissioning of WR-1. Alternative 3 allows sufficient time for radioactive decay to occur for the safe handling of radioactive material. Alternative 1 subjects workers to much higher radiation fields. Alternative 2 results in slightly lower radiation fields than Alternative 3 in decommissioning WR-1, but contributes additional radioactivity dose through the refurbishment of facilities and the relocation of wastes to interim storage to manage the project over such a long period.

Public Health

The operation of Whiteshell Laboratories has had no measurable effect on public health. Clearly the longer radioactive decay is allowed, the lower will be the risk of an accident when handling high level waste. Thus although small, Alternative 1 has the potential for creating more significant public health effects because of the risk associated with the early off-site transportation of more highly radioactive wastes. Alternatives 2 and 3 benefit from additional radioactive decay and do not result in the same concerns over off-site transportation.

Physical and Cultural Heritage; Land and Resource Use; Archaeology; and Aboriginal Interests

The effects from all Alternatives would be essentially the same.

3.4.2 Comparison of Alternatives

The Canadian Environmental Assessment Agency (1998) describes four criteria for comparing alternatives: economic feasibility, technical feasibility, public concerns and environmental effects. Table 3.2 provides a preliminary comparison of the alternatives using the first three of these criteria. Based on the environmental effects analysis described above, the fourth criteria can now be added as presented in Table 3.4.

Table 3.4
Comparison of Alternatives

Criteria / Alternatives	Economic Feasibility [1]	Technical Feasibility [1]	Public Concerns [1]	Environmental Effects
Alternative 1 **End-State in a Short Time Period**	Poor	No	Low	Beneficial Best on socio-economics, highest risk to worker health and safety
Alternative 2 **End-State in a Long Time Period**	Moderate	Yes	High	Beneficial Worst on socio-economics
Alternative 3 **End-State in a Moderate Time Period**	Good	Yes	High	Beneficial Best on worker health and safety

(1) More details are given in Table 3.2

All three alternatives were found to benefit the environment since the property is decommissioned to a clean condition compared to its current state.

Environmental effects from each alternative are expected to be similar with the exception of higher risk to Worker Health and Safety for Alternative 1 than for Alternatives 2 and 3.

Of the three alternatives, Alternative 3 is the preferred option. Alternative 1 was dismissed because of the poor economic feasibility and the higher risk to worker health and safety. Alternative 3 was preferred over Alternative 2 because of:

- Socio-economics – The public would like to see the site released as soon as possible making Alternative 3 preferable over Alternative 2.
- Economic feasibility – Decommissioning costs for Alternative 3 are expected to be lower than for Alternative 2.

3.5 DECOMMISSIONING ALTERNATIVES WITHIN THE PREFERRED TIME PERIOD

Within the preferred option, Alternative 3, it is recognized that various strategies, approaches and technologies will be available to achieve the end-state. It is expected that an optimization exercise will be conducted for each facility and the results will form the basis for the individual detailed decommissioning plans. Because of the technical developments that will be achieved over the lifetime of the project, it is not possible to speculate on what new processes or techniques will be available to those implementing the decommissioning plans. When the detailed decommissioning plans are developed in the future, the regulator will be able to verify that the optimization process took place and that the applicable standards will be met.

That said, there exist two fundamental alternatives that apply to project components or facilities. One such option is complete removal. It applies to most of the facilities at Whiteshell Laboratories. When complete removal is achieved, the land will become available to other uses.

However, for some other components or facilities, the advantages of complete removal are not easily demonstrated. For those components, in-situ management is an option that warrants consideration. Therefore, a decision has to be made on whether a facility or component can be managed in-situ or if it merits full removal. A number of criteria need to be established to make that decision. These may include:

- Nature and level of contaminants still present.
- Exposure pathways (workers and public).
- Potential environmental effects.
- Technical feasibility of remediation.
- Economic feasibility of remediation.
- Level of public concern.

The two areas involving possible in-situ disposal include the river sediments downstream of the outfall and the low-level radioactive waste (LLW) trenches at the Waste Management Area. The option for permanent disposal is discussed in 4.3.1 and will be subject to regulatory review and approval. Descriptions of the river sediments and of the Waste Management Area are provided in Sections 4.3.3 and 4.3.1 respectively.

During the assessment, it was established that additional fieldwork was necessary to gain enough information to make that decision.

The investigation work for the river sediments is provided in Appendix B and sediment quality data is provided in Section 5.4.7. Appendix C contains the information on the LLW trenches investigation. Key information on the groundwater flow regime in the vicinity of the WMA is provided in Section 5.4.4.

The results of the assessment for those two components are summarized in Section 6.3. It was demonstrated that safe in-situ abandonment of the sediments is feasible. Safe in-situ management of the Waste Management Area is considered feasible. However, as mentioned above, the final safety case for in-situ disposal of WMA waste must be prepared to support the final decision on in-situ disposal.

Table 3.5 provides an overview of factors considered in deciding whether to manage the LLW trench contaminants in-situ or to fully remove them.

Table 3.5
Comparison of Alternative Methods

Criteria	River Sediments	LLW Trenches
Contamination	1.3 GBq in a small area immediately downstream of outfall	Limited to trench area. No evidence of upward or lateral migration
Technical feasibility of removal	Feasible	Feasible
Economical feasibility	Feasible	Prohibitive cost associated with retrieval, interim storage facilities and final disposal of site.
Main environmental impacts – In-situ	Insignificant	Not significant due to low inventory, favorable groundwater flow regime and controls
Main environmental impacts – Removal	Re-suspension of contaminants. Need for site to store dredgate.	Doses to workers, interim storage facility and transport to off-site disposal.
Public Concern	Protection of water quality and fish resources is important	Complete removal preferred

Based on the available information, AECL selected in-situ abandonment of the river sediments. There is currently a very small area of contamination immediately downstream of the outfall and the inventory in the sediments is quite small (1.3 GBq). Given that the estimated doses to humans and non-human biota is extremely low, remediation poses a greater risk through re-suspension of the contaminated sediments and cannot be justified.

AECL also believes that the LLW currently stored in the waste management area can be managed in-situ and that this approach represent no significant risk to workers or members of the public. This conclusion is based on the relatively small contaminant inventory, a favorable groundwater flow regime and the absence of pathways that could lead to significant exposure to hazardous levels of contaminants. There is no merit in recovering the LLW and moving it to another storage facility. The removal would unnecessarily expose workers handling the waste. The waste management area will continue to be monitored closely for any change in the current conditions.

4.0 PROJECT DESCRIPTION

4.1 INTRODUCTION AND OVERVIEW

The Whiteshell Laboratories is a nuclear research facility located approximately 100 km northeast of Winnipeg near Pinawa, Manitoba. The site occupies approximately 4375 ha of land owned by AECL, adjacent to the Winnipeg River. Whiteshell Laboratories consists of ten major buildings and a number of smaller support facilities. The Waste Management Area (WMA), the Concrete Canister Storage Facilities (CCSF) and the Large Scale Vented Combustion Test Facility (LSVCTF) are located approximately 1 km northeast of the main laboratory site. The main laboratory site layout is shown schematically in Figure 4.1.

4.1.1 History

The Whiteshell Laboratories site was established by AECL to carry out research and development of higher temperature versions of the CANDU reactor during the early 1960s. The site originally included Whiteshell Reactor-1 (WR-1) an Organic Cooled Reactor (OCR), which was brought on-line in 1965. The OCR program was eliminated in the early 1970s to focus on the heavy water-cooled CANDU reactor system. Development of programs including the Nuclear Fuel Waste Management Program, SLOWPOKE Demonstration Reactor, CANDU Reactor Safety research projects and accelerator projects maintained Whiteshell Laboratories as a diverse centre for research. Many other support facilities were required over the years to support the research programs. These included the WMA, CCSF and Active Liquid Waste Treatment Centre (ALWTC) in 1963, Hot Cell Facilities (HCF) in 1965, the Immobilized Fuel Test Facility (IFTF) in 1984, the Van de Graaff Accelerator in 1970 (upgraded in 1979) and the Neutron Generator Facility in 1975.

AECL decided to discontinue research programs at Whiteshell Laboratories as a result of the federal program review process that significantly reduced funding to nuclear research. The federal government examined various alternatives for the site and recommended privatization. Subsequent attempts to attract a private owner to take over the facility were unsuccessful. Subsequently, AECL made the business decision in 1998 to close Whiteshell Laboratories and to decommission the facilities to meet regulatory requirements. Certain operations at the site are presently in various stages of operational shutdown. Experimental work except for processing of active liquid wastes (TFRE/Amine) was concluded in the Shielded Facilities (SF) Cleanup and removal of research equipment has also been completed. Both the Neutron Generator Facility and the Van de Graaff Accelerator have been shutdown and detailed decommissioning plans have been prepared. The WR-1 reactor was permanently shutdown in 1985 and Phase 1 decommissioning, which started in 1989, was completed in 1995. This shutdown involved removal of sources and readily-removable radioactive materials, such as irradiated reactor fuel, from the facility and loose contamination from the main floor (600 level) and first sub-level (500 level) space. The completion of Phase 1 prepared WR-1 for a long deferment period during which radioactivity levels will be reduced significantly through natural decay prior to implementing further decommissioning work. At present, WR-1 is under a monitoring and surveillance program.

4.1.2 Project Components

To define the scope of the Whiteshell Laboratories Decommissioning Project, the site has been segregated into affected and unaffected lands. The affected lands are defined as the lands where nuclear development, operations or supporting activities are conducted and also includes land potentially affected by such activities. The unaffected lands are the balance of the site which have not been associated with AECL nuclear operations, and are not linked to or required for the decommissioning project.

The Whiteshell Laboratories decommissioning program encompasses all of the site facilities, buildings and land within the affected lands. Project components were identified from an examination of the Whiteshell Laboratories Detailed Decommissioning Plan, discussions with decommissioning project staff, and review of Whiteshell Laboratories' reports. Project components were finalized at a workshop in August 1999 attended by AECL and consultant team representatives, and were determined to be as outlined in Table 4.1.

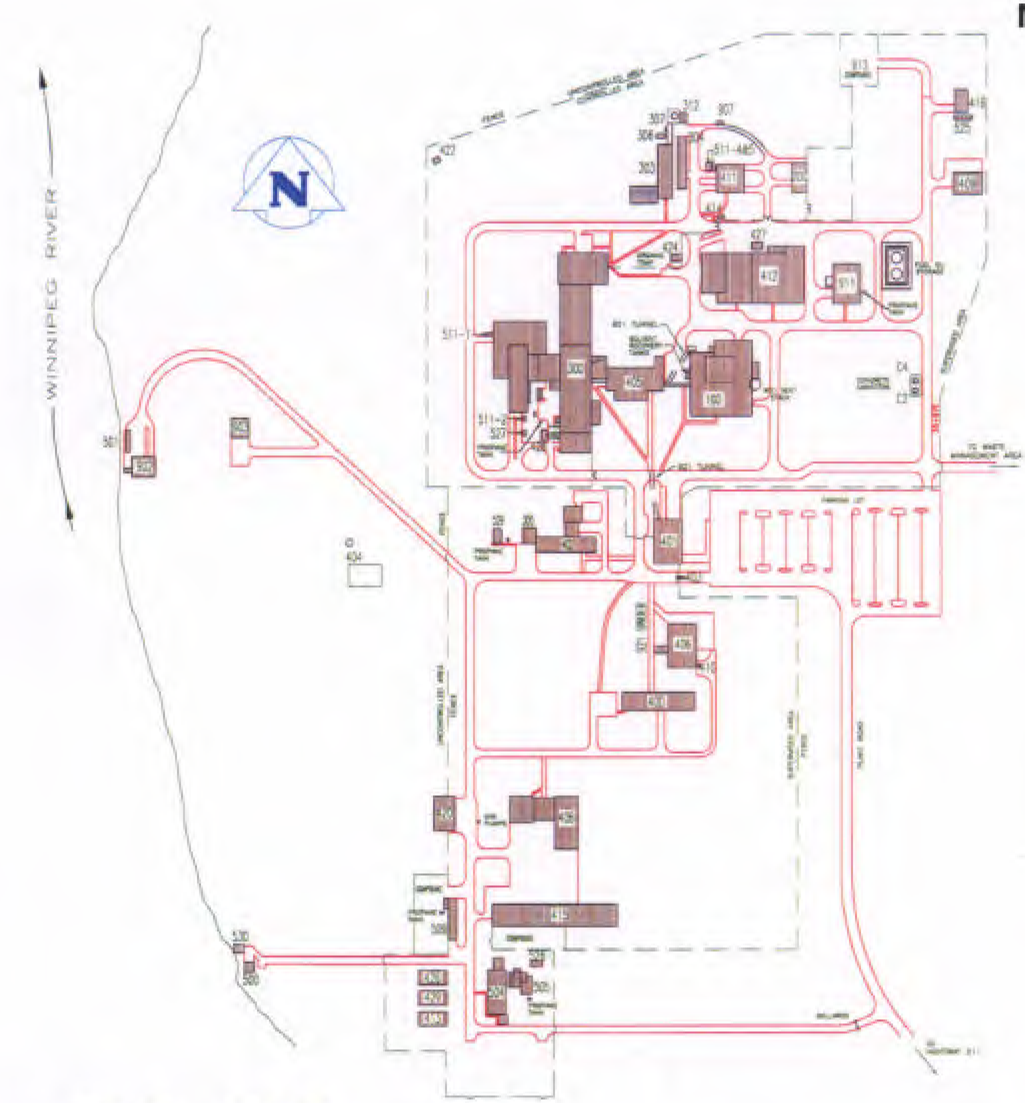
Table 4.1
Project Components

Nuclear Facilities	Radioisotope Facilities	General Infrastructure
Shielded Facilities Van de Graaff Accelerator Neutron Generator Active Liquid Waste Treatment Centre Whiteshell Reactor -1 Concrete Canister Storage Facility Waste Management Area	B300 Decontamination Centre B402	Non-nuclear Buildings Landfill Sewage Lagoon Buried Services Contaminated Lands ("Affected Lands") Off-site Contamination including River Sediments

Project activities for each of the project components were identified for the three phases of the decommissioning project at the workshop in August 1999. Subsequently, project component activities were documented for Alternative 3, the Preferred Alternative, by Whiteshell Laboratories decommissioning program staff. The source documents are Whiteshell Laboratories Detailed Decommissioning Plan Volume 1: Program Overview (Helbrecht 1999) and The Whiteshell Laboratories Decommissioning Project Descriptions for the Comprehensive Study Report (Ridgway 1999).

FIGURE 4.1

MAIN LABORATORY SITE LAYOUT



WHITESHELL LABORATORIES
LIST OF BUILDINGS

100	REACTOR OPERATIONS
200	ACTIVE LIQUID TREATMENT
300	RESEARCH AND DEVELOPMENT
303	GAS DYNAMICS RESEARCH LABORATORIES
304	GAS DYNAMICS RESEARCH LABORATORIES
305	ACCELERATOR APPLICATIONS RESEARCH FACILITY
306	GAS DYNAMICS EQUIPMENT STORAGE
307	DIFFUSION FLAME FACILITY
312	STEAM GENERATOR STORAGE
400	ENGINEERING AND ADMINISTRATION
401	SECURITY AND RECEPTION
402	HEALTH AND SAFETY
403	VEHICLE GATE HOUSE
404	METEOROLOGICAL TOWER
405	TECHNICAL INFORMATION CENTRE
406	CAFETERIA
408	MATERIAL HANDLING
409	ACTIVE AREA STORES
411	DECONTAMINATION CENTRE
412	MACHINE SHOP AND MAINTENANCE
413	WASTE CHEMICAL STORAGE
414	CONTROLLED AREA 2 ENTRANCE
415	MATERIAL WAREHOUSE
416	STORAGE
420	MOBILE EQUIPMENT STORAGE
422	OUTFALL MONITORING STATION
424	WR-1 ORGANIC MONITOR BUILDING
426	CIVIL STORAGE #1
427	MECHANICAL SHOP STORAGE #1
428	MECHANICAL SHOP STORAGE #2
429	CIVIL STORAGE #2
500	INTERNAL FRICTION LABORATORY
501	AQUATIC TOXICOLOGY LABORATORY
504	ENGINEERING DEVELOPMENT AND TEST
505	SOILS RESEARCH LABORATORY
509	CIVIL UTILITY BUILDING
511-1	ACTIVE WASTE STORAGE #1 (Bldg. 100)
511-2	ACTIVE WASTE STORAGE #2 (Shield Facility)
511-3	ACTIVE WASTE STORAGE #3 (Bldg. 300)
511-4	ACTIVE WASTE STORAGE #4 (Bldg. 411)
511-5	ACTIVE WASTE STORAGE #5 (Bldg. 411)
525	METEOROLOGY TRAILER #2
526	BOREHOLE INSTRUMENTATION TEST FACILITY
527	INFLAMABLE LIQUID STORAGE BUILDING
529	EXERCISE FACILITY
530	INTERNAL FRICTION LABORATORY ANNEX 500
902	PUMPHOUSE
903	WATER FILTRATION PLANT
907	SEWAGE LIFT STATION AND LAGOONS
911	POWER HOUSE
913	MAIN SUBSTATION
921	PEDESTRIAN LINKS BETWEEN BUILDINGS

100 50 0 50 100m

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

4.2 DECOMMISSIONING PROJECT

4.2.1 Decommissioning Strategy

Plans are being developed to transform Whiteshell Laboratories safely and effectively from an operational state to a shutdown and decommissioned state. The shutdown and decommissioning of Whiteshell Laboratories address business objectives, and operational and decommissioning constraints as follows.

Business Objectives

- Ensure an orderly consolidation of remaining CANDU programs so as not to jeopardize CANDU business.
- Continue to fulfil management responsibilities for the Nuclear Fuel Waste Management Program until privatization or termination of the program occurs.
- Minimize the operational costs for Whiteshell Laboratories by aligning site operational activities with the level of activity in the remaining programs.
- Fulfil management responsibilities for the decommissioning program and provide operational support to the decommissioning program.

Operational Constraints

- AECL's Reactor Safety Research Program will continue to operate at Whiteshell Laboratories until December 2003 and will require continued operations in three active area buildings.
- The Nuclear Fuel Waste Management Program will continue to operate out of Whiteshell Laboratories and/or the Underground Research Laboratory until an as yet undefined date and will require continued operations in one active area facility (B300).
- The Whiteshell Laboratories Waste Management Area will need to continue as an operational facility for the initial decommissioning work to support continuing AECL programs and decommissioning of buildings no longer required by AECL.
- AECL assets not required for continuing CANDU programs will be made available for commercialization purposes.

Decommissioning Constraint

- Currently there is no nuclear waste disposal facility in Canada, thus limiting the decommissioning activities to achieving and maintaining a secure monitoring and surveillance state for the nuclear facilities until such a facility is available.

4.2.2 Overview of the Decommissioning Program

The decommissioning program proposed for Alternative 3, AECL's preferred alternative for Whiteshell Laboratories, is described in the document by Helbrecht (1999) and is part of a series of planning actions now in progress. With the exception of radioisotope facilities that will have shutdown plans, there is, or will be, a separate detailed decommissioning plan for each major component or facility. The detailed decommissioning plans will meet the requirements of the Canadian Nuclear Safety Commission's *Decommissioning Planning for Licensed Activities* (CNSC 2000a). A generic outline of a Detailed Decommissioning Plan (DDP) is provided in Table 4.2.

Table 4.2
Elements of a Detailed Decommissioning Plan

Brief description of the components and structure to be decommissioned
History of operation
Statement of the final end-state objectives
Description of specific requirements for institutional control
Result of radiological and hazardous chemical survey
Overview of decommissioning strategy
Description of each work package
Schedule
Description of waste management plan
Assessment of potential environmental effects (this document)
Conservative cost estimate
Description of public consultation (included in this document)
Description of project management structure
Quality Assurance plan
Emergency response plan
Site security program
Radiation protection program
Environmental protection and monitoring program
Personnel training program
Human factors program
Summary of health and safety issues and plan to address them
Listing of governmental agencies involved in the decommissioning program
Listing of operational and decommissioning record

It is fully expected that the level of detail to be included in the DDP will reflect the characteristics of the facility to be decommissioned. The DDP will also provide a mechanism to address uncertainties where decommissioning is deferred well into the future.

The proposed Whiteshell Laboratories decommissioning program will be implemented through a phased approach preceded by operational shutdown work. Actual decommissioning cannot proceed until the Comprehensive Study Report (CSR) is approved. The operational shutdown work which can be conducted in parallel with the preparation of the CSR will require a period of approximately 15 months. Preparatory work for the initial phase of decommissioning will be completed as follows:

- prepare and submit facility-detailed decommissioning plans for approval;
- secure transfer of the listed facilities addressed in Phase 1 to a site licence structure recognizing the decommissioning on acceptance of the CSR and approval of detailed decommissioning plans; and

- establish the licensing requirements for the remainder of site facilities.

Shutdown operations for the research facilities at Whiteshell Laboratories are in progress and occur in parallel with decommissioning planning. Operational shutdown work for the ALWTC and the Decontamination Centre will commence following shutdown of those facilities.

There is a logical series of steps needed to decommission a nuclear, radioisotope, or general infrastructure facility. Decommissioning work includes the following activities:

- assessing and characterizing hazards;
- decontaminating/remediating contaminants;
- packaging/dispositioning of waste (radiological, industrial, chemical and clean);
- surveying to document interim end-state or final surveying for unrestricted use;
- monitoring and surveillance during a deferment period;
- dispositioning of structures (i.e. for demolition or reuse); and
- surveying, characterizing and monitoring at the final end-state.

Some of the steps outlined above may be skipped or duplicated, depending on the facility. As an example of skipping a step, final decommissioning of the Neutron Generator and the Van de Graaff Accelerator will be carried out shortly after the conclusion of this environmental assessment and issuance of a decommissioning licence by the CNSC. There will be no need for documentation of an interim end state or for monitoring and surveillance because the final end-state is achieved in Phase 1.

Conversely, there may be the need to repeat decontamination steps in some radioisotope facilities. Decontamination and remediation of contaminants will be carried out shortly after assessment of hazards. Later on, duct work and active drain lines will be disconnected and capped. During this process, pieces of duct work and drain lines will be removed, potentially causing recontamination. Therefore, additional decontamination work may be needed.

Phased Approach

The decommissioning project proposes a phased approach over a sixty-year time period. Within each phase, and, therefore, over the entire program, the decommissioning activities are of a discontinuous nature (i.e. flow from the ALWTC will not be continuous, air emissions from decontamination and demolition activities will be intermittent and there are considerable periods of monitoring and surveillance).

Decommissioning is planned in three phases followed by an institutional control period:

Phase 1 – Activities will be directed toward nuclear and radioisotope buildings and facilities to place them in a safe, secure interim end state. The Van de Graaff Accelerator and the Neutron Generator will be completely decommissioned (approximately 5 years).

Phase 2 – Regular monitoring and surveillance of all buildings and facilities. Most of project activity is focussed on the WMA. Most waste management facilities will be placed in a passive operational state meaning that no further waste can be added but facility monitoring is maintained. Interim processing, handling and storage facilities, required during monitoring and surveillance and decommissioning project activities, will be established (approximately 10 years).

Phase 3 – Activities directed to bringing the site to a final end state will fulfil all pertinent regulatory and national policy requirements. The timing and sequence of decommissioning activities will be determined largely by the availability of disposal facilities and by the age and condition of engineered structures and buildings (approximately 45 years).

Institutional Control Period – The three phases of decommissioning activities will be followed by a period of institutional control where the performance of the remaining in-situ disposal components (low-level waste trenches) is monitored and controlled. The institutional control activities are designed to demonstrate that the in-situ components perform in the manner predicted in the related safety assessments and to ensure that there is no development or intrusion into affected areas until the hazards have been reduced to acceptable levels. For Whiteshell Laboratories this period is expected to extend for approximately 200 years beyond the physical project work.

Contingency Long-Term Waste Storage

The decommissioning program described above is based on an assumption that Canadian nuclear waste disposal facilities will be available for low-level waste by 2025 and for high-level waste by 2050. Given the uncertainty of when those facilities will actually be available, the decommissioning program includes contingency provisions for longer-term waste storage on the site and/or at other interim locations until the permanent disposal facilities are available. Any such interim waste storage facilities will be designed, constructed, operated and monitored using proven technologies for protecting people and the environment. All long-term storage facilities will remain under CNSC licensing controls for as long as is necessary to protect people and the environment.

4.3 DESCRIPTION OF FACILITIES

The following sections provide descriptions of the project components listed in Table 4.1, as well as a brief discussion of the decommissioning approach for each component. Details regarding decommissioning activities for each of the three phases for each component are provided in Helbrecht (1999) and Ridgway (1999).

4.3.1 Nuclear Facilities

The decommissioning approach is similar for nuclear facilities and radioisotope facilities, and has been summarized below. A description of each project component under the category of "Nuclear Facilities" follows.

In Phase 1, nuclear facilities and radioisotope facilities, with the exception of the waste management facilities and part of the ALWTC, will be placed in a safe, secure interim end state. Decommissioning operations will ultimately be conducted from the B100 supervised area. Heating, ventilation and air conditioning of this facility will remain at the current level and will be reduced in all remaining buildings and facilities. By the end of Phase 1, all of the remaining buildings will have been prepared for monitoring and surveillance. Phase 1 decommissioning activities will be completed and the buildings will be shutdown. All buildings and facilities will be advanced to an interim end state. The laboratory site nuclear and radioisotope facilities will be administered under a decommissioning licence structure.

In Phase 2, there will be regular monitoring and surveillance of all buildings and facilities. Most of the project activity will be focused on the WMA. This work will include decommissioning the incinerator, relocating irradiated fuel waste from standpipes and high-level waste from trench 6 and placing most of the WMA bunkers and buildings in a monitoring and surveillance state. A new facility will be constructed to accommodate radioactive solid waste arising from TFRE/Amine waste processing and decommissioning operations in Phase 2 and Phase 3. By the end of this phase, there will only be a small operating area for processing packaging and storage of waste. This work is scheduled to be completed in about 10 years. However, part of the ALWTC aqueous waste processing facility will be retained until the end of Phase 3.

In Phase 3, the site will be brought to a final end state. This will occur over a time frame of approximately 45 years. Work will begin in the WMA, then continue in the nuclear and radioisotope facilities and for the Active Drainage system. The Building Decontamination Centre will be relocated to B100 and interim domestic sewage facilities will be installed to replace the sewage lagoon. The Shielded Facility, WR-1, and the CCSF will be the last to be decommissioned. Some low-level waste in the WMA will be disposed of in-situ. There will be the need for a period of institutional control for the WMA.

Shielded Facilities

a) Description

The Shielded Facilities (SF) includes the Hot Cell Facility (HCF) and the Immobilized Fuel Test Facility (IFTF), both of which form the west extension of the Research and Development Building (B300).

The HCF began operation in 1965, and was used to provide shielded, remote handling facilities in support of the CANDU reactor safety research programs including post-irradiation examination of fuels and reactor core components, post-experimental examination of radioactive materials used in waste management studies and services for other AECL programs or industrial work involving radioactive materials.

The HCF is a single-storey structure with a main floor area of about 1200 m^2 and a ceiling height of 9.5 m. A 1-2 m deep crawl space is located beneath the main floor Operating Area and a full basement is located beneath the balance of the HCF.

The main floor of the HCF consists of the Cells, the Decontamination Area, the Horizontal and Vertical Storage Blocks, the Manipulator Decontamination and Repair Facility, the Operating Area, a Scanning Microscope facility, a workshop, a photographic laboratory, office areas, hallway, a change room and a shipping room. The Cells consist of 11 steel-lined, ilmenite-concrete shielded cells (Cells 1-11) and one steel-lined lead-shielded cell (Cell 12). All cells are equipped with remote manipulators and lead-glass shielding windows.

The IFTF began operation in 1984 and was used to provide space and facilities for a wide range of experiments using radioactive materials in support of the Canadian Nuclear Fuel Waste Management and CANDU Reactor Safety research programs.

The IFTF is a building extension located at the northwest corner of the HCF. It is a single-storey structure and has a main floor area of about 1300 m^2, with a high-ceiling area 9.5 m high and a low-ceiling area 3.5 m high. A 3 m deep crawlspace is located beneath the high-ceiling area and a full basement is located beneath the low-ceiling area.

The main floor of the IFTF consists of six Cells, the Decontamination Vestibule, the Operating Area, the Canister Storage Area, the Mock-Up and Mechanical Maintenance Area, five laboratories, change rooms and several offices.

b) Decommissioning Approach

Operational Shutdown

Experimental work has been terminated in both facilities and operational cleanup of Cells and work areas to remove research program equipment, materials and wastes is in progress as part of operational shutdown. The operational shutdown work also focuses initially on the processing of two active-liquid waste volumes stored at the site. 270 L of Thorium Fuel Reprocessing Experiment (TFRE) waste, stored in a tank in the HCF and 180 L of Amine Experiment waste (Amine), stored at the WMA will be processed to a solid waste form for interim storage at Whiteshell Laboratories. This work will emphasize identification, design, construction and operation of a processing facility in the HCF to solidify these wastes in an acceptable form for interim storage. The work includes the transfer of the amine wastes to the HCF. Processing of these wastes requires the continued operation of the HCF remote handling and safety systems (Cells 1, 2 and 3) identical to the requirements during the routine operating period. Therefore, this work is planned to be conducted under the existing Facility Authorization under SF operating licence. However, some decommissioning work activities, in other areas of the SF, may be implemented in parallel with the waste processing.

Decommissioning

Phase 1 decommissioning work will address decontamination and/or fixation of contamination, sealing of the shielded cells and operating areas. Minimum building heating and ventilation, to maintain building structural integrity meeting safety needs, will be established and the facility will be placed in a monitoring and surveillance state.

The SF will remain under monitoring and surveillance throughout Phase 2 and well into Phase 3. Final decommissioning to achieve a cleanup level suitable for releasing the facility from regulatory control will commence in about 2040.

Van de Graaff Accelerator

a) Description

The Van de Graaff Accelerator operated from 1970 to 1997, initially in the electron-beam mode and following an upgrade in 1979 exclusively in a proton continuous-beam mode. The facility is contained in four laboratories in B300 with the accelerator in two rooms separate from the target room and the control room. The facility occupies approximately 170 m^2 of space.

b) Decommissioning Approach

The facility is permanently shutdown and a Detailed Decommissioning Plan has been prepared. A scoping survey of the facility indicates very low radiation fields. No radioactive contamination is indicated in the accelerator work areas.

The equipment in this facility will be fully decommissioned in Phase 1. Decommissioning includes dismantling and removal of the system components and the associated support systems. All that will remain at the end of Phase 1 are the bare walls. Rooms will be decontaminated and released for monitoring and surveillance. In Phase 2, monitoring and surveillance work will be integrated with monitoring and surveillance operations for B300.

Subsequent demolition of the space occupied by these facilities will be part of B300 Final Demolition Plan.

Neutron Generator

a) Description

The 14 MeV Neutron Generator Facility is located in the Research and Development Complex (B300) rooms B-152/153. The facility was built in 1975 and was used in the development of methods for the assay of fissile and fertile materials in reactor fuels and components. Usage eventually shifted to fast neutron activation analysis.

The facility shutdown in 1988 and a Detailed Decommissioning Plan has been prepared. The tritium target was replaced with a blank target and all vacuum pumps were shutdown.

b) Decommissioning Approach

The equipment comprising this facility will be fully decommissioned in Phase 1. Decommissioning includes dismantling and removal of the system components and the associated support systems. All that will remain at the end of Phase 1 are the bare walls. Rooms will be decontaminated and released for monitoring and surveillance. In Phase 2, monitoring and surveillance work will be integrated with monitoring and surveillance operations that are planned to be carried out in the SF.

Subsequent demolition of the space occupied by these facilities will be part of the SF Final Decommissioning Plans.

Active Liquid Waste Treatment Centre

a) Description

The ALWTC, which is located in B200, began operation in 1963, receiving low-level liquid waste effluent from operating nuclear facilities (WR-1, SF, B300 Research Laboratories, Laundry/ Decontamination). The liquid effluents are transferred via underground piping connecting existing facilities to the ALWTC.

The ALWTC includes a medium-level liquid waste processing system which concentrates the waste stream originating from the SF. The resulting concentrate is solidified and stored at the WMA.

The ALWTC is a two-storey building, with external dimensions of 24.7 m by 12.8 m and a height of 7.6 m. Exterior walls from grade to 3.0 m above grade are constructed of 0.30 m thick reinforced concrete on the inside, followed by 25 mm of rigid insulation and 0.10 m thick brick facing. A thicker wall (0.46 m reinforced concrete) is used in Room 1-07. The upper part of the building is similar except that 0.20 m thick hollow concrete blocks are used rather than reinforced concrete. Two-storey shielded process cells run along both sides of the ground-floor pump gallery and second-floor operating gallery. The process cells contain holding tanks which are provided to store liquid wastes as follows:

Room 1-04	Laundry Tanks Cell
Room 1-05	Decontamination Tanks Cell
Room 1-07	Evaporator Cell
Room 1-08	B300 Tanks Cell
Room 1-09	B100 Tanks Cell

The evaporator cell (Room 1-07) and the adjacent areas of the building house the medium-level waste concentration and solidification system.

The decommissioning of the aqueous waste collection system connecting WR-1, B300 and the Decontamination Centre to the ALWTC is addressed as part of that plan. The in-ground collection system is a double containment system consisting of small diameter polyethylene piping inside a larger diameter polyurethane pipe. The system is equipped with leakage detection wells.

b) Decommissioning Approach

For the first part of Phase 1, the ALWTC will remain fully operational. By the end of Phase 1, most of the facility will be decommissioned to an interim end state. The process systems required for managing the reduced amount of aqueous Low-Level Waste from building sumps and small amounts of aqueous Medium-Level Waste generated from monitoring and surveillance and site decommissioning operations will be retained in an operational state beyond Phase 1 as follows:

- seven existing waste collection tanks will be consolidated into two tanks to collect building sump wastes during the monitoring and surveillance period; and
- a replacement waste concentration system will be designed and constructed to process medium level aqueous waste arising from WMA waste processing operations (e.g. standpipe waste retrieval). The existing method of treatment using an evaporator is worker radiation dose intensive and was eliminated as an option.

Phase 1 decommissioning of the unused portion of the ALWTC will include sealing active systems and active drainage. For example, drainage and ventilation systems will be removed or modified. Any systems remaining in place, which are not being used, will be capped off. Rooms will be decontaminated, hazards assessed and remediation applied where needed. In some areas contamination may be sealed/fixed in place until the final decommissioning in Phase 3. Radiological surveying will be carried out to document the facility condition for the interim end state.

In Phase 2, the unused portion of the ALWTC will remain in a monitoring and surveillance state. Liquid waste processing operations will be continued in a portion of the building. The design and operation of the remaining facility will be controlled to ensure the impact of operation is well within regulatory requirements.

The ALWTC will be decommissioned to an unrestricted use level in Phase 3. However, the decommissioning will not be completed until all decommissioning work is done for WR-1 and the WMA.

Whiteshell Reactor 1

a) Description

The WR-1 reactor was placed in service in 1965 to demonstrate the organic-cooled reactor concept using heavy water as the moderator. The system also provided a facility for engineering tests on alternative fuels, fuel channels and reactor coolants.

WR-1 operated from 1965 to 1985, accumulating 120,000 operating hours during its lifetime. The reactor was permanently shutdown in 1985 and placed in a secure shutdown state in preparation for decommissioning. The shutdown activities included defueling the reactor, placing the irradiated fuel in the storage bays and removing bulk heavy water to storage. Bulk organic coolant was removed from the reactor cooling circuits and transferred to the WMA for incineration. Reactor control systems were isolated. All building services required for decommissioning were maintained in an operating mode.

b) Decommissioning Approach

The initial decommissioning work for WR-1 commenced in 1989 and was completed in 1995. This work addressed the removal of easily mobilized radioactivity (fuel, fluids, etc.) from the facility and decontamination of the main floor (600 level) and first sub-level (500 level) space with potential for reuse by Whiteshell Laboratories. Phase 1 work substantially decreased potential hazards from the facility and reduced the monitoring and surveillance requirements for the deferment period. The Phase 1 end state prepared WR-1 for a deferment period during which significant radioactivity decay will reduce the postulated dose commitment associated with future decommissioning work.

- WR-1 will remain under monitoring and surveillance throughout Phases 1 and 2. Final decommissioning will be implemented as part of Phase 3 in about 2050.

The approach for WR-1 is to fully remove and package all activated and contaminated components for disposal in offsite facilities, to decontaminate the facility structure and then to demolish the building to achieve unrestricted release criteria. The dismantling and remediation activities include:

- removal of reactor vault components;
- removal of process piping and equipment;
- transfer of radioactive waste to off-site facilities;
- decontamination of building structure;
- demolition of the building structure; and
- remediation of the site to a “natural” state.

Concrete Canister Storage Facility

a) Description

The Concrete Canister Fuel Storage Program was developed at Whiteshell Laboratories to demonstrate that dry storage is a feasible alternative to water pool storage for irradiated reactor fuel. Because of the success of the demonstration program, concrete canisters have been used to store all remaining WR-1 used fuel. The CCSF is composed of two storage areas: (1) the main canister site adjacent to the WMA; and (2) the demonstration canister site within the site laboratory area.

The main canister site is located on a prepared site about 1000 m to the northeast of the plant site. The site was excavated to a depth 0.6 m and then backfilled with gravel to the original elevation. The centre-to-centre canister spacing is 7.5 m within a row and the canister rows are 9 m centre-to-centre apart. Each canister is located on a pad of reinforced concrete 3.66 m square and 0.2 m thick.

The main canister site is surrounded by a heavy duty galvanized chain link fence 2.5 m high, with three strands of barbed wire on top. Locked gates restrict access to the canisters. Control B425, located within the CCSF, houses the necessary instrumentation, electrical, monitoring, sampling and alarm equipment for the canisters.

The demonstration canister site is located within the present Whiteshell Laboratories site active area approximately 140 m east of B100 and 85 m southeast of the central powerhouse. There are two canisters, located in a north - south row immediately adjacent to an existing access road running along the east boundary of the plant active area. The demonstration canister site is surrounded by a 2.4 m fence topped with three strands of barbed wire. The canisters are placed on 3.048 m square reinforced concrete pads, 0.2 m thick. These pads rest on 46 cm of compacted granular fill (replacing the excavated topsoil) over undisturbed native soil. Fuel from these canisters has already been transferred into the main canister facility and both demonstration canisters are empty.

b) Decommissioning Approach

The CCSF will remain in operation throughout Phase 1 under the current facility authorization.

In Phase 2 the continuing operational requirements will be assessed and the CCSF will be placed in a passive operational state. The design life of the canisters will be confirmed as part of the Phase 2 assessments.

Monitoring and surveillance will be carried out during most of Phase 3. Once a disposal facility has been established for the fuel inventory, the fuel will be transferred (planned for 2050). All canisters then will be decontaminated and demolished. The canister rubble will be disposed of or recycled and the CCSF sites will be rehabilitated to unrestricted release.

Waste Management Area

a) Description

The WMA is located approximately 1 km northeast of the Whiteshell Laboratories site. The area is approximately 148 m by 312 m. The WMA has been in operation since 1963, providing storage for low- and medium-level radioactive wastes. Other materials also stored here include irradiated fuel waste placed in standpipes, high level wastes in trench no. 6, high level liquid waste in a dedicated storage tank and hazardous chemicals in bunker no. 4.

The WMA is surrounded by a 2.5 m-high wire mesh fence. Personnel access is through B423, and road access is through a normally locked gate west of B423.

The following facilities are located within the WMA:

1. the main access building, (B423);
2. the organic incinerator (B514);
3. the organic drum storage building (B430);
4. the LLW processing building (B421);
5. the LLW storage bunkers (LLW #1,2,3,4);
6. LLW storage buildings (B431, B432, B433);
7. LLW unlined earth trenches (#1-23);
8. MLW in-ground concrete bunkers (101-01 to 20);
9. MLW storage bunkers (ILW #6,7);
10. HLW/MLW in-ground concrete standpipes; and
11. Amine storage tanks (B417).

The location of these facilities is illustrated schematically in Figure 4.2.

FIGURE 4.2

WASTE MANAGEMENT AREA LAYOUT SCHEMATIC

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

b) Decommissioning Approach

The WMA will remain fully operational during Phase 1. Surveying/assessment will be carried out in the latter part of this phase. This work will be used to characterize the waste inventory and determine if there are any associated contaminant plumes.

In-situ disposal is proposed to manage low-level wastes stored in earthen clay trenches in the WMA. The case for in-situ disposal is presented in Appendix C.

Phase 1 work will include the design and implementation of an enhanced hydrogeological and environmental monitoring program to collect additional site data to support a final decision on in-situ disposal. Throughout Phase 1, 2 and much of Phase 3 the wastes will continue to be managed under CNSC licensing conditions which provide an audit and review mechanism to ensure that any additional monitoring or environmental assessment required to support a final decision is conducted.

Phase 1 activities are:

- Acceptance of low-, medium- and high-level radioactive waste generated from decontamination of the site research facilities (e.g. Shielded facility, B300). Waste includes:
    - solidified TFRE/Amine active liquid waste;
    - decontamination waste;
    - contaminated laboratory equipment; and
    - contaminated building service system components.
- Construction of additional bunker storage space to meet capacity requirements for Phase 1 decommissioning waste.
- Maintenance of the WMA facilities and grounds.
- Design and implementation of an enhanced monitoring system for the LLW trenches to collect data in support of the final in-situ disposal decision.

In Phase 2, waste processing operations will be implemented to address wastes which cannot remain in existing storage structures until waste disposal becomes available. This work will specifically address irradiated fuel waste in standpipes and high level waste in trench 6. The key activities to be carried out are:

- Establishing the remaining operating area required to process, package and provide interim storage throughout Phases 2 and 3. New facilities will be constructed to meet regulatory requirements and will include retrieval, processing, segregation and interim storage for waste which cannot be managed in existing facilities until waste disposal facilities become available.
- Placing the WMA facilities, no longer receiving or processing waste, into a passive operational state. This may include modification to facilities and some relocation of waste within facilities.
- Recovering and processing the fuel waste from the standpipes and the irradiated reactor components from Trench 6.

- Constructing facilities in the remaining operating area to meet Whiteshell Laboratories' requirements for managing waste from decommissioning activities.
- Carrying out enhanced monitoring in support of trench in-situ disposal.

Several new facilities will be designed and constructed in the newly defined operating area located within the existing WMA boundary. New facilities comprise:

- interim storage bunker for solidified TFRE / Amine active liquid waste;
- interim bunker storage for routine monitoring and surveillance waste;
- interim storage for processed waste arising from WMA retrieval operations and from any site decommissioning work required prior to the availability of off-site disposal;
- a deminimis segregated facility to process waste into appropriate handling categories for off-site disposal; and
- transport equipment (shielded tanker) to accommodate transfer of aqueous waste to the ALWTC.

WMA storage facilities which are not required for Phase 2 activities will be transitioned to a passive operational state.

In Phase 3, the waste processing operations for wastes being generated from the remainder of the site will focus on preparation and packaging of waste for immediate transfer to disposal facilities, since the major site decommissioning activities are planned in accordance with assumptions on waste disposal facility availability. Monitoring and surveillance will be carried out in the passive operational area until the wastes are removed to disposal facilities or in-situ management controls are in place.

Low-Level Trenches

The final safety case for in-situ disposal of trench wastes must be prepared to support the final decision on in-situ disposal. The final safety case will consider any enhancements or additional actions which may be required to manage these wastes in-situ. Optimization of the disposal plan will consider:

- removal / remediation of trench waste unsuitable for in-situ disposal;
- engineered barriers;
- surface drainage patterns;
- additional monitoring locations; and
- institutional controls following Phase 3.

Remaining activities for Phase 3 are:

- processing final decommissioning project wastes as required to accommodate transport to disposal facilities (e.g. segregation of contaminated waste from clean waste, packaging, loading shipping containers);
- retrieving and transfer all WMA waste that cannot be managed in-situ at the site to final disposal;
- stabilizing/capping/securing the low-level trench area to manage waste in-situ and establish institutional controls; and
- remediating the balance of the WMA to a more "natural" condition.

4.3.2 Radioisotope Facilities

The decommissioning approach for radioisotope facilities was discussed in Section 4.3.1. A description of these facilities is provided below.

Building 300 (B300)

a) Description

B300 is the primary research laboratory for the Whiteshell Laboratories site, which provided support to the full range of nuclear research and development programs conducted at Whiteshell Laboratories during the operating period. The building comprises an area of approximately 17,000 m^2 and was built in six stages over the period of 1964 to 1982. Most of the building was used to provide general laboratory work areas and contains 68 laboratories designed to handle various levels of radioactivity. The south end of the building is a high bay area which supported experimental activities requiring large room areas and significant head room. The RD-14M experimental loop is located in the south high bay. Although the SF is part of the B300 complex, it is addressed separately as a listed facility. Two other facilities in the building, the Van de Graaff Accelerator and the Neutron Generator, are similarly addressed as individual listed facilities.

Research program work remains in progress in two significant areas of B300, the north extension utilized by the Nuclear Fuel Waste Management Program and the south high bay utilized by the Reactor Safety Research Program.

b) Decommissioning Approach

All research activities are currently being consolidated into the two operating areas noted above to allow progress on operational shutdown and decontamination of the building between the south high bay and the north extension. Building service systems (ventilation, heating) for this area can be isolated from the balance of the building to minimize impacts of decontamination on the continuing operational research programs. Since the emphasis of continuing research program work is on non-radioactive work, no increase in radioactive inventory is anticipated for the continued operation areas. Phase 1 decommissioning of the continued operation area of B300 is planned for year four of the project.

The Phase 1 work for B300 includes decontamination and/or fixation of contamination throughout the facility. Fumehoods will be isolated from the exhaust ventilation system and active drainage lines will be drained and capped. Active drainage system connections to the ALWTC will be maintained to manage building sump waste water. Minimum heating and ventilation will be established and the facility will be placed under Monitoring and Surveillance.

Monitoring and surveillance will be maintained throughout Phase 2 and in Phase 3 the facility will undergo final decommissioning to an unrestricted release state commencing in about 2030.

Decontamination Centre

a) Description

The Decontamination Centre (B411) provides a decontamination service for maintaining research and development experimental rigs, equipment and tools in a safe useable state. It also provides a laundry service for radioactively contaminated clothing. The building comprises an area of approximately 850 m^2. The decontamination area contains eight fumehoods and the work area is designed to accommodate a broad range of contaminated equipment cleanup. The laundry contains four fumehoods to accommodate sorting of contaminated clothing, and laundry equipment consists of six industrial washing machines and four dryers.

b) Decommissioning Approach

This facility will be retained in service to support the first phase of decommissioning, as well as shutdown and decontamination activities in B300. Shutdown and decontamination activities for the Decontamination Centre will be conducted in the final two years of Phase 1 of the decommissioning program. The facility will be placed in Monitoring and Surveillance at the end of Phase 1. Decontamination processes required to meet monitoring and surveillance and future decommissioning operations will be established in B100. These comprise a small laundry operation and respirator decontamination equipment.

Final decommissioning of the Building Decontamination Centre to an unrestricted release state is planned for 2025.

Building 402 (B402)

B402 will operate throughout Phase 1 to provide dosimetry services to AECL and to accommodate commercialization activities such as ACSION. Space within this building is currently being marketed to privatization interests. B402 is suitable for low-level radioactive work. It is designated as zone 1 (considered a "clean zone", dose levels do not exceed 1 mSv/a) suitable for use as routine laboratory space.

The decommissioning approach for the building is dependent on the extent of continued commercial use beyond Phase 1. The options include:

- characterization and environmental audit to provide for turnover of the facility to a new owner; or
- characterization and decontamination activity similar to the Decontamination Centre to prepare the building initially for monitoring and surveillance and ultimately for decommissioning to an unrestricted release level.

If commercialization activity is discontinued, B402 could undergo final decommissioning as early as the first part of Phase 2.

4.3.3 General Infrastructure

The other buildings and infrastructure at Whiteshell Laboratories are administered under the general terms of the site licence and include a total of nearly 40 buildings or structures that were used for a variety of purposes. Such uses have included:

- general and administrative offices;
- cafeteria and coffee areas;
- laboratories;
- storage;
- workshops;
- receiving docks; and
- other service buildings.

In general, the only work that will be done in Phase 1 is characterization of the building spaces to ensure safety during the deferment period. Very little decontamination work is expected to be needed. Heating and ventilation will be retained, as required, in some buildings.

The demolition of the other buildings and infrastructure will begin in Phase 3, targeted for completion by 2020. If commercialization is unsuccessful, demolition of some buildings may occur much sooner (e.g. 2005 and onward). Prior to demolition, the buildings will be surveyed and remediated to unrestricted release requirements. Finally, once a building has been demolished, the building footprint area will be returned to green state conditions. As well, B405 and connectors between B100 and B300 will be retained until B300 laboratories are fully decommissioned.

Alternatively, certain buildings may be transferred to private ownership. The long-term use of non-nuclear buildings is entirely dependent on economic development activity at the site. Planning to develop an industrial park to utilize the buildings outside the controlled active area of the laboratory site is in progress. It is anticipated that redundant buildings which are not commercialized within a timeframe of 5 to 10 years will be demolished.

Non-Nuclear Buildings

a) Description

The most significant buildings and services that are part of the non-nuclear buildings and infrastructure of the supervised and controlled area are:

- Gas Dynamics Research Laboratory (B303).
- Gas Dynamics Research Laboratory (B304).
- Engineering and Administration (B400).
- Security and Reception (B401).
- Technical Information Centre (B405).
- Cafeteria (B406).
- Material Handling (B408).
- Active Area Storage (B409).
- Machine Shop (B412).
- Material Warehouse (B415).
- Pumphouse (B902).
- Large Scale Vented Combustion Test Facility (B308, B309, B310).

There are a number of additional smaller buildings of various classifications. Table 4.3 lists non-nuclear buildings and provides a brief description of their function.

Table 4.3
Description of Non-Nuclear Buildings

Building (B) Number	**Description**	**Building (B) Number**	**Description**
300	Thermal hydraulics Annex	427	Mechanical Shop Storage No. 1
301	FIG Control	428	Mechanical Shop Storage No. 2
302	ZEUS Control	429	Civil Materials Storage
303	Containment Test Facility (CTF)	500	Internal Friction Lab
304	Gas Dynamics Research Labs	501	Aquatic Toxicity Lab
306	Gas Dynamics Research Lab	503	Ecology Lab
307	Diffusion Flame Facility	504	Inactive Lab/Offices
308	Large Scale Vented Combustion Test Facility	505	Soils Research Lab
309	LSVCTF-Local Services	509	Civil Materials Storage
310	LSVCTF-Remote Control	515	Drill Site Office
311	LSVCTF-Hydrogen Storage	518	B300 Coffee Room
312	Steam Generator Storage	523	Controlled Environment Building

Building (B) Number	Description	Building (B) Number	Description
400	Engineering and Administration	526	Borehole Instrumentation
401	Security and Reception	527	Flammable Liquid Storage Shed
403	Vehicle Gate House	530	Internal Friction Lab Annex
404	Meteorological Tower	902	Pumphouse
405	Technical Information Centre	903	Water Filtration
406	Cafeteria	904	Fire Protection Water System
408	Stores Workshop and Garage	905	Process Water System
409	Active Area Storage	906	Storm Drainage System
410	Cafeteria Garbage Storage	907	Sewage Lift Station and Lagoons
412	Engineering Products and Services	911	Powerhouse
413	Waste Chemical Storage	913	Main Substation
414	Controlled Area to Entrance	914	Main Power Distribution
415	Unheated Storage	916	Communications System
416	Storage	917	Supervisory Control and Alarm
420	Mobile Equipment Storage	918	Clarified Water System
426	Civil Material Storage	921	Pedestrian Links Between Buildings

(Adapted from Helbrecht 1999)

Although not among buildings listed as nuclear, B503 has laboratories where radioactive and bio-hazardous materials were previously used. Cleanup of this contamination may be undertaken as part of the operational cleanup. Other buildings will only have incidental contamination, if any, resulting from their proximity to the nuclear facilities.

b) Decommissioning Approach

During the operational shutdown period, non-nuclear buildings will be prepared for demolition or for transfer to other (commercial) owners.

The general site buildings are maintained in an operational state to support continuing research programs (e.g. B303, B304), the decommissioning program, commercialization opportunities (e.g. B400, B408, B401,) or to support the site operation generally (e.g. Powerhouse B911, Pumphouse B902). An assessment will be made of the timing of the decommissioning of the general site service facilities by the end of Phase 1.

The Whiteshell Laboratories' Irradiator in B305 is excluded from the Shutdown and Decontamination Plan because it is administered by the CNSC under a separate licence with ACSION, a private business operation at the site.

Inactive Landfill

a) Description

The inactive (i.e. non-radioactive) landfill was placed in operation when the Whiteshell Laboratories site was established to contain non-radioactive and non-hazardous wastes, excluding food waste. It is located at a high point in the local terrain approximately 2 km east of the main site at the end of a service road and next to the entrance gate to the Field Irradiator Gamma (FIG) facility. The surficial geology in this area is mainly sand and gravel. The area is a recharge zone, and groundwater will move either toward the river or northeast toward a large black spruce and sphagnum bog.

The landfill is less then 10 m in height and less then 1 ha in area. Typical materials placed in the landfill include plastic, paper, wood, cardboard, glass, and building materials. Standard activities include dumping, ditching, and capping with sand and gravel from surrounding borrow pits.

b) Decommissioning Approach

The inactive landfill will remain fully operational for Phases 1 and 2. Waste processing operations and maintenance will be consistent with that done prior to decommissioning. A plan for remediation of the landfill will be developed during Phase 2. Environmental, radiological and geotechnical evaluations will be carried out to provide inputs to the plan.

The landfill will be decommissioned to a final end state toward the end of Phase 3. The landfill will be capped and the surface restored to a more "natural" condition. Subsequent to closure, monitoring will be carried out to confirm that the landfill is fully stabilized.

The operation and decommissioning of the inactive landfill falls under federal jurisdiction. *Manitoba Environment Act* Regulation 150/91 on closure of landfills will be considered in developing the remediation plan for this facility.

Sewage Lagoon

a) Description

The lagoon system, placed in operation when the Whiteshell Laboratories site was established, is located north of the main plant site. It comprises a primary settling pond, a secondary pond, an outlet and the sewage lift station (B907). The lagoon receives liquid wastes from lavatories, showers and non-active drains. The lagoon water is retained for approximately six months to allow for settling and biodegradation. It is analyzed for fecal coliform and biochemical oxygen demand and if within limits may be released in May and October each year to the Winnipeg River.

The lagoon was constructed of low permeability clay embankments placed on a prepared clay surface, with no additional lining. The primary and secondary ponds are connected to each other via a culvert.

There are levees around each lagoon, with a roadbed at the top. At various times of the year the water level in the lagoons is higher than the surrounding land surface. Emergent macrophytes (primarily cattail) vegetate the water's edge. Water is released from the pond every spring and fall and flows from the lagoon to the Winnipeg River through a drainage way that is about 400 to 500 m in length.

b) Decommissioning Approach

The sewage lagoons will remain fully operational for Phase 1. Waste processing operations and maintenance will be consistent with that done prior to decommissioning. A plan for remediation of the lagoon system will be developed in the early part of Phase 2. Environmental, radiological and geotechnical evaluations will be carried out to provide inputs to the plan.

In Phase 3, the lagoon system will be decommissioned to a final end state by 2020. The lagoon will be backfilled and restored to a more "natural" condition. Subsequent to closure, monitoring will be carried out to confirm the lagoon is fully stabilized. Interim domestic sewage facilities (e.g. septic tanks) will be required to meet Phase 3 operations needs.

The operation and decommissioning of the lagoon falls under federal jurisdiction. *Manitoba Environment Act* Regulation 163/88 will be taken into consideration in developing remediation plans for this facility.

Buried Services

a) Description

Buried services run through the entire site and include:

- drainage systems;
- district heating;
- electrical;
- fire (250 mm diameter pipe) and process water (600 mm diameter pipe); and
- domestic water (200 mm diameter pipe).

The most significant buried services from a decommissioning perspective are the three types of drainage systems:

- *Sanitary drains* (250 mm diameter pipe): collect waste water from toilets, showers, sinks etc., and discharge it to the site sewage lagoon.
- *Aqueous radioactive waste collection drains* (38 mm diameter pipe enclosed in 200 to 300 mm diameter pipe): collect wastewater containing radioactive (and chemical) contaminants. The waste is pumped through double walled pipes to tanks in the ALWTC. The low-level tank waste is sampled and if radioactivity levels are acceptably low, the waste is pumped to the process drain/storm sewer at a maximum rate of 8 L/s. Medium radioactivity level aqueous wastes are concentrated and solidified for storage at the WMA. Any leaks in the active lines would be contained within the outer wall of the transfer pipes and flow to leak collection points (man-holes or sumps) located at low

points along the route. No leaks have been detected since the system was placed in operation.

- *Storm drains* (process drains, 1200 mm diameter pipe): collect cooling water from experimental facilities, site runoff water, low-level radioactive liquid waste from the ALWTC following sampling and monitoring, inactive effluent from non-active building sump floor drains and laboratory sinks, and process water that is used to maintain a minimum flow (50 L/s) at the outfall for a flow measurement. The storm drain water is discharged via the outfall to the Winnipeg River.

The aqueous radioactive waste collection system was replaced by the existing double pipe system in the mid-1980s. The old system had failed and leakage from some lines adjacent to the ALWTC had occurred. The area was partially remediated through removal of excavated soil; however, in subsequent years, the vegetation in the spill area was found to have elevated levels of beta and gamma emitting radioactivity, in particular ^{137}Cs and ^{90}Sr. Routine monitoring of the area is maintained to provide an indication of mobility which would require early remediation.

b) Decommissioning Approach

The buried services will remain fully operational for the first part of Phase 1. In the latter part of Phase 1, drains will be assessed, remediated and capped. In Phase 2, monitoring and surveillance and maintenance will be conducted as required. Most systems, other than parts of the active drainage, will remain functional during Phase 2. The active drain lines required to collect monitoring and surveillance building sump wastes for transfer to the ALWTC will be identified and retained.

The buried services and soil contamination associated with the old active drainage system leakage will be remediated in Phase 3. Removals will be staged because certain parts of the system (e.g. fire water) will be needed until WR-1, the last major project component, is fully decommissioned.

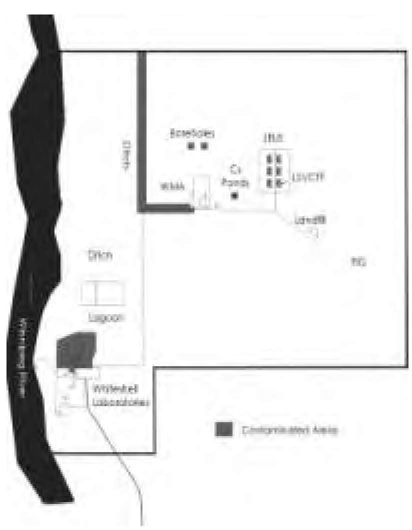
"Affected" Lands

a) Description

The affected lands are those lands within the Whiteshell Laboratories' site (the Licensed Property Study Area) that are contaminated, potentially contaminated or affected by nuclear operation and are more than 1 m away from buildings. Decommissioning of land within 1 m of the buildings is considered part of the decommissioning of the building.

The affected lands may contain contamination because of proximity to facilities and unusual occurrences. Known contamination areas identified in the affected lands are shown in Figure 4.3:

Figure 4.3
Affected Lands



Active Area Soil Contamination

Surface contamination attributed to releases from the HCF exhaust stack was detected in 1971 and 1972. The releases were at very low-levels and there is no detectable contamination remaining in these areas.

Leakage to topsoil has occurred as a result of active drain line failures, particularly in the ALWTC area, where 3 incidents released about 65 GBq of mixed fission product contamination. About 9 GBq of ^{137}Cs and ^{90}Sr are estimated to remain in the ground and the area is routinely monitored. There is no indication of contamination movement from the area.

Cesium Ponds

This area is located directly east of the WMA. The ponds were developed to study the distribution of dose received by organisms living at the water-mud interface. 0.5 Ci of ^{137}Cs were injected into the pond in the 1960's. This has decayed to approximately half of the original injection and elevated levels of ^{137}Cs remain detectable but limited to the pond area.

Field Irradiator Gamma (FIG)

This project was conducted in the late 1970s to early 1980s to study the ecological effects on a mixed boreal forest ecosystem from continuous exposure to gamma radiation. Only sealed sources were used. These have been removed and there is no radioactive contamination in the FIG area.

Zoological Environment Under Stress (ZEUS)

The ZEUS project studied the effects of ionizing radiation on small mammals. Only sealed sources were used. These have been removed and there is no radioactive contamination in the area.

Deep Borehole Site

The borehole site is located north of the CCSF. Small amounts of short half-life tracers were injected into three wells to study radionuclide transport in bedrock. The radioactivity has decayed to background.

A summary of release quantities and current radiological status is given in Section 5.3.3.

b) Decommissioning Approach

The approach to decommissioning will be the same generally for each of the known affected areas. In Phase 1, the emphasis will be on surveying, assessing and developing remediation plans. Any identified need for early remediation or stabilization will be completed late in Phase 1 or early in Phase 2. Stabilization/remediation is the first step in addressing each incident or the termination of an experiment. Therefore, only limited work is expected for these areas as an interim measure. Final remediation in Phase 3 will be focused on the active areas soil contamination and on the cesium ponds contamination.

In Phase 3, remediation will be completed to a level where any remaining contamination is within acceptable levels for unrestricted release. In some areas, institutional controls may be required after Phase 3 has been completed.

Off-Site Contamination

Off-site contamination resulting from the operation of the Whiteshell Laboratories has occurred in two areas. Routine releases (well within regulatory limits) and some spill incidents have resulted in contamination of river sediments. The north property ditch and the natural drainage creek northwest of the AECL site boundary was contaminated as the result of a spill in the WMA. These off-site contamination areas are described below.

River Sediments

a) Description

The Whiteshell Laboratories is situated on the east bank of the Winnipeg River. The river in this area is wide and flows rapidly several metres below the level of the surrounding land. The average flow is approximately 950 m^3/s, although this is controlled by Manitoba Hydro control stations, and may vary from time to time according to Manitoba Hydro policies.

Liquid effluent from the ALWTC is discharged to the Winnipeg River via the process sewer at the sewer outfall located about 8 m offshore in 5 m of water. The ^{137}Cs (the dominant radionuclide) concentration in downstream river water is 0.005 Bq/L, which is well within the 10 Bq/L Canadian Drinking Water Quality Guidelines (Canadian Council of Ministers of the Environment 1999a).

A reduction in the effluent particulate load was accomplished in 1998-99 by the installation of filter stations to collect the larger particulate for the most critical waste streams. The effluent from the WMA sumps is routinely filtered through 5 micron filters before being transferred by tanker to the ALWTC. In 1995, a decision was made to reduce the concentration control point for ALWTC waste by reducing the Administrative Level from 1 GBq/m^3 to 0.1 GBq/m^3. By these means the overall level of releases was reduced and a significant fraction of the larger particulate (settable solids) was collected, and therefore prevented from being released to the river.

Elevated sediment contamination has been measured in the local outfall area (an area 20m wide by 80m downstream). The total inventory is very low, approximately 1.3 GBq. A detailed evaluation of the sediment contamination is presented in Appendix B.1. The assessment concludes that using the most conservative dose estimation methods, doses to non-human biota and humans are below accepted guidelines.

b) Decommissioning Approach

Based on the evaluation in Appendix B.1, the decommissioning approach is to abandon the contaminated sediments in-situ.

Environmental monitoring of sediments will take place throughout Phase 2 and most of Phase 3 to determine if contaminants deposited as a result of the decommissioning project require remediation to achieve the final end-state objectives.

North Ditch/Creek

a) Description

A spill incident at the WMA in 1979 led to fission product contamination of a 2 km ditch system, (including the west ditch, the north ditch, and a small creek). The creek is located in the public domain north of Whiteshell Laboratories, and discharges into the Winnipeg River. A follow-up ditch sampling program indicated radioactivity was deposited throughout the 5 to 10 cm of clay-silt soil in the ditch system near the WMA. Surface water was present in the ditches at the time, and contamination of the water flowing down the drainage system exceeded the maximum permissible concentration in drinking water for continuous consumption.

The ditch flowing west from the WMA was excavated to remove contaminated soil. The entire ditch/creek system was surveyed to determine the immediate remediation required. Routine monitoring continues to be carried out in this ditch/creek system.

b) Decommissioning Approach

A full assessment of environmental monitoring data and of the original spill documentation will be conducted to confirm that the initial remediation following the incident was satisfactory and that no additional remediation is required.

4.3.4 Timing for Decommissioning Activities

The general decommissioning approach for the various facilities and components was outlined in the preceding sections. The timing of the decommissioning activities are summarized in Table 4.4 and illustrated in Figure 4.4.

There is a logical flow of decommissioning work commencing with nuclear facilities and nuclear support facilities to handle the most significant hazards while maintaining the site infrastructure. Service systems are addressed subsequent to nuclear facilities decommissioning. This also tends to avoid overlapping or conflicting effects between individual project components.

The decommissioning work is concentrated in Phase 1 and the latter half of Phase 3. For the interim period, most of the facilities will be under monitoring and surveillance. The figure also shows the remaining operating period for the site infrastructure and support facilities required during the decommissioning activities.

Table 4.4
Whiteshell Laboratories Decommissioning Schedule

Facility	Decommissioning Activity / State	Phase
Shielded Facilities	Operational - processing of high level liquid waste	Phase 1
	Decontamination	Phase 1
	Monitoring and surveillance	Phases 2 and 3
	Final Decommissioning	Phase 3
Van De Graaf Accelerator	Final Decommissioning	Phase 1
Neutron Generator	Final Decommissioning	Phase 1
Active Liquid Waste (ALWTC)	Part of facility remains operational through to Phase 3	Phase 1, 2 and 3
	Decommissioning of unused portion	Phase 1
	Monitoring and Surveillance	Phase 2
	Final Decommissioning	Phase 3
Concrete Canister Storage Fac.	Operational	Phase 1
	Placed in a Passive Operational State	Phase 2
	Monitoring and Surveillance	Phase 2 and 3
	Final Decommissioning	Phase 3
WMA	Operational	Phase 1
	Define and operate remaining facility	Phase 2 and 3
	Storage of monitoring and surveillance wastes	Phase 2 and 3
	Recover and process stored waste from facilities requiring upgrading	Phase 2
	Placing retrieved waste into new upgraded facilities	Phase 2
	Transfer WMA storage facilities not required for Phase 2 activities to a passive operational state	Phase 2
	Monitoring and Surveillance in the Passive Operational State until wastes are removed to disposal facilities.	Phase 3
	Maintain institutional controls until in-situ waste is acceptable for unconditional release	Institutional control period
	Preparation and transfer of waste to disposal facilities	Phase 3
Building 300	Decontamination and or Fixation of Decontamination	Phase 1
	Monitoring and Surveillance	Phase 2 and 3
	Final Decommissioning to an unrestricted release state	Phase 3
Decontamination Centre	Shutdown and decontamination in the final 2 years of Phase 1	Phase 1
	Monitoring and surveillance	Phase 2 and 3
	Final Decommissioning to an unrestricted release state	Phase 3
B402	Operational throughout Phase 1 Decommissioning. Approach is dependent on the extent of continued commercial use of B402 beyond Phase 1	Phase 1
	Final decommissioning as early as the first part of Phase 2 (if commercialization is discontinued)	Phase 2
Non-Nuclear Bldgs	An assessment will be made of the decommissioning of the general site service facilities by the end of Phase 1	Phase 1
	Final decommissioning	Phase 2 and 3

Facility	Decommissioning Activity / State	Phase
Inactive Landfill	Operational throughout Phases 1 and 2	Phase 1and 2
	Development of a remediation plan	Phase 2
	Final Decommissioning	Towards the end of Phase 3
Sewage Lagoon	Operational throughout Phase 1and 2	Phase 1 and 2
	Development of a remediation plan	Phase 2
	Final Decommissioning	Phase 3
Buried Services	Operational	First part of Phase 1
	Drains will be assessed, remediated and capped	Phase 1
	Monitoring and Surveillance	Phase 2
	Most systems, other than parts of the active drainage, will remain functional during Phase 2 Remediation of buried services and soil contamination associated with the active drainage system	Phase 2 and 3
Affected Lands	Surveying, assessing and developing remediation plans	Phase 1
	Monitoring and surveillance	Phase 2 and 3
	Remediation to levels acceptable for unrestricted release	Phase 3
River Sediments	Monitoring and surveillance	Phase 1, 2 and 3
	Re-evaluation to confirm final in-situ end state	Phase 3
North Ditch	Identification of contamination above levels acceptable for unconditional release.	Phase 1
	Preparation of a remediation plan	Phase 1
	Remediation if necessary	Early in Phase 2

Figure 4.4
Whiteshell Laboratories Decommissioning Project Component Timelilnes

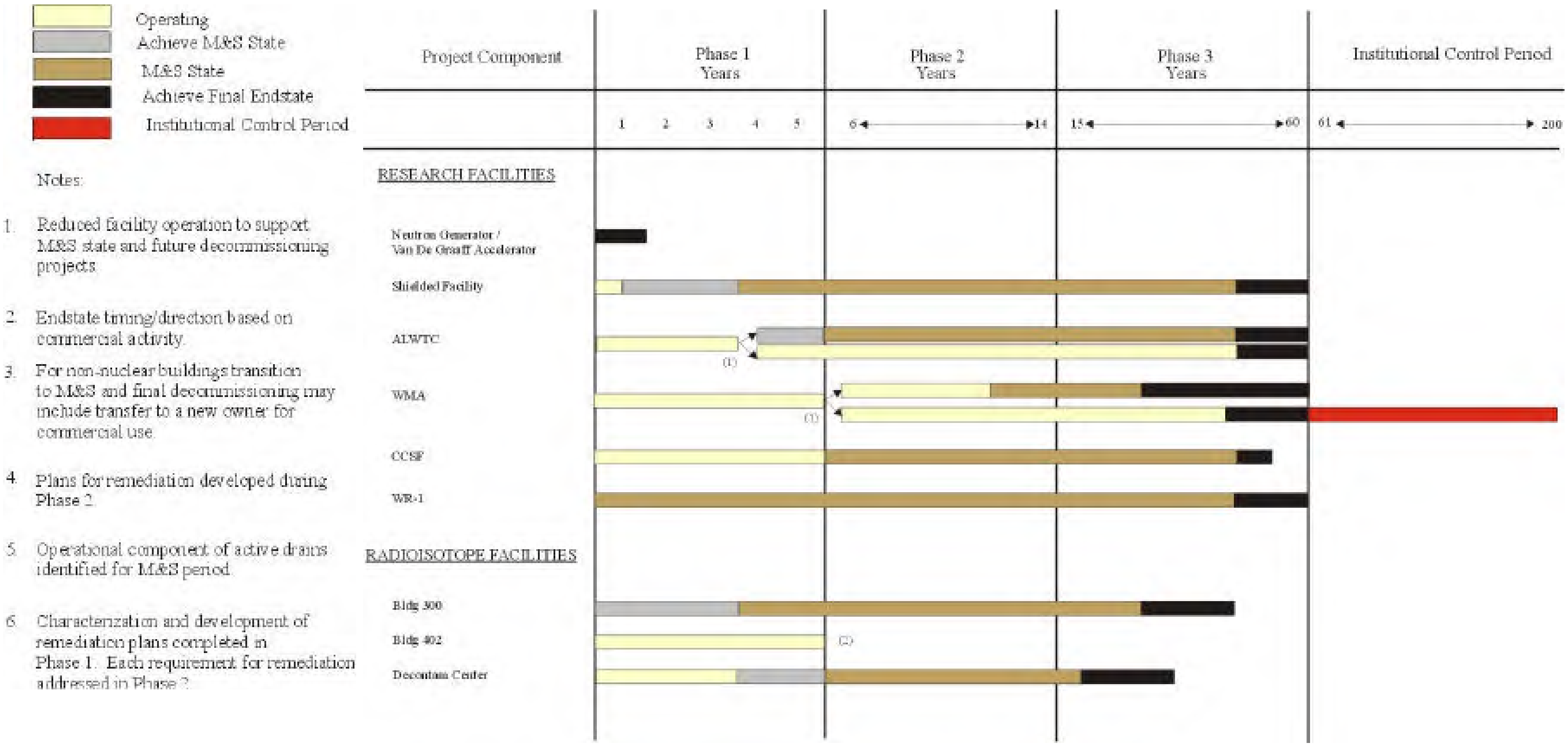
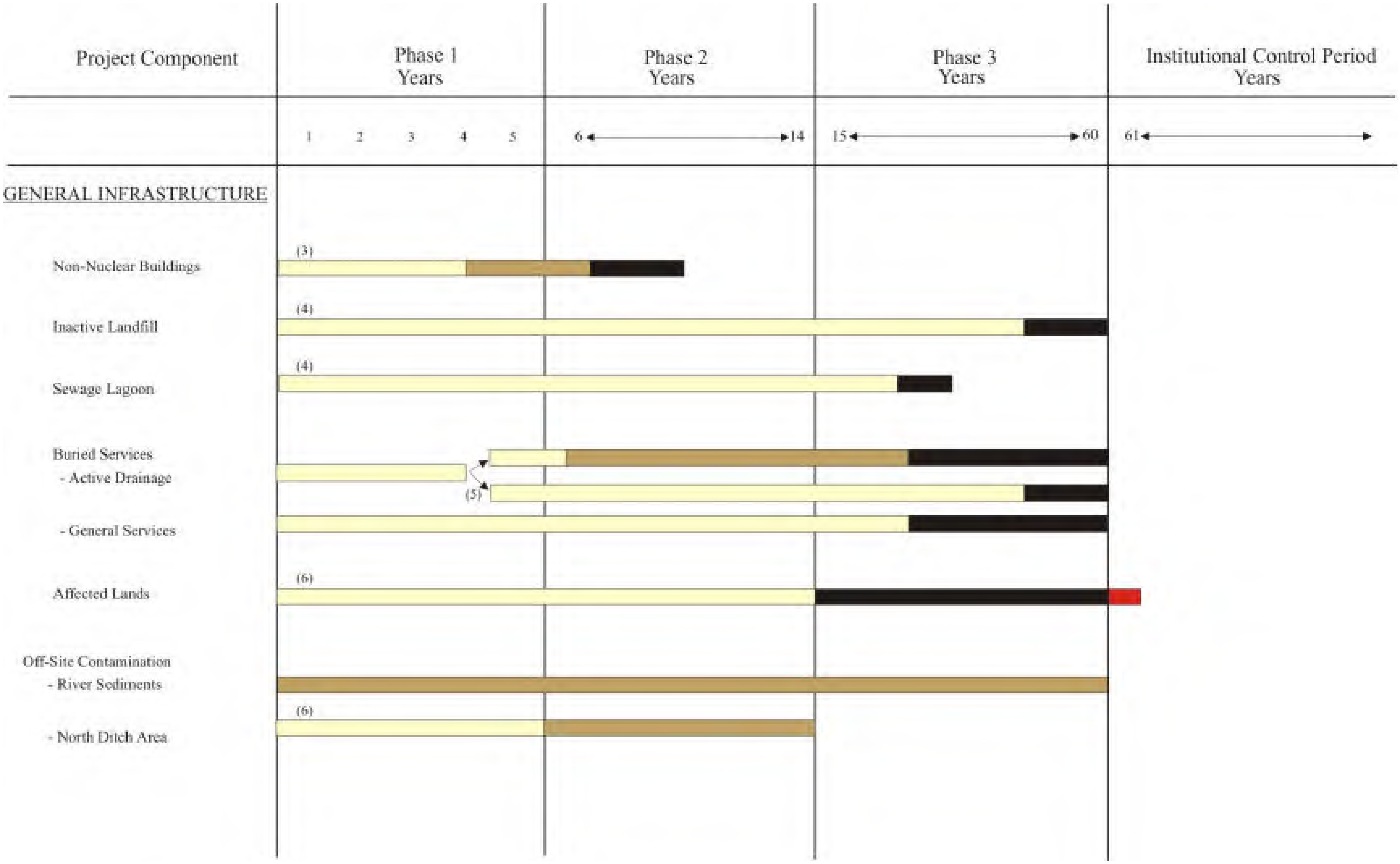


Figure 4.4 (continued)

Whiteshell Laboratories Decommissioning Project Component Timelilnes



4.4 KEY DECOMMISSIONING ACTIVITIES

The specific decommissioning activities related to each facility, as detailed in Ridgway (1999), were used in the assessment of potential environmental effects. Several of these activities which are common to many of the facilities, have the potential to result in environmental effects. Brief descriptions of these key decommissioning activities are provided below.

4.4.1 Decontaminating

Interior

Decontamination will be used to remove radioactive contamination from contaminated surfaces or materials. Removal of chemical hazards (e.g. asbestos, PCBs) will be undertaken prior to or in parallel to decontamination activities. Typical decontamination activities include vacuuming, cleaning, washing, washing with high pressure, swabbing, scabbling, chemical treatment and CO_2 blasting (Table 4.5). This will be carried out for individual rooms and on areas of the walls, ceiling and floors to remove loose contamination.

Table 4.5
Decontamination Activities

ACTIVITY	DESCRIPTION
1. Washing	Washing is an important method for removal of loose contamination. For floors, a cotton mop is typically used with a decontamination cleaner.
2. Cleaning	Aggressive cleaning is used to remove embedded contaminants.
3. High Pressure Washing	High pressure washing is used to remove embedded contaminants. A jet spray (1000 - 1200 psi) is used with detergent and a cleaner.
4. Jack Hammer	An air-powered jack hammer (1000 psi) is used to remove deeply embedded contaminants (e.g. those embedded in concrete).
5. Scabbling	An air-powered (80 – 90 psi) hammering system is used for light percussive work (e.g. cracks or pores in concrete). The three main tools are hand-held, a corner tool and a floor tool. The system includes a HEPA vacuum that sucks the debris and dust created by scabbling action.
6. Swabbing	Mopping floors for removal of contamination (see washing).
7. Vacuuming	A high-capacity air-operated industrial vacuum, complete with a HEPA filtration system, is used for heavy duty vacuuming. This includes removal of concrete, plaster dust and other rubble.
8. Carbon Dioxide Blasting	Pressurized CO_2 is used with a variety of tools for percussive work.

Note: Wherever possible, the use of water is avoided. This reduces formation of secondary waste.

Minor decontamination activities may be required when building services are handled and removed. Work will be directed to the active ventilation and drainage systems. For example, the process for removal of ventilation ductwork will likely follow these steps:

- opening a sealed section of ductwork;
- decontaminating ductwork to a level that is safe for handling;

- disassembling the piece of ductwork that has been decontaminated;
- further decontaminating the piece of ductwork;
- packaging the piece of ductwork, and
- sending the ductwork to the WMA for storage.

If a portion of a machine cannot be easily decontaminated, the machine may be disassembled and the contaminated portion sent for storage in the WMA. The remaining uncontaminated portion of the equipment will be sent for reuse or recycle following surveying in the deminimis segregation facility to be located in the WMA.

Exterior

Most contamination originates inside the building and occasionally works its way through to the exterior walls. The normal decontamination process is to work from the inside out removing material until release levels are achieved. This means that the internal control systems to prevent loss of material remain in effect even when the work affects outside surfaces. Exterior contamination can also occasionally be found around vents and exhausts and on roofs. Cleaning of these surfaces is conducted under enhanced local contamination controls.

4.4.2 Removing Fixed Surplus Equipment (Interior)

Any remaining fixed equipment will be removed from the various rooms, facilities or laboratories. Typical fixed equipment includes:

- machinery;
- equipment;
- benches and tables;
- ovens and dryers;
- experimental apparatus;
- electrical components;
- grinders; and
- hoists.

Unfixed surplus items such as furniture, chemicals, laboratory apparatus and computers would already have been removed as part of the shutdown operations.

Work related to removal of equipment includes:

- removing and capping water supply and drain lines;
- disconnecting, isolating and sealing power to these units; and
- removing and sealing any other mechanical services.

4.4.3 Fixing in Place (Interior)

Fixing is the process of stabilizing contamination through methods such as the application of spray or brushed-on paint or paint-like products. Fixing is done to ensure that any loose, surface contamination is stabilized for any planned deferment period.

4.4.4 Demolishing

Buildings and structures will be dismantled and demolished in an orderly manner. For example, a building would likely be stripped to the bare shell, with all of the wood, plaster and room dividers removed. The metal roof would then be removed, leaving the concrete structure available for final demolition. If feasible, the building material and structure will be reused or recycled.

4.4.5 Remediating the Building Sites

Building sites will be remediated, stabilized and rehabilitated. This work will include:

- removing the building foundations; and
- excavating any remaining contaminated soil with concentrations above applicable guidelines.

4.4.6 Rehabilitating

Rehabilitation is aimed at returning the building sites to a more "natural" condition. Work activities will include:

- backfilling the building area with clean soil or fill;
- re-grading the area to "natural" condition;
- establishing an appropriate drainage arrangement (e.g. ditching, berm construction); and
- re-vegetating the building site and the area.

4.4.7 Transporting Radioactive Waste Off-Site

The transport of radioactive waste is regulated under the *Packaging and Transport of Nuclear Substances Regulations* (CNSC 2000c). Transported waste includes High-Level Waste (fuel, solidified active liquid waste and irradiated reactor components) as well as Medium and Low-Level waste. Key activities consist of:

- loading the waste into an approved shipping container;
- loading the container onto the vehicle;
- monitoring the vehicle for contamination and cleaning it if necessary; and
- driving the transport vehicle to an approved facility.

4.5 WASTE MANAGEMENT PRACTICES

In essence, the decommissioning program is a process of managing the Whiteshell Laboratories' site waste streams to secure an end state where all wastes are dispositioned to off-site disposal facilities or to in-situ management. The following sections describe the proposed approach to waste management for the decommissioning project.

4.5.1 Inventory of Stored Wastes

Radioactive laboratories and waste storage occupy approximately 1% of the site land (approximately 40 ha). The active area totals approximately 4 ha (0.1% of the site). Radioactive wastes are stored in waste management facilities. These wastes are categorized in three levels according to AECL procedures defined in Barnard et al. (1985) and as approved by the CNSC.

1. Low-level waste (LLW), which consists of used lab-ware, rubber gloves, shoe covers, wipe paper, and mops. The total accumulation of LLW is approximately 21,000 m^3 and is located in trenches (40 TBq as an upper limit), bunkers and storage buildings;

2. Medium-level waste (MLW), which is typically composed of scrap metal materials from experiments, filters, and radioactive liquid waste that has been solidified. This waste is stored in the standpipes and bunkers in the WMA. The total accumulation of MLW in the WMA is approximately 1,400 m^3; and

3. High-level waste (HLW), comprises of irradiated reactor fuel and metals from nuclear reactor core components. The Concrete Canister Storage Facility (CCSF) provides storage for 25 metric tonnes of irradiated reactor fuel. Some fuel wastes (approximately 3 metric tonnes) from operations prior to 1975 are stored in standpipes in the WMA.

Two other categories of stored waste are:

- 450L of active liquid waste processed to a solid form as part of shutdown operations; and
- a small volume of PCBs (16.6 L) is stored in B413 located at the main laboratory site.

4.5.1.1 Inventory of Decommissioning Wastes

The decommissioning project will handle waste from five broad categories. Preliminary estimates of the waste generation are summarized as follows:

1. Nuclear facilities and radioisotope facilities will produce the largest component of radioactively contaminated waste estimated at approximately 10,400 m^3 of LLW and approximately 1,400 m^3 of MLW. Deminimis waste from these facilities is estimated at approximately 20,000 m^3 and about 10-15% is expected to be recyclable.

2. Non-nuclear buildings and services will produce approximately 30,000 m^3 of deminimis waste and approximately 2,000 m^3 of suspect LLW.

3. Contaminated soil waste will be produced from remediation of individual building sites and from remediation of affected lands (spill incident areas, active drain lines etc.). This category cannot be estimated until additional assessments are carried out during Phase 1 to delineate the extent of contamination.

4. Another category of waste is hazardous chemicals. Some PCB-filled electrical components remain in operation at the site and many nuclear facilities contain asbestos insulation on process piping systems. Most building floor and ceiling tiles contain some asbestos. Estimates for asbestos waste volumes will be prepared as part of detailed decommissioning planning. Some laboratory chemicals may be encountered; this is expected to be negligible because Whiteshell Laboratories has continuously disposed of redundant or waste chemicals through contract firms. Also, laboratory chemicals remaining on shutdown have been disposed of in that manner as part of shutdown operations.

Table 4.6 summarizes the site waste inventory.

Table 4.6
Whiteshell Laboratories Total Waste Inventory (Preliminary Estimate)

Facility/Storage	ALW (L)	HLW (metric tonnes)	MLW (m^3)	LLW (m^3)	DEMINIMIS[1] (m^3)	Hazardous Chemicals
Stored Inventory						
WMA	180	3 25	1,400 -	21,000 -	- -	• 3000 lbs. of arsenic • 1800 lbs. of lead • DDT, glycol, solvents • Small Volume of Carcinogens[2]
CCSF B413		-	-	-	-	- • -16.6 L of PCB's
Decommissioning Waste						
Nuclear/Radioisotope Facilities - AD-TK3	270	-	1,400	10,400	20,000	• Asbestos[3] • Insulation • Lead Shielding[4]
Non-nuclear Buildings/ Infrastructure		-	-	2,000[5]	30,000	• Asbestos[3] • Floor and Ceiling Tiles
Chemical Wastes from in-Service Facilities						
PCB's Freon [7]						332 L 3,014 kg
Total Waste Inventory	**450**	**28**	**2,800**	**33,400**	**50,000**	**348.6L PCB's[6]** **3,014 kg Freon** [7]

(1) Approximately 10-15% of deminimis waste is expected to be recyclable.
(2) Small volumes of carcinogenic chemicals are stored in dedicated quadrant of Bunker B-4.
(3) Asbestos insulation was used on much of the WR-1 process systems and on some building service systems (High Temperature Hot Water Lines). Also building ceiling and floor tiles contain asbestos. Waste estimates will be prepared as part of detailed decommissioning planning.
(4) Lead shielding exists on many experimental/lab work areas. Estimates are being produced as part of detailed decommissioning planning.
(5) Suspect LLW which may be cleared for inactive landfill disposal.
(6) Storage of PCB materials is managed with in accordance with the Federal "Storage of PCB Materials Regulations".
(7) Ozone-depleting substances consist of Halons, CFCs, HCFCs and HFCs.

4.5.2 Waste Streams and Disposal Pathways

Figure 4.5 indicates the various decommissioning waste streams, disposal pathways and additional/new facilities which will be required to manage wastes arising from monitoring and surveillance activities and from decommissioning work at the site, until national waste disposal facilities become available. The waste sources (i.e. the various existing site facilities) are indicated in the left column. The interim processing and storage facilities are in the centre column and final disposal location or facility is indicated on the right. The primary waste sources requiring interim treatment and handling are:

- aqueous waste collected from sumps in monitoring and surveillance buildings;
- processing of site TFRE/Amine active liquid waste to a solid form;
- MLW and LLW retrieved from existing waste management facilities where enhanced packaging and storage is required prior to the availability of a waste disposal facility;
- wastes produced from carrying out monitoring and surveillance activities; and
- wastes produced from decommissioning activities prior to the availability of disposal facilities.

Figures 4.6 and 4.7 indicate the timing for shutdown and decommissioning of existing waste management facilities and the replacement facilities required to manage liquid and solid waste, respectively, produced from monitoring, surveillance and decommissioning project activities.

The upper half of the figures indicate which waste management facilities will be available over the duration of the project, whereas the lower half shows the nature of the wastes arising from decommissioning activities as well as the period when they are to be generated. The same colour codes are used in the upper and lower halves and show the destinations of the wastes.

4.5.2.1 Active Liquid Waste Processing

As indicated previously, 450 L of TFRE/Amine active liquid waste are stored at Whiteshell Laboratories. As part of operational shutdown, these wastes will be immobilized in steel containers in the Shielded Facilities, and placed into steel baskets which will be stored in a new interim storage bunker located in the WMA. These wastes will be transferred to off-site waste disposal facilities when such facilities are available.

4.5.3 Waste Processing Facilities

As indicated by the boxes in the centre column of Figure 4.5, modification of existing facilities and several new facilities are needed to process waste and provide interim storage until final disposal facilities are available. The anticipated interim processing and storage facilities required are described briefly as follows:

- Deminimis Segregation Facility

  This facility will be used to monitor wastes that are identified for off-site disposal. Wastes having radioactivity levels above free-release requirements will be segregated and placed in interim storage until disposal facilities are available. Materials below free-release levels will be transported off-site for recycling or disposal.

- Reduced Active Liquid Waste Treatment Centre

  By about year 4 of Phase 1, most of the ALWTC will be decommissioned to an interim end state. A small portion of the facility will be retained in an operational state to process aqueous LLW collected from the building sumps and small amounts of aqueous LLW and MLW originating from WMA retrieval, processing and interim storage operations.

- WMA Retrieval, Reprocessing and Repackaging Facility

  A retrieval, reprocessing and repackaging facility will be required to process waste generated from monitoring and surveillance activities and from decommissioning project work implemented prior to the availability of disposal facilities.

  Retrieval of wastes which cannot be accommodated in existing storage facilities until disposal becomes available (e.g. fuel waste in standpipes and trench 6 MLW) will require portable shielded processing facilities.

- New WMA Interim Storage Facilities

  New interim storage facilities will be required for interim storage of LLW and MLW until disposal becomes available. This will likely be composed of a segregated storage area within the WMA and include or be adjacent to the reprocessing facilities. The wastes expected to require new interim storage are:

  - solidification waste from the processing of HLW and aqueous wastes arising from WMA retrieval and processing operations;
  - monitoring and surveillance waste;
  - contaminated building maintenance materials; and
  - retrieved, processed and repackaged (WMA) waste.

Construction of new storage facilities will be subject to review and approval by AECL Safety Review Committee and the CNSC.

4.5.4 Final Waste Disposal

The final waste disposal paths are shown on the far right of Figure 4.5. There are five main disposal paths for the site decommissioning waste. These are described briefly as follows:

- In-Situ Disposal

  Waste items may be left in place for permanent disposal. In-situ disposal is proposed as the reference option for most of the LLW trenches in the WMA and for contaminated sediments at the outfall.

- Chemical Safe Storage / Disposal

  These are engineered off-site facilities expected to be available in Canada for disposal or safe storage of hazardous chemical wastes.

- Off-Site Landfill

  These are engineered sanitary landfills expected to be available within the Regional Study Area. It would likely be an off-site facility capable of handling building rubble.

- River

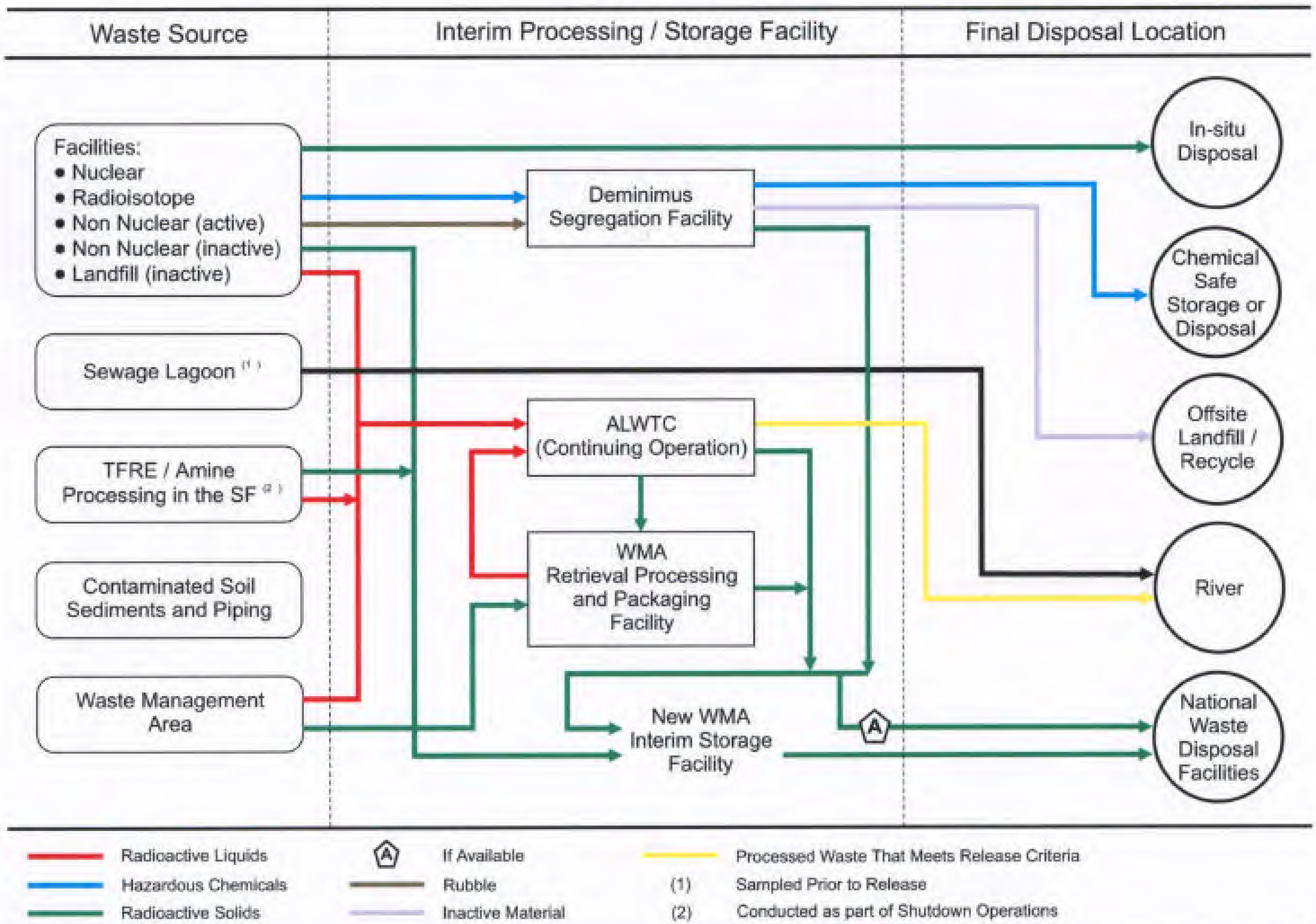
  Liquids are batch processed at the ALWTC to remove contamination and only released to the Winnipeg River if they meet release criteria. All releases to the environment will be controlled within administrative levels set well below the site Derived Release Limits (DRLs) (Soonawala 1998). Aqueous wastes above these levels are processed and stored as a solid product at the WMA. It is expected that liquid releases will be gradually reduced approaching the deferment period (end of Phase 1), and will remain at low levels throughout the deferment period.

- National Waste Disposal Facility

  A national waste disposal facility or series of facilities is required for all of the radioactive waste materials at Whiteshell Laboratories, except for the WMA low-level wastes which may be managed in-situ. Separate facilities may be required for the three main categories of solid waste. These categories are low-level, medium-level and high-level radioactive waste.

FIGURE 4.5

PROJECT WASTE STREAM AND INTERIM HANDLING FACILITIES



AECL EACL

FIGURE 4.6

TIMING FOR MANAGEMENT OF RADIOACTIVE LIQUID WASTE

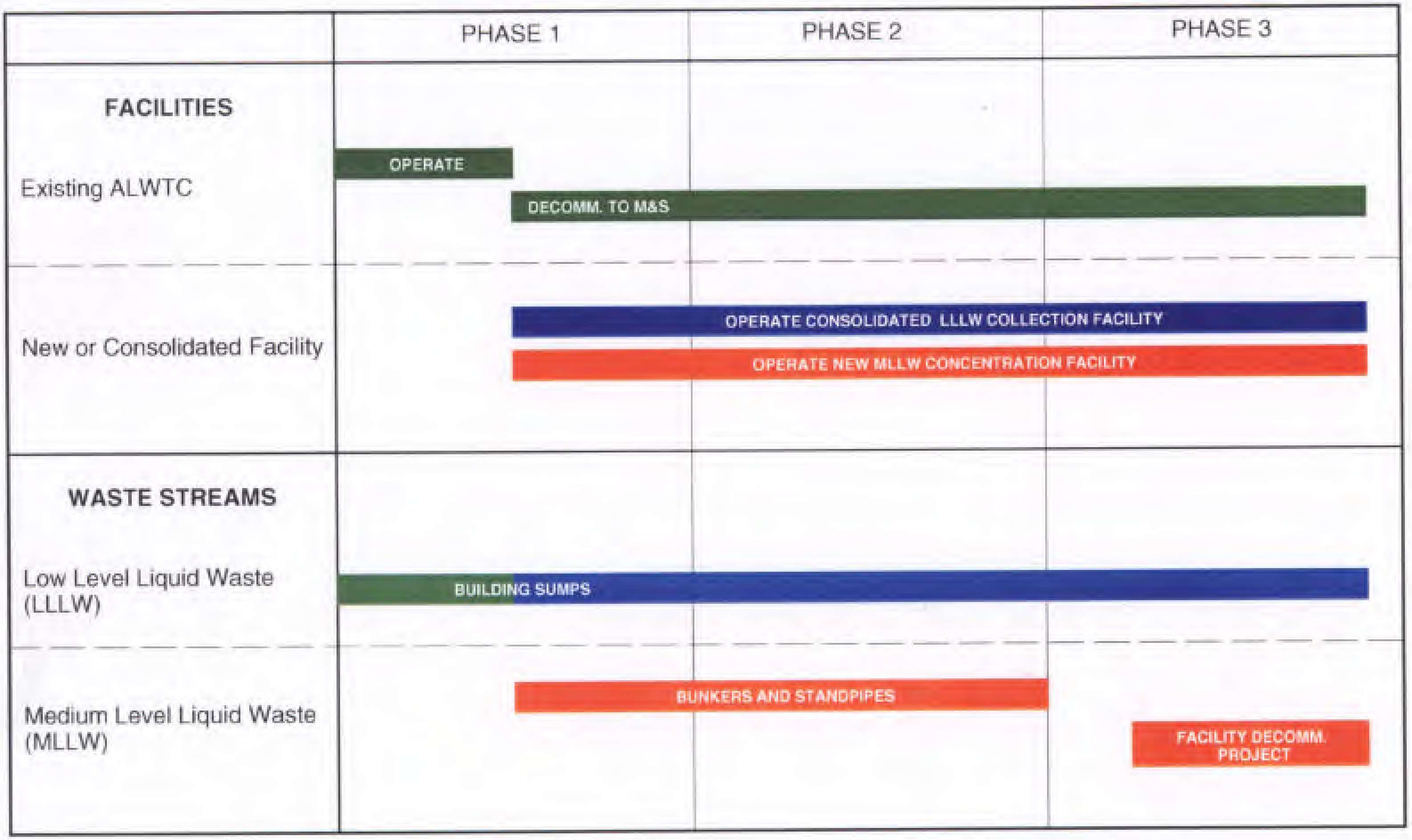
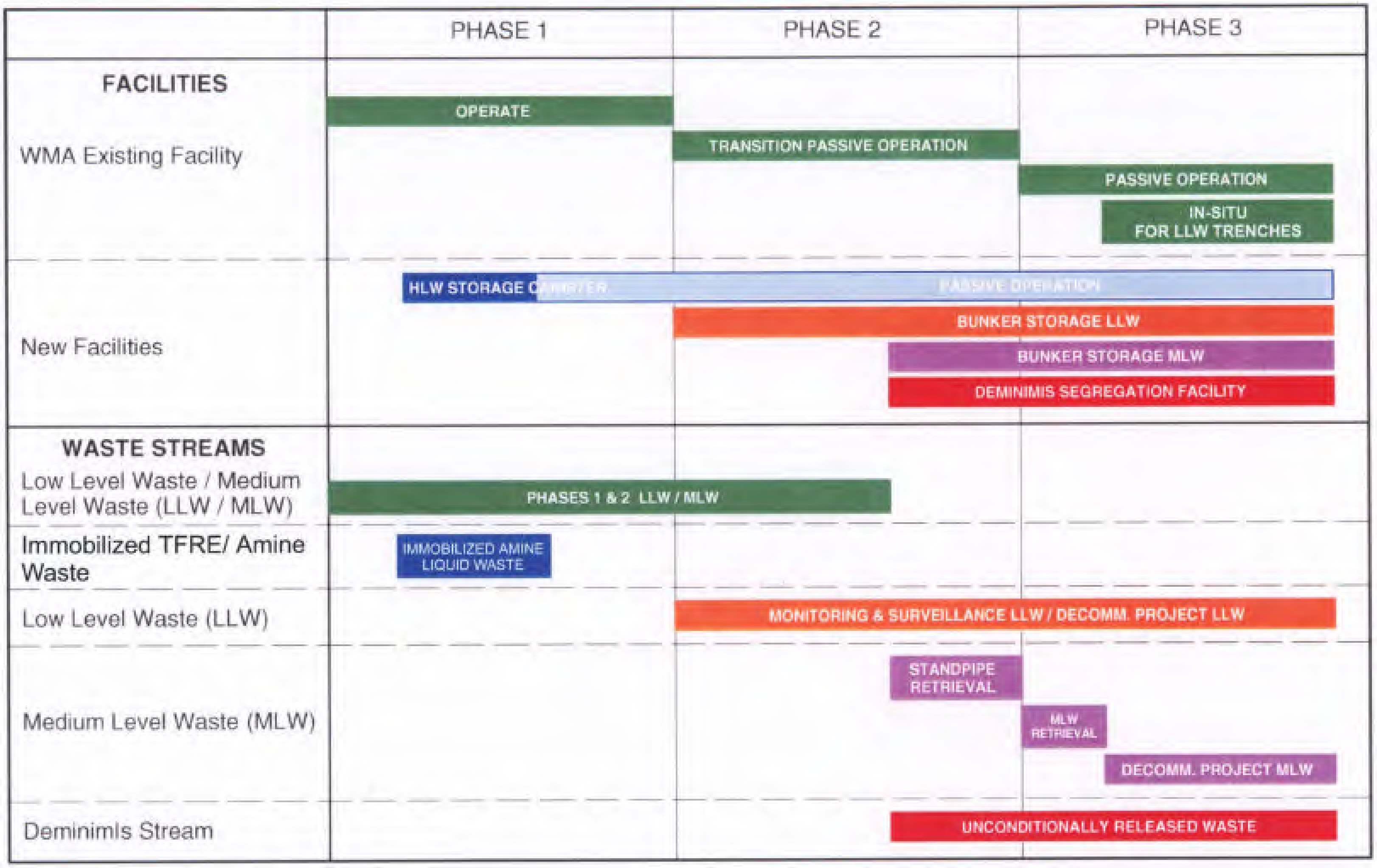


FIGURE 4.7

TIMING FOR MANAGEMENT OF RADIOACTIVE SOLID WASTE



5.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 LOCATION

5.1.1 Geographic Setting

The Whiteshell Laboratories site is located on the east bank of the Winnipeg River (50º 11'N; 96º 03'W), approximately 100 km northeast of Winnipeg, approximately 10 km west of Pinawa and 9 km upstream of the Village of Lac du Bonnet (Figure 1.1). The site lies approximately 267 m above sea level (Reimer 1966), within a broad zone where prairie grassland to the southwest merges with boreal forest to the northeast. It is on the western edge of the Precambrian Shield and is surrounded by cleared land, which supports agriculture, interspersed with peat bog (Canada Land Inventory 1968, 1975).

Forty-three percent of the site is forested and leased farmland, 46% is occupied by buildings, facilities and developed lands, and the remaining 11% is a fenced area for nuclear and non-nuclear buildings and facilities. The fenced area contains ten major buildings, and a number of small support facilities.

5.1.2 Study Areas

Regional Study Area

The Regional Study Area (Figure 2.3) is partially a Canadian Shield landscape. A large number of shield lakes (approximately 25 lakes) and connecting rivers are found in the area. The Winnipeg River, which has its outlet in Traverse Bay at the southern end of Lake Winnipeg, is among these rivers. The area includes approximately 60 km of Lake Winnipeg's shoreline, and a small portion of the lake, consisting mostly of Traverse Bay and Elk Island Heritage Park. There are a number of provincial parks in the region: Whiteshell Provincial Park (approximately one quarter of the eastern edge), Nopoming Provincial Park (the south-eastern tip), and Grand Beach Provincial Park. Also falling within the study area are the Agassiz, Whiteshell, Brightstone Sand Hills, and Belair Provincial Forests (Manitoba Highways and Transportation 1999).

Local Study Area

The Local Study Area (Figure 2.2) falls primarily within the Canadian Shield. The area includes a public airport just north of Lac du Bonnet, a hospital at Pinawa, the Seven Sisters Dam, two government picnic grounds, and a government campsite. The La Verendre Trail, connecting a number of communities in Eastern Manitoba near Whiteshell Provincial Park, passes through the centre of the Local Study Area (Manitoba Highways and Transportation 1996).

Licensed Property Study Area

The licensed Property Study Area (Figure 2.2) of Whiteshell Laboratories consists of land on both sides of the Winnipeg River. The developed and larger portion is on the east-side of the river, roughly 10 km from the Town of Pinawa. This east side of the licensed area is composed of all Whiteshell Laboratories facilities and the Field Irradiator Gamma (FIG) area. However, the vast majority of the east side is undeveloped and comprises bush land, swamp and undeveloped river frontage. All land on the west side of the river is leased to farmers for agricultural purposes.

Project Study Area

The Project Study Area consists of approximately 1340 ha of the licensed Property Study Area which has been used and/or affected by AECL nuclear development and operations.

The majority of the Whiteshell Laboratories facilities fall within a 40 ha area, adjacent to the east shore of the Winnipeg River. The Project Study Area is identified in Figure 2.1.

5.2 EXISTING CONDITIONS FOR THE CURRENT OPERATION OF THE WHITESHELL LABORATORIES FACILITY

Extensive data is collected for radiological and non-radiological conditions in and around Whiteshell Laboratories. The most recent emissions monitoring data describing the current operation of the Whiteshell Laboratories facility is presented in the 1998 Annual Report of Radiological Monitoring - Volume 2 (Niemi and Soonawala 1999a). This report summarizes radioactive emissions from Whiteshell Laboratories and compares effluent release data to the Derived Release Limit (DRL). A DRL is derived from regulatory dose limits by analytical modelling of all significant pathways to an individual in the most exposed group (the critical group). A DRL is, therefore, the upper limit of a single radionuclide for a facility in airborne and/or liquid effluents. Continued release of any radionuclide at a rate equal to the DRL would, in theory, result in an annual radiation dose equal to the regulatory limit. The operation of Whiteshell Laboratories has consistently maintained releases well below the DRL and has never resulted in adverse effects on the environment or human health.

The 1999 operations have resulted in lower emissions due to shutdown of a majority of the facilities.

Standards for Radiological and Non-Radiological Effluents

(a) *Radiological Effluents*

Standards followed for radiological effluents are based on dose limits for members of the general population prescribed by the CNSC, which in turn are based on ICRP recommendations. The current dose limit is 1 mSv per annum (CNSC 2000b). These dose limits are used to back-calculate the DRLs for every source of radiological effluents, liquid or gaseous, and for every radionuclide, released on a site. DRLs, in units of Bequerels per week or month, are approved by the CNSC and subsequently published by AECL. Critical groups and contaminant transfer pathways are important components of models used to calculate DRLs. Dose limits are shown in Table 5.1.

Table 5.1
Recommended Dose Limits

Application	Annual Dose Limits *	
	Atomic Radiation Worker	Public
Effective Dose: Current Limits	20 mSv (averaged over 5 years)	1 mSv

* This limit is the same as the current Administrative Control Limit effective dose per year.

In addition, the facility is operated in accordance with administrative controls as specified in AECL RC-2000-633-1. This document in part addresses the responsibilities and procedures for monitoring employee dose accumulation and restricting exposure to ionizing radiation. It sets out the Administrative Control Limits which are below the levels set by ICRP and the CNSC (See Table 5.2).

Table 5.2
Current Administrative Control Levels mSv (rem) for Atomic Radiation Workers

Organ or Tissue	Per 4 Weeks or Longer Monitoring Period	Per Year
Effective Dose	4 (0.4)*	20 (2)
Shallow Dose	50 (5)	200 (20)
Extremity Dose	50 (5)	----------

* Administrative Control Limits for workers who have declared pregnancy shall be 0.3 mSv. (0.03 rem) per two weeks and 5 mSv (0.5 rems) to the abdomen for the remainder of the pregnancy.

(b) *Non-Radiological Effluents*

Guidelines are followed for determining acceptable concentrations of various elements and pH in non-radiological effluents from AECL sites. These guidelines are listed in the AECL Environmental Protection Manual (RC 2000-021-00). Guidelines are for daily releases and monthly releases, the latter being the more restrictive of the two. The guidelines were obtained or derived from the following existing federal and Ontario guidelines:

- Environment Canada - Guidelines for Effluent Quality and Wastewater Treatment at Federal Facilities: EPS 1-EC-76-1, 1976 April.
- Environment Canada - Environmental Codes of Practice for Steam Power Generation: Design Phase and Operation Phase. EPS 1/PG/1 (1985 March) and EPS 1/PG/5 (1992 November).
- Ontario Ministry of the Environment - Objectives for the Control of Industrial Waste Discharges in Ontario. 1988.
- Environment Ontario - The Development Document for the Effluent Monitoring Regulation for the Electric Power Generation Sector. 1990 February.
- The MISA protocol is followed for sampling and analysis of non-radiological effluents.

Non-radiological monitoring data for Whiteshell Laboratories is documented in Atomic Energy of Canada Limited (1998).

5.2.1 Whiteshell Laboratories Airborne Effluents

The major sources of airborne radioactive effluents from Whiteshell Laboratories in 1998 were:

- the reactor building (B100) stack;
- the Active Liquid Waste Treatment Centre (B200);
- the Hot Cell Facility;
- the Immobilized Fuel Test Facility;
- Laboratory 2-136 in B300; and
- the Incinerator and the Compactor/Baler in the Waste Management Area.

A summary of air effluent monitoring results for Whiteshell Laboratories are provided in Table 5.3. Results for 1998 and the three previous years are also shown.

Table 5.3
Radionuclides in Air Effluents from Whiteshell Laboratories – 1995 to 1998

		Average Weekly Release								
	DRL * (Bq/wk)	**1995 (Bq/wk)**	**1995 (% DRL)**	**1996 (Bq/wk)**	**1996 (% DRL)**	**1997 (Bq/wk)**	**1997 (% DRL)**	**1998 (Bq/wk)**	**1998 (% DRL)**	**1998 Max Weekly Release (% DRL)**
Tritium										
Reactor Building	9.76E+15	4.8E+09	4.9E-05	9.7E+09	9.9E-05	2.0E+09	2.1E-05	1.9E+09	1.9E-05	5.7E-05
Beta**										
Reactor Building	3.21E+10	7.9E+03	2.5E-05	5.8E+03	1.8E-05	7.1E+03	2.2E-05	3.8E+03	1.2E-05	2.3E-05
ALWTC	9.83E+09	5.6E+03	5.7E-05	1.1E+04	1.1E-04	3.6E+03	3.6E-05	1.7E+03	1.8E-05	5.1E-05
Hot Cell Facility	1.05E+10	1.7E+04	1.6E-04	1.0E+04	9.7E-05	8.0E+03	7.7E-05	6.1E+03	5.8E-05	1.3E-04
IFTF	1.05E+10	4.8E+03	4.6E-05	4.9E+03	4.7E-05	3.0E+03	2.8E-05	4.1E+03	3.9E-05	1.0E-04
Incinerator	1.50E+11	7.1E+02	4.7E-07	1.5E+04	9.9E-06	2.7E+03	1.8E-06	2.9E+04	1.9E-05	6.5E-04
Compactor/Bailer	4.64E+09	2.8E+02	6.0E-06	2.1E+02	4.5E-06	3.4E+02	7.4E-06	3.9E+02	8.4E-06	1.6E-04
Total Beta		3.6E+04	2.9E-04	4.7E+04	2.9E-04	2.5E+04	1.7E-04	4.5E+04	1.5E-04	
^{131}I										
ALWTC	6.82E+09	2.96E+03	4.33E-05	<	<	<	<	<	<	<
Hot Cell Facility	7.25E+09	3.13E+04	4.29E-04	<	<	<	<	<	<	<
IFTF	7.25E+09	2.46E+03	3.40E-05	3.8E+05	5.3E-03	1.4E+04	1.9E-04	9.6E+04	1.3E-03	3.4E-02
Total ^{131}I		3.7E+04	5.1E-04	3.8E+05	5.3E-03	1.4E+04	1.9E-04	9.6E+04	1.3E-03	
TOTAL			0.0009		0.0057		0.0004		0.0015	

DRL * for members of the public at the Whiteshell Laboratories boundary.

** The DRL for ^{90}Sr is applied to beta activity.

Average emissions, in Becquerels per week and as a percentage of DRLs and the maximum weekly emissions as a percentage of DRL are shown for tritium, gross beta and ^{131}I for facilities in B300, B200 and B100. The releases from the various sources at Whiteshell Laboratories for various radionuclides, expressed in percentages of DRLs, are added to provide an indicator of the overall performance of the site. The highest such sum is 0.0057% for 1996, whereas the corresponding sum for 1998 is 0.0015%. The conclusion is that releases are very small, well below one thousandth of the DRL, and that this situation has been stable over several years. The year to year variations within these extremely small numbers are of no consequence.

5.2.2 Whiteshell Laboratories Liquid Effluents

The primary source of liquid radioactive effluents at Whiteshell Laboratories is the process water outfall (Outfall) which discharges continuously to the Winnipeg River. The discharge from the outfall is composed of tank discharges (including discontinuous discharges from the Active Liquid Waste Treatment Centre), storm water run-off, and miscellaneous cooling water. The secondary source of liquid effluents is the sewage lagoon which is discharged twice a year (usually June and October) to the Winnipeg River. The sewage lagoon collects sanitary sewage and wastewater from most buildings on the site.

Some drainage ditches also discharge to the Winnipeg River, but their contribution to the radioactivity in the effluent from the site is insignificant compared to the outfall and the lagoon.

Table 5.4 provides a summary of radioactive contaminants in liquid releases from Whiteshell Laboratories for the years 1995 to 1998. The average monthly releases, expressed as a percent of DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. In all cases, the releases were well below one thousandth of the DRL.

Table 5.4

Radionuclides in Liquid Effluents from Whiteshell Laboratories 1995-1998

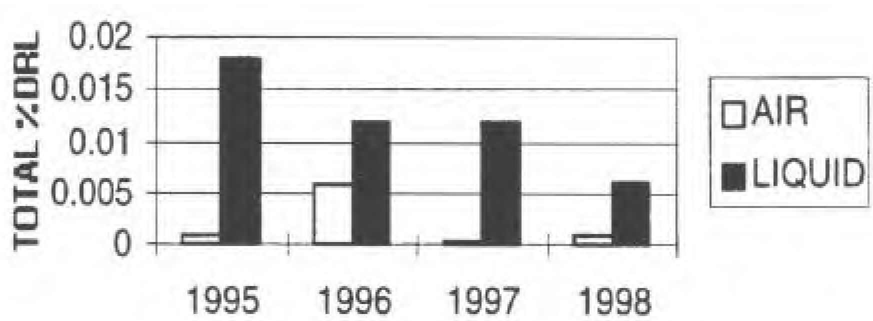
			Average Monthly Release							
	DRL * (Bq/month)	**1995 (Bq/month)**	**1995 (% DRL)**	**1996 (Bq/month)**	**1996 (% DRL)**	**1997 Bq/month**	**1997 (% DRL)**	**1998 Bq/month**	**1998 (% DRL)**	**Max 1998 (%DRL)**
OUTFALL										
Gross Alpha	3.30E+11	1.1E+07	3.3E-03	8.3E+06	2.5E-03	7.96.E+06	2.4E-03	7.9E+06	2.4E-03	7.0E-03
Gross Beta	~~	3.4E+08	~~	2.1E+08	~~	2.38E+08	~~	6.1E+07	~~	~~
^{60}CO	3.18E+12	8.7E+05	2.7E-05	6.1E+05	1.9E-05	7.96E+05	2.50E-05	8.2E+04	2.6E-06	1.7E-05
^{90}Sr	4.11E+12	9.0E+07	2.2E-03	6.7E+07	1.6E-03	8.46E+07	2.06E-03	1.5E+07	3.7E-04	1.4E-03
^{134}Cs	1.12E+12	3.0E+06	2.7E-04	3.0E+06	2.8E-04	8.52E+05	7.61E-05	<	<	<
^{137}Cs	1.59+12	2.0E+08	1.2E-02	1.2E+08	7.2E-03	1.12E+08	7.06E-03	4.2E+07	2.7E-03	6.0E-03
SEWAGE LAGOON										
Gross Alpha	3.30E+11	2.4E+05	7.3E-05	1.5E+05	4.5E-05	3.2E+05	9.8E-05	9.1E+04	2.8E-05	3.3E-04
Gross Beta	~~	3.7E+06	~~	2.4E+06	~~	2.27E+06	~~	1.6E+06	~~	~~
^{90}Sr	4.11E+12	7.1E+05	1.7E-05	5.9E+05	1.4E-05	4.87E+05	1.18E-05	4.6E+05	1.13E-05	9.5E-05
^{137}Cs	1.59E+12	1.0E+05	6.5E-06	9.0E+05	5.6E-05	5.18E+04	3.26E-06	<	<	
TOTAL			0.018		0.012		0.012		0.006	

Notes:
1. Averages shown for sewage lagoon equal the total of 2 releases divided by 12.
2. DRL for ^{241}Am is applied to alpha. In previous reports DRL for ^{239}Pu was applied to alpha. Percent DRL values for 1995 to 1997 have been recalculated.
3. DRLs are for members of public at the site boundary.

In summary, expressed as DRLs, the airborne and liquid emissions from Whiteshell Laboratories have been low in 1998 and previous years. It can be noted that over this time period, the highest sum of the site-wide DRL, is about 0.02% of the cumulative DRL (liquid emissions in 1995).

Figure 5.1 summarizes annual monitoring results for airborne and liquid effluents from the Whiteshell Laboratories site from 1995 to 1998, as percent of DRL.

Figure 5.1
Radioactive Emissions from Whiteshell Laboratories 1995-1998



Non- radiological Contaminants in Liquid Effluents

A table from AECL-MISC-390-99 presented below, show the trends for 1995 to 1999 for average annual concentrations, conformance with daily emission limits, conformance with monthly emission limits and loadings. Data are presented for the two effluent release points from the site, the lagoon and the outfall. The monthly and daily emission limits adopted by AECL are also shown.

Table 5.5
Trends in Average Annual Concentrations, 1995 to 1999

Parameter	Unit	Monthly Limit (Average)	Daily Limit (Any Single Sample)	Lagoon					Outfall				
				1995	1996	1997	1998	1999	1995	1996	1997	1998	1999
pH	pH	6 to 9	5.5 to 9.5	9.10	8.5	8.3	8.1	8.3	7.5	7.8	8.1	7.4	7.56
Phosphorus	mg/L	1.0	5.0	1.03	0.74	0.60	0.61	0.50	0.03	0.05	0.09	0.00	0.02
Total Susp.Solids	mg/L	25	125	4.00	65.6	7.70	3.50	7.00	6.65	5.9	4.6	1.92	4.10
Chromium	mg/L	0.5	2.5	0.01	0	0.00	0.01	0.0005	0.00	0.01	0.01	0.01	0.003
Copper	mg/L	0.5	2.5	0.01	0.01	0.00	0.02	0.07	0.01	0.04	0.02	0.02	0.05
Iron	mg/L	1.0	5.0	0.17	0.36	0.20	0.18	0.17	0.34	0.41	0.29	0.24	0.27
Lead	mg/L	0.1	0.5	0.00	0.01	0.00	0.00	< 0.002	0.00	0.01	0.10	0.00	0.00
Nickel	mg/L	0.5	2.5	0.00	0.01	0.00	0.05	0.009	0.00	0.01	0.00	0.00	0.003
Zinc	mg/L	0.5	2.5	0.00	0	0.00	0.01	0.02	0.01	0.03	0.00	0.01	0.01
Mercury	ug/L	n/a	0.001	0.32	0.01	0.00	0.20	0.030	0.06	0.07	0.00	0.05	0.047
Phenolics	mg/L	0.02	0.1	0	0.5	0	0.008	< 0.001	N/A	N/A	N/A	N/A	N/A
Oil & Grease	mg/L	15	75	1.18	0.5	0.9	4.30	0.60	1.05	0.82	1.1	1.33	1.10

5.2.3 Estimated Dose from Whiteshell Laboratories Effluent Emissions

Environmental monitoring data (Niemi et al. 2000) have been used to estimate the incremental dose that could be caused to members of critical groups by operations at Whiteshell Laboratories. The estimates take into account water, fish and vegetable ingestion and beach exposure. Immersion in air and ingestion of wildlife (game) are not considered because of the extremely low radioactivities associated with those two sources.

Table 5.6 shows the reported dose estimates for 1997 to 1999.

Table 5.6
Estimated dose from Whiteshell Laboratories Liquid Effluents

	ADULT (mSv/a)			**INFANT (mSv/a)**		
Pathway	1997	1998	1999	1997	1998	1999
Water Ingestion	2.1E-04	3.19E-04	2.10E-04	5.6E-05	2.82E-04	1.82E-04
Fish Ingestion	1.0E-04	1.46E-04	8.32E-05	5.0E-06	7.28E-06	3.84E-06
Vegetable Ingestion	NA	5.95E-05	1.18E-04	NA	3.0E-04	2.12E-05
Beach Exposure	4.6E-05	3.69E-05	2.42E-05	7.1E-05	5.57E-05	3.63E-05
Total	3.6E-04	5.61E-04	4.35E-04	1.3E-04	6.45E-04	2.43E-04

NA: not analyzed

For comparison, typical radiation doses to adults from major natural sources and from medical diagnostic procedures amount to about 3.2 mSv/a. Actual background doses vary as a function of various factors such as elevation, local geology and housing material.

5.3 GENERAL RADIATION ENVIRONMENT

The following section provides an overview of the general radiation environment in the Pinawa area. The radiation data presented consists of routine ambient gamma radiation measurements made at 12 ambient air monitoring stations, gamma radiation survey data for various locations in the area and gross alpha/beta data for surface water, sediment and vegetation. Specific radionuclide data are presented in Section 5.3, Biophysical Conditions. The data in this section is drawn from the 1998 Annual Report of Radiological Monitoring – Volume 3 (Niemi and Soonawala 1999b). In most cases, the 1998 results of gross radiological parameter monitoring are presented along with 1994 – 1998 data in order to identify any trends.

5.3.1 Ambient Gamma Radiation Level

In 1998, ambient gamma radiation in air was monitored by means of thermoluminescent dosimeters (TLDs) at 12 locations in the three following general areas:

- at 5 locations near the perimeter of the Whiteshell Laboratories site;
- at the Pinawa hospital, Pinawa Resort (Kelsey House), Pinawa town yard; and
- at 4 locations on the Controlled Area fence.

The annual TLD readings for years 1994 to 1998 for each of the 12 TLD monitoring locations are shown in Table 5.7 in units of milligray per year (mGy/a). Figure 5.2 shows the mean of the readings from the TLDs at the site perimeter, Pinawa and Whiteshell Laboratories site Controlled Area fence areas, respectively, for the years 1994 to 1998. The reported readings include the gamma background exposure.

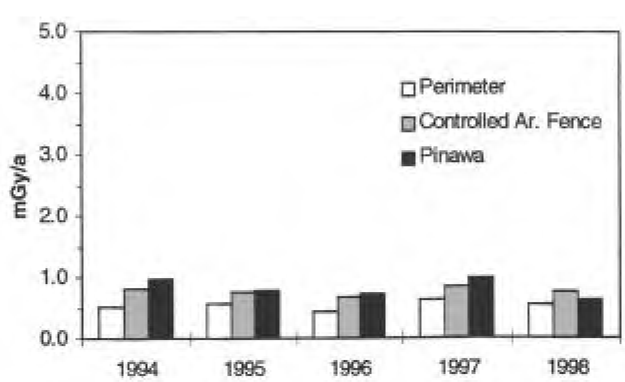
Data in Table 5.7 and Figure 5.2 show that ambient gamma radiation at all locations has remained stable over the period 1994 to 1998. The 1998 levels are marginally lower than the 1997 levels, but such small variations are of no particular significance.

Table 5.7
Ambient Gamma Radiation

Location	Total Gamma Dose (mGy/a)				
	1994	1995	1996	1997	1998
Perimeter					
1 North	0.530	0.603	0.503	0.719	0.668
2 East-southeast	0.390	0.482	0.381	-	0.511
3 South-southeast	0.523	0.617	0.497	0.636	0.526
4 West	0.588	0.605	0.410	0.628	0.466
5 Northwest	0.520	0.570	0.403	0.540	0.559
Mean (Perimeter)	0.510	0.575	0.439	0.631	0.546
Pinawa					
Town Yard	1.134	0.699	0.527	0.831	0.609
Resort (Kelsey House)	0.956	1.044	1.116	1.173	N/A
Hospital	0.852	*0.601	0.532	0.877	N/A
Mean (Pinawa)	0.981	0.782	0.725	0.960	0.609
Controlled Area Fence					
South Fence	0.712	0.727	0.662	0.634	0.735
East Fence	0.732	0.849	0.699	0.771	0.673
North Fence	0.683	0.732	0.694	0.874	0.931
West Fence	1.066	0.734	0.664	1.079	0.661
Mean (Fence)	0.798	0.761	0.680	0.839	0.750

N/A Data not available because of vandalism of TLDs.
* Sum of 3rd and 4th quarter readings multiplied by two.
Natural background, caused by cosmic and terrestrial sources, is included in the TLD readings.

Figure 5.2
Ambient Gamma Radiation 1994-1998



5.3.2 Gamma Radiation Survey Data

The dose rate due to ambient gamma radiation was measured once during 1998 at control points on road routes along a 16 km radius surrounding the Whiteshell Laboratories site. Results for 13 points in the off-site public area and 10 points within the Whiteshell Laboratories site are shown in Table 5.8 for the years 1994 to 1998. The results for 1998 are similar to those for previous years.

Table 5.8
Land Gamma Radiation Survey Data for Whiteshell Laboratories and Vicinity

Control Point	Mean Gamma Dose Rate (mGy/h)				
	1994	1995	1996	1997	1998
Public Area (16 km Route)					
Plant Road & HWY. 211	0.06	0.10	0.12	0.11	0.10
HWY. 211 & Rifle Range	0.07	0.11	0.11	0.12	0.09
Pinawa Stage 1	0.07	0.14	0.13	0.11	0.11
Pinawa Stage 2	0.07	0.13	0.14	0.12	0.12
Junction HWY. 11 & HWY. 307	0.05	0.09	0.15	0.11	0.11
Bridge to Seven Sisters	0.06	0.11	0.12	0.13	0.12
Town Circuit at Dam	0.05	0.11	0.13	0.12	0.10
Junction HWY. 214 & HWY. 111	0.08	0.06	0.08	0.10	0.09
Lac du Bonnet Circuit	0.09	0.08	0.09	0.09	0.09
West Side of LDB Bridge	0.11	0.09	0.08	0.11	0.08
HWY. 520 at Old Pinawa	0.14	0.11	0.13	0.14	0.11
Riverland School	0.12	0.11	0.12	0.12	0.12
Road at ARMS #1	0.14	0.13	0.15	0.12	0.11
Whiteshell Laboratories Site					
B401 into Active Area	0.08	0.09	0.11	0.12	0.13
Road South side of 300	0.12	0.09	0.13	0.19	0.10
Road West side of 300	0.12	0.07	0.15	0.13	0.16
South Side of 200 & 411	0.23	0.13	0.40	0.19	0.20
East of 100	0.19	0.07		0.14	0.16
East gate	0.13	0.09	0.10	0.11	0.14
North Road at Lagoon Road	0.12	0.06	0.12	0.09	0.09
Rd. East of Canister Area	0.19	0.10	0.16	0.17	0.17
East Rd. at WMA Gate	0.11	0.12	0.20	0.18	0.15
East Rd. at Landfill site	0.12	0.06	0.10	0.09	0.11

5.3.3 Affected Lands

Information on the nature and extent of potential contamination on the affected lands, resulting from some of the more significant unplanned events as well as planned tests and experiments, is presented in Table 5.9.

Table 5.9
Contamination in Affected Lands at Whiteshell Laboratories

Date	Event	Purpose/Scope	Release Quantity	Current Status	Reference
67 May	Cesium Pond experiment	Study of dose distribution in a pond containing Cs	18.5 GBq (0.5 Ci)	Elevated levels of Cs-137	Guthrie & Scott, 1969
71 May	Contamination of lawns near B300, and north side of B402 due to fission product release from Hot Cells stacks.	N/A	Max I-131 concentration in grass was 2.07E4 dpm/m^2	No detectable contamination	Acres, 1971
72 May	Contamination of grass north of B300, due to fission product release from Hot Cells stacks	N/A	92.5 MBq (25 mCi) of old fission products	No detectable contamination	Plunkett, C.H., 1972
73 March	Field Irradiator Gamma (FIG) facility	Study of ecological effects of gamma exposure on boreal forest ecosystem.	No activity released. Sealed source of 370 TBq Cs-137	No radioactivity above background	Guthrie and Dugle, 1983
1976	Zoological Environment Under Stress (ZEUS) facility	Study effects of ionizing radiation on small mammals	No activity released. Sealed source of 0.22 PBq (6000 Ci) Cs-137	No radioactivity above background	Turner and Iverson, 1976
79 May	Water containing fission products dumped at WMA into the North Ditch that discharges into the Winnipeg River.	N/A	7 GBq of fission products	Elevated levels of gross beta, about 1.25 to 2.5 times activity in West Ditch	Guthrie and Acres, 1980
80 Aug	Contamination of ground and roadway south of B200 caused by pumping of ALWTC Tank 801 into a leaking line.	N/A	65 GBq (total of 3 incidents)	About 9 GBq of Cs-137 and Sr-90 remain in ground	Ridgway et al., 1997
91 Feb and Mar	Tracer Experiment in deep boreholes, Whiteshell Laboratories borehole site	Study of radionuclide transport in rock.	1.4 GBq (37.6 mCi) of Br-82, I-131, Sr-85 and Cs-134.	Negligible activity-- short half-lives.	Frost, L.H. et al. 1995

Note: Units of radioactivity used in references have been retained. 1 Ci = 37 GBq.

An airborne gamma survey was performed to assist with site wide characterization of ground-level radiation and to verify that any significant manmade contamination was restricted to the Whiteshell Laboratories site (Gamma Bob and Sander Geophysics Ltd. 2000). Airborne gamma ray maps of the Project Study Area were produced (Figures 5.3, 5.4 and 5.5) and show ^{137}Cs and ^{60}Co gamma radiation and the total due to all sources of gamma radiation (nGy/h).

Four localized sources of ^{137}Cs were detected within the affected lands. Three of these areas are associated with the Whiteshell Laboratories nuclear facilities and the remaining area is the site of the cesium pond experiment. One of the sources associated with the Whiteshell Laboratories nuclear facilities also showed the presence of ^{60}Co and ^{232}Th. ^{137}Cs was also detected throughout the affected lands and was attributed to atomic weapons testing carried out in the 1950s and early 1960s. The ^{137}Cs activities ranged from 0 to 15 Bq/kg and are typical of those found in southeast Manitoba. No other areas with elevated levels of manmade radiation were detected within the affected lands.

It is important to note that the ^{60}Co map reveals concentrations in the WMA and not in WR-1, although there are much higher levels of ^{60}Co in WR-1. The reason for this is the integrity of the WR-1 reactor shielding structure, which attenuates the gamma radiation from ^{60}Co. This supports the argument presented in Section 3.3 that the best storage location for the WR-1 components is the reactor vault until radioactivity decay is optimized.

5.3.4 Unaffected Lands

Environmental monitoring data, (i.e. ambient gamma radiation and vegetation monitoring) referenced in Atomic Energy of Canada Limited (2000) indicate that the unaffected lands at the Whiteshell Laboratories have not been utilized, impacted or affected by Whiteshell Laboratories' operations. This was verified through a detail radiological survey in the summer of 2000 (Gamma Bob and Sander Geophysics Ltd. 2000). Until the release of unaffected lands is authorized by the CNSC, the lands will remain under CNSC licenced control.

5.4 BASELINE CONDITIONS: BIOPHYSICAL

Biophysical conditions are described for climate and meteorology, air quality, geology, hydrogeology, hydrology, terrestrial biota and habitats, aquatic biota and habitats, regional land and resource use, and valued ecosystem components.

5.4.1 Climate and Meteorology

Site

Meteorological measurements were made at the Whiteshell Laboratories' climate station located on a 50 m x 50 m grass field located about 200 m west of the Whiteshell Laboratories' plant site and 200 m east of the Winnipeg River, which runs approximately north-south of the site. The field is located within a 2 ha clearing with the nearest trees or buildings at least 100 m distant. The Whiteshell Laboratories' climate station consisted of a louvered shelter used to house two liquids in glass thermometers, as well as two precipitation gauges. The Whiteshell Laboratories station was closed in 1998. Also on the field are a 61 m tower operated by Whiteshell Laboratories and a 10 m tower operated by Environment Canada. The 61 m tower is instrumented at the 61, 25, 6 and 1.5 m levels with wind and air temperature sensors. Environment Canada monitors instruments mounted on or near a 10 m tower to measure air temperature, wind, rainfall, snow cover on the ground, dewpoint temperature and barometric pressure.

<u>*Period of Record*</u>

The climate station has data covering the 34 year period from 1964 to 1997 inclusive for temperature and precipitation. Wind data are available for 21 years from 1978 to 1997. Summary data in Table 5.10 covers 32 years from 1964 - 1995.

Temperature

The near surface temperature affects the reaction rates of contaminants as well as atmospheric stability.

Table 5.11 presents the temperature variations by month over the 32 year period of record. The daily minimum ranges from a high of 12.9°C in July to a low of –23.8°C in January, while the daily maximum ranges from a high of 24.7°C in July to a low of –13.0°C in January. The daily mean temperature varies from a low of –18.4°C in January to a high of 18.8°C in July.

Over the 32 year period of record, the extreme maximum temperature was 37.5°C recorded on 17 June 1995 and the extreme minimum was –47.8°C recorded on 19 February 1966.

Table 5.10
Whiteshell Laboratories Normals and Extremes 1964-1995 for Temperature

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual	32-Year Extreme
Temperature														
Daily Maximum (°C)	-13.0	-8.9	-1.0	9.3	17.7	22.0	24.7	23.4	17.2	9.6	-1.5	-9.9	7.5	
Daily Minimum (°C)	-23.8	-21.2	-12.9	-2.8	4.4	9.7	12.9	11.4	6.1	0.4	-8.7	-19.1	-3.6	
Daily Mean (°C)	-18.4	-15.0	-7.0	3.2	11.1	15.9	18.8	17.4	11.7	5.0	-5.0	-14.5	1.9	
Extreme Maximum (°C)	7.8	9.5	20.0	29.9	34.6	37.5	35.0	35.6	36.0	27.2	23.3	10.0		37.5
Extreme Minimum (°C)	-43.9	-47.8	-39.4	-28.9	-13.9	-3.9	-0.6	-1.6	-6.7	-14.5	-34.5	-40.0		-47.8
Degree-Days														
Monthly Degree-Days (below 18°C)	1125.1	929.6	772.1	444.6	224.4	90.8	29.5	59.6	197.8	404.0	688.0	1005.0	5971.0	
Sunshine Hours														
Monthly Hours of Sunshine	112.6	133.7	172.8	205.9	346.2	243.6	287.6	249.0	148.5	106.6	83.0	94.2	2083.6*	

* 16 Year Normal.

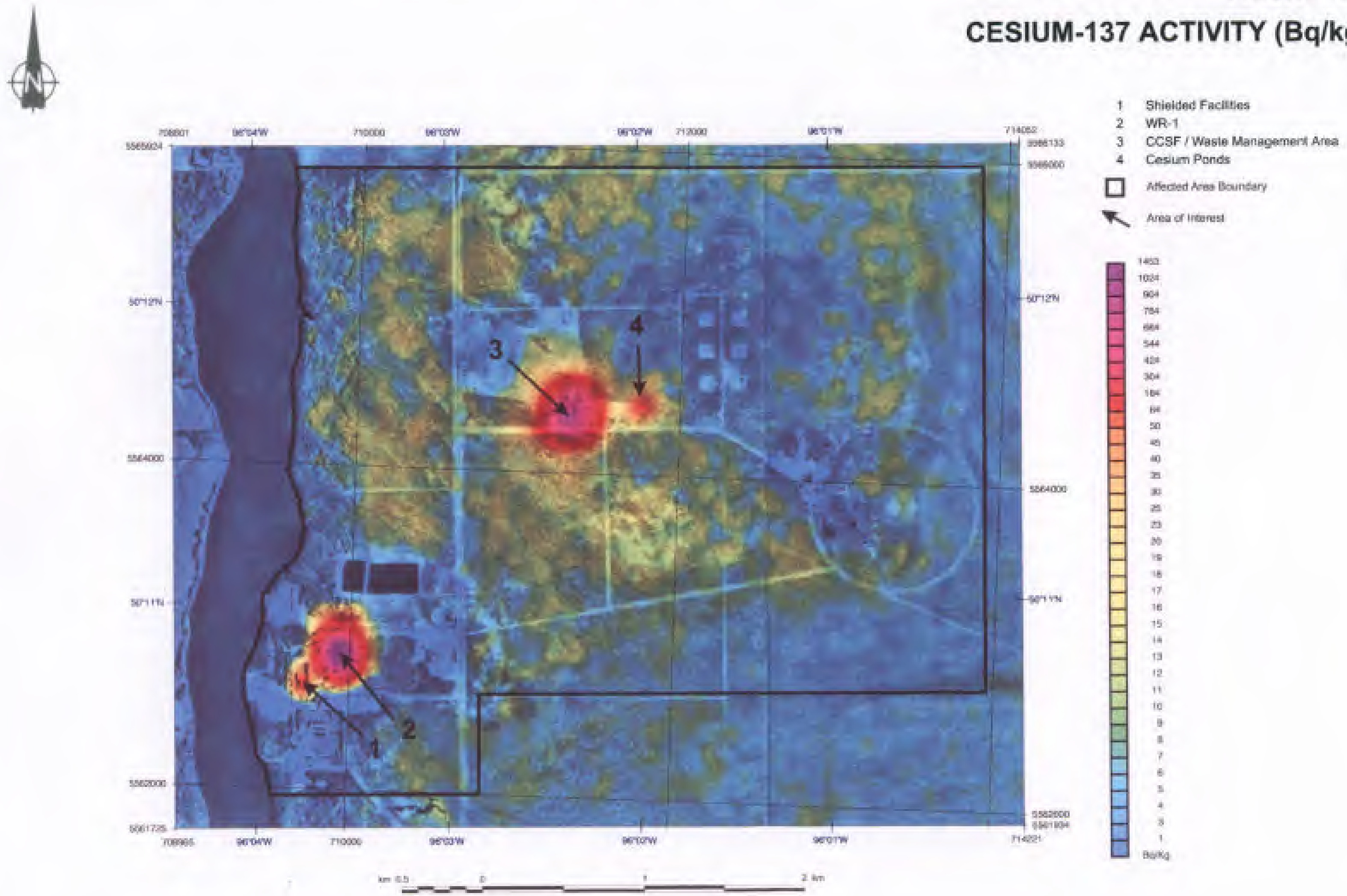
Precipitation

Contaminants in the atmosphere can be deposited to the Earth's surface by precipitation. This can contribute to contaminant levels in soil and groundwater.

Table 5.11 shows that Whiteshell Laboratories receives an average of 562 mm of precipitation per year, including an average of 127.1 cm of snowfall. The mean maximum monthly rainfall is 91.3 mm in June. Both July and August also have relatively high rainfall of 77.8 mm and 72.5 mm, respectively.

FIGURE 5.3

CESIUM-137 ACTIVITY (Bq/kg)



SOURCE: Adapted from Gamma Bob and Sander Geophysics, 2000

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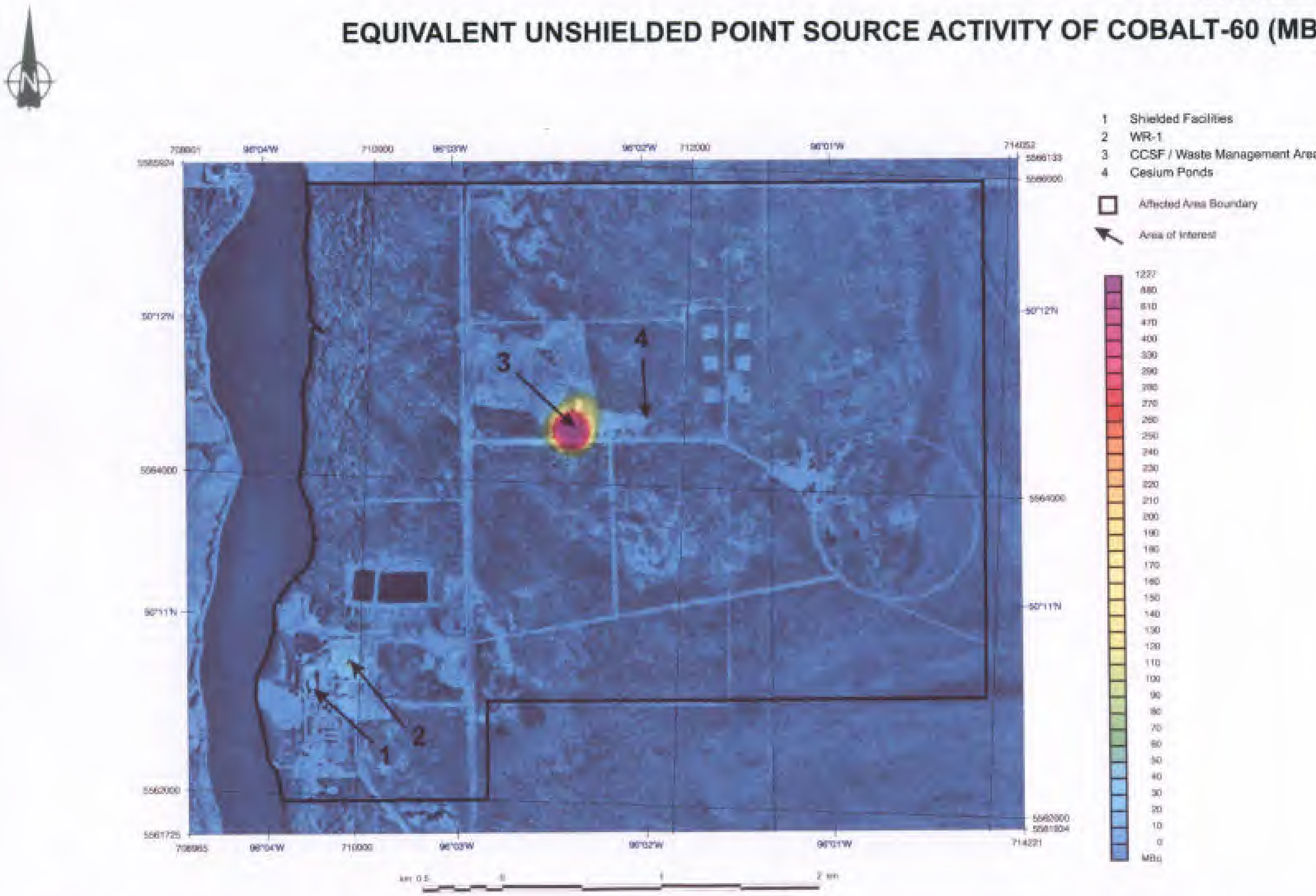
FIGURE 5.4

EQUIVALENT UNSHIELDED POINT SOURCE ACTIVITY OF COBALT-60 (MBq)



SOURCE: Adapted from Gamma Bob and Sander Geophysics, 2000

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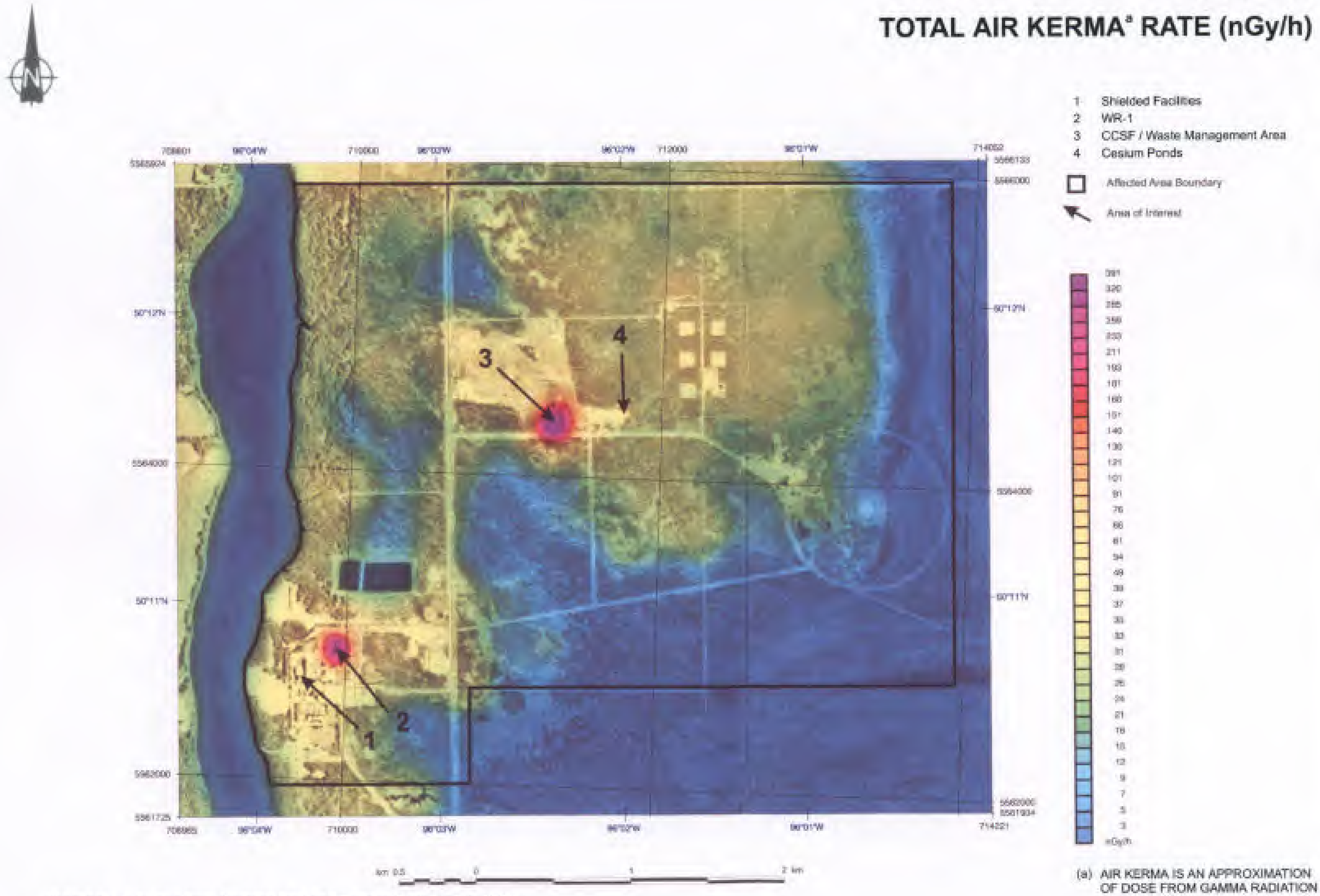
FIGURE 5.5

TOTAL AIR KERMA[a] RATE (nGy/h)



(a) AIR KERMA IS AN APPROXIMATION OF DOSE FROM GAMMA RADIATION

SOURCE: Adapted from Gamma Bob and Sander Geophysics, 2000

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The maximum 24-hour accumulation of rainfall occurred on 15 June 1973 when 168.4 mm was measured. The maximum snowfall in one day was 36.8 cm on 31 October 1971.

Measurable precipitation occurs on an average of 128 days per year based on the Environment Canada Whiteshell Station over the period 1961 to 1990 (Environment Canada 1993).

Table 5.11
Whiteshell Laboratories Normals and Extremes 1964-1995 for Precipitation

Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Annual**	**32-Year Extreme**
Rainfall (mm)	0.4	0.4	7.0	24.6	55.2	91.3	77.8	72.5	62.6	36.5	5.5	1.0	434.9	
Snowfall (cm)	23.3	14.6	20.4	10.5	1.9	0.0	0.0	0.0	0.6	8.4	23.1	24.3	127.1	
Total Precipitation (mm)	23.8	15.0	27.4	35.1	57.1	91.3	77.8	72.5	63.2	44.9	28.6	25.3	562.0	
Greatest Rainfall in 24 Hours (mm)	5.1	3.3	17.4	32.0	65.0	168.4	60.0	77.2	75.2	56.5	18.4	17.6		168.4
Greatest Snowfall in 24 Hours (cm)	23.9	15.7	34.3	32.5	10.0	0.0	0.0	0.0	4.0	36.8	20.8	20.8		36.8

Wind Speed

Figure 5.6 presents the average wind speed and shows that at Whiteshell Laboratories, the wind speed varies from 8 to 9 km/h near the surface (6 m) to 17 to 20 km/h at a height of 61 m. The annual average wind speed at the reference 10 m height is 14 km/h (Environment Canada 1982).

Dilution of airborne emissions increases with wind speed.

Figure 5.6
Average Wind Speed vs Height for the Period 1978 to 1995

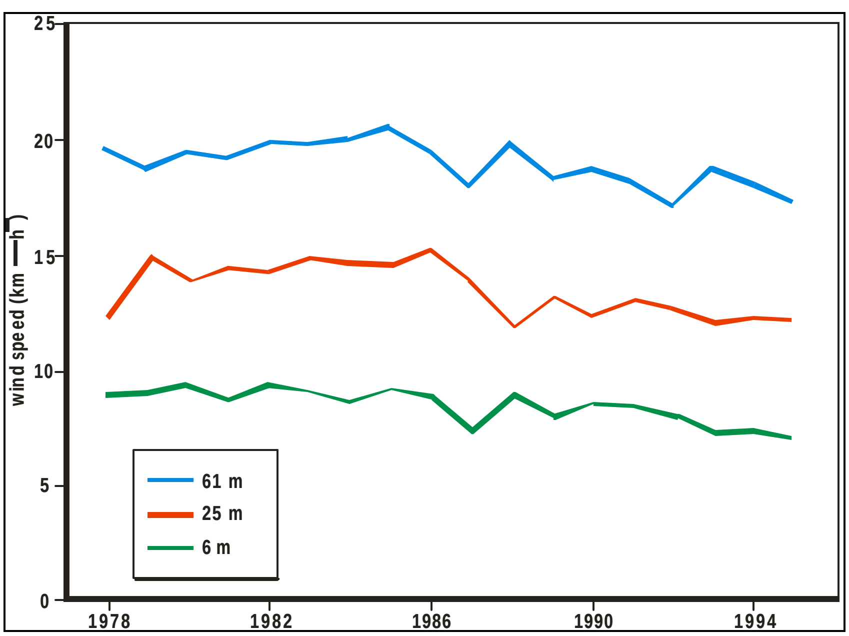


Table 5.12 presents the percentage frequencies of various wind speed categories as a function of wind direction. Wind speed data were divided into four classes: calm, 1.5 to 12, greater than 12 to 20, and greater than 20 km/h. Calm was defined as any wind speed less than 1.5 km/h.

Table 5.12
Wind Rose Data (6 m) for 1978 – 1995

Wind Direction	Hourly Observations of Wind Speed (km/hr)				Totals
	<1.5 (calm)	**>1.5 to 12**	**>12 to 20**	**>20**	
N	0.89%	4.81%	1.32%	0.17%	7.19%
NNE	0.35%	2.58%	0.72%	0.06%	3.72%
NE	0.23%	1.31%	0.57%	0.09%	2.20%
ENE	0.31%	1.35%	0.37%	0.05%	2.08%
E	0.39%	1.87%	0.70%	0.12%	3.09%
ESE	0.66%	2.36%	0.76%	0.06%	3.84%
SE	1.00%	3.42%	1.05%	0.06%	5.54%
SSE	1.12%	6.59%	3.03%	0.43%	11.17%
S	1.62%	6.89%	1.60%	0.18%	10.29%
SSW	1.75%	4.25%	0.38%	0.01%	6.39%
SW	1.52%	3.11%	0.31%	0.02%	4.96%
WSW	1.45%	3.32%	0.59%	0.07%	5.44%
W	1.22%	3.51%	1.49%	0.33%	6.55%
WNW	0.92%	2.71%	2.01%	0.99%	6.63%
NW	0.76%	3.23%	2.85%	1.59%	8.43%
NNW	0.76%	5.66%	2.57%	0.73%	9.72%
Totals	**14.94%**	**56.98%**	**20.32%**	**4.98%**	**97.22%**

Missing Data = 2.78%.
Source: Johnston 1996.

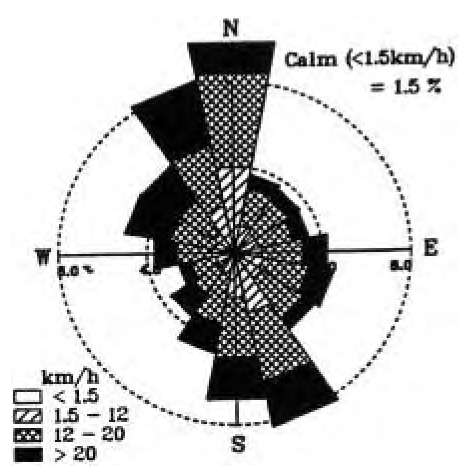
Table 5.12 shows that only about 5% of the wind speeds are above 20 km/h which is the wind erosion threshold speed. This indicates that there is a very low potential that fugitive dust resulting from decommissioning will be resuspended and carried off-site.

Wind Direction

Wind direction is reported as the direction from which the wind blows. In general terms, if the wind does not blow toward a receptor, there is no air quality problem. However, at most locations the wind blows in all directions with varying frequencies. Certain directions occur more frequently than others, and these are known as the prevailing winds.

Table 5.12 presents the wind rose data for the 6 m level at Whiteshell Laboratories. It shows that the prevailing wind directions are SSE, S and NNW. This bi-directional prevailing wind characteristic is caused by a channelling of the wind by the local topography (the river valley).

Figure 5.7
Whiteshell Laboratories Windrose, 1998 for 61 m Height



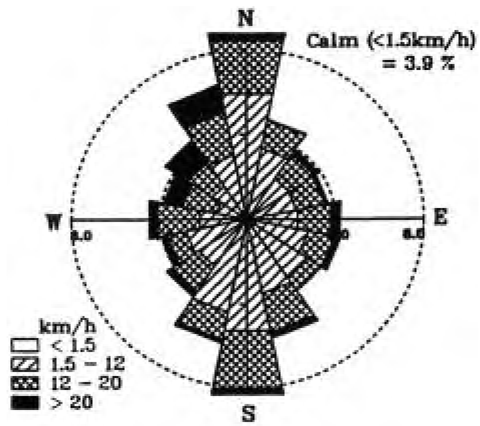
Recent Wind Data

The 1998 data from the Whiteshell Laboratories' observing station shows a similar pattern to the 17 year summary presented in Table 5.12. The data presented in Figures 5.7, 5.8, 5.9 and 5.10 show an increasing percentage of calms and a shift to lower windspeeds as the surface is approached. This is consistent with theory. The high level of calms near the surface (20.5%) means that any dusts generated tend to stay on or near the site.

Figures 5.7, 5.8, 5.9 and 5.10 also show a shift in the predominant wind directions from SSE-NNW near the surface (6 m) to N-S aloft (61 m). Again, this is consistent with boundary layer physics with a clockwise rotation due to the coriolis forces as one moves away from the earth's surface.

Figure 5.10 presents the 1998 wind rose data from the Environment Canada tower. It is very consistent with the Whiteshell Laboratories' data except that it shows lower wind speeds and a high frequency of occurrence of winds from the NW and SE sectors.

Figure 5.8
AES/Whiteshell Laboratories Windrose, 1998 for 25 m Height



5.4.2 Air Quality

Figure 5.9
Whiteshell Laboratories Windrose, 1998 for 10 m Height

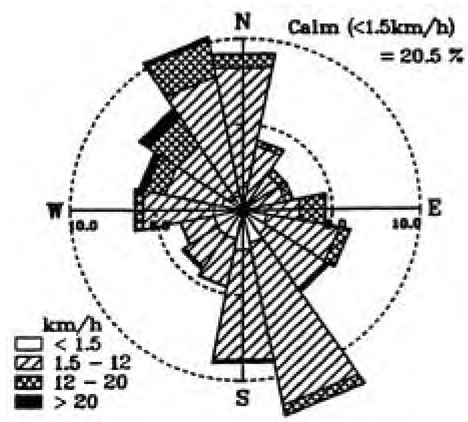
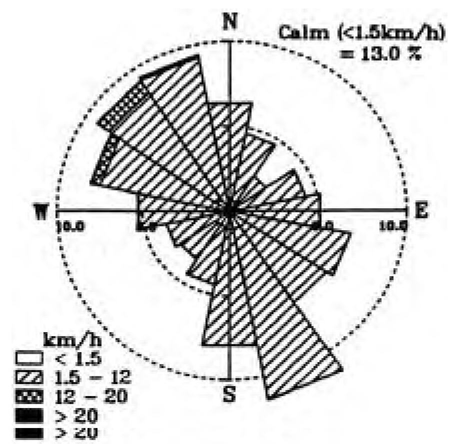


Figure 5.10
AES/Whiteshell Laboratories Windrose, 1998 for 6 m Height



<u>Introduction</u>

The existing air quality is being documented to provide a baseline against which the effects of the decommissioning of Whiteshell Laboratories can be assessed. The decommissioning will generate dust (particulate matter) with varying particle sizes. These are generally categorized into three forms:

- PM_{10} is the fraction of the particulate matter that is less than 10 µm in diameter. PM_{10} will remain in the atmosphere longer since the particles are smaller. Particles of this size have been linked with increased cardiopulmonary effects in humans.
- $PM_{2.5}$ is the fraction of particulate matter that is less than 2.5 µm in diameter. This size of particle can be breathed deep into the lungs and behaves like a gas, remaining in the atmosphere for days to weeks before being deposited.
- Dustfall which is made up primarily of larger dust particles that can collect on flat surfaces.

<u>Regional Study Area</u>

There is no air quality monitoring in the region (Van Dusen 2000). The closest data available are from the following stations:

- Stations 9118 and 9119 in Winnipeg, MB.
- Stations 62030, 62032 and 62035 in Fort Frances, ON.
- Stations 63200, 63046, 63120 and 63121 in Thunder Bay, ON.

These stations have been set up primarily as significant local source monitors and as such will not be representative of conditions in the Regional Study Area. The lowest 10th percentile of the observations will, however, represent background air quality. These data can be used to estimate the background air quality at the study area as this level is fairly constant from site to site. Data from the above stations for 1995 were reviewed and the 10th percentile values are presented in Table 5.13.

Table 5.13
1995 10th Percentile Air Quality Data Summary

Parameter	Units	Averaging Time	Station Location ID #								
			Winnipeg, MB		Fort Frances, ON			Thunder Bay, ON			
			9118	9119	62030	62032	62035	63200	63046	63120	63121
CO	ppm	1 hour	0.20	0.40	nd	nd	nd	nd	0.00	nd	nd
NO_2	pphm	1 hour	0.30	0.70	nd	nd	nd	0.00	nd	nd	nd
NO	pphm	1 hour	0.00	0.00	nd	nd	nd	0.00	nd	nd	nd
NO_x	pphm	1 hour	0.30	0.80	nd	nd	nd	0.00	nd	nd	nd
O_3	ppb	1 hour	2.00	2.00	12.70	nd	nd	2.60	nd	10.10	nd
SO_2	ppm	1 hour	nd	nd	nd	nd	nd	0.00	nd	nd	nd
COH	COH units	1 hour	0.00	0.00	0.00	nd	nd	0.00	0.00	nd	nd
PM_{10}	$\mu g/m^3$	24 hours	nd	8.20	nd	nd	nd	6.00	nd	nd	nd
TSP	$\mu g/m^3$	24 hours	14.00	15.00	nd	10.00	14.00	16.00	21.00	nd	12.00
Lead (Pb)	$\mu g/m^3$	24 hours	0.03	0.03	nd	nd	nd	0.01	nd	nd	nd
SO_4	$\mu g/m^3$	24 hours	0.85	0.97	nd	nd	nd	1.48	nd	nd	1.46
NO_3	$\mu g/m^3$	24 hours	0.08	0.14	nd	nd	nd	nd	nd	nd	nd
TRS	ppb	1 hour	nd	nd	0.00	0.00	nd	0.00	0.00	nd	nd

Note: nd = no data.

Table 5.14 shows regional air quality background concentration levels in the following range:

Table 5.14
Air Quality Background Concentration Levels

Parameter		Concentration Range (various units)	Concentration Range ($\mu g/m^3$)	Air Quality Standard ($\mu g/m^3$)	Range (%)
CO	(1 hour average)	0 – 0.4 ppm	0 – 466	36200	0 – 1.2
NO_2	(1 hour average)	0 – 0.7 pphm	0 – 13	400	0- 3.3
NO	(1 hour average)	0 pphm	0	ns	-
NO_x	(1 hour average)	0 – 0.8 pphm	0 – 15	400	0 – 3.4
O_3	(1 hour average)	2 – 13 ppb	4 – 26	160	2.5 – 16.3
SO_2	(1 hour average)	0 ppm	0	690	0
TRS	(1 hour average)	0.00 ppb	0	40	0
PM_{10}	(24 hour average)		6 – 8	50	12 – 16
TSP	(24 hour average)		10 – 21	120	8.3 – 17.5
Pb	(24 hour average)		0.01	2	0.5
$SO_4^{=}$	(24 hour average)		0.85 – 1.48	ns	-
NO_3^-	(24 hour average)		0.08 – 0.14	ns	-

In summary, the regional air quality ranges from 0 to 17% of the relevant provincial and/or federal standards. Therefore, this area is classified as “very clean”.

Local Study Area (Including the Licensed Study Area)

The 1998 Annual Report of Radiological Monitoring - Volume 3 (Niemi and Soonawala 1999b) was used to develop the baseline air quality for the Whiteshell Laboratories site. Levels of non-radiological pollutants including dust (Particulate Matter less than 10 µm in diameter (PM_{10}), Particulate Matter less than 2.5µm in diameter ($PM_{2.5}$), Sulphur dioxide (SO_2), Nitrogen oxides (NO_x) and Volatile Organic Compounds (VOCs), in the Project Study Area are not expected to differ from the regional levels.

Radioactivity and Air Quality

The monitoring data collected for the above mentioned 1998 report shows consistently low levels of radioactivity at all monitoring stations both within the Project Study Area and in the Local Study Area (Niemi and Soonawala 1999b). It concludes that "*…monitoring of potential atmospheric effluent exposure pathways did not indicate any measurable contribution in excess of natural background levels from Whiteshell Laboratories operations. This is consistent with effluent monitoring results which indicated that airborne emissions were very small.*"

The estimated dose to the most heavily exposed members of the public (assumed to be living at the site boundary) was a negligible percentage of the typical background radiation dose in Canada.

5.4.3 Geology

Bedrock Geology

Regional Study Area

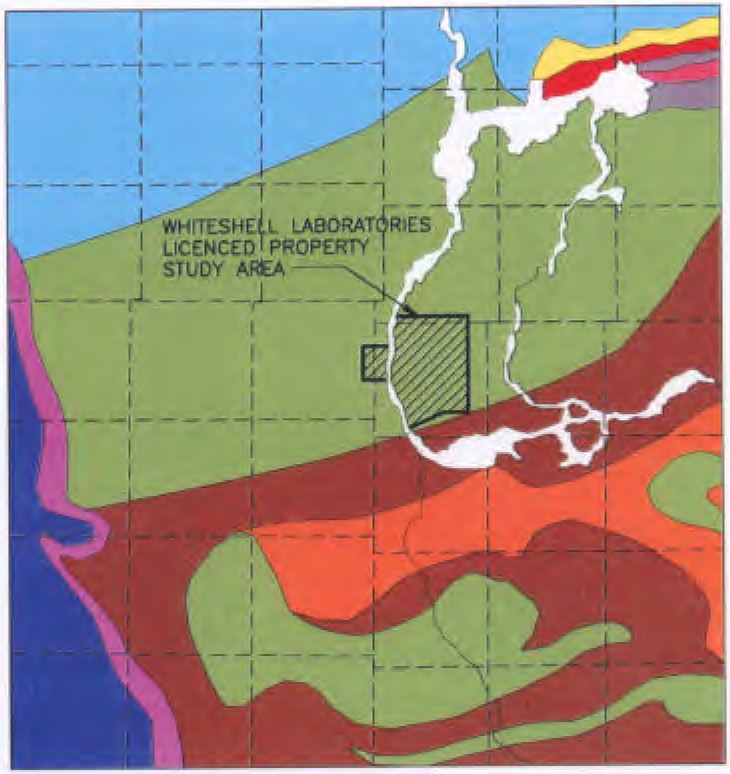
In the eastern portion of the Regional Study Area, the chief rock types consist of predominately acidic to intermediate gneisses that have been extensively intruded by granitic to granodioritic rocks. In the western region, Precambrian rocks are overlain by gently dipping (to the west) Paleozoic sediments forming the eastern margin of the Western Canadian Sedimentary Basin. The basal unit of this formation is the Winnipeg Formation, comprising inter-bedded shales and sandstones, which lie unconformably on the Precambrian surface. Overlying the Winnipeg Formation is the Red River Formation, comprising limestones and dolomites. To the northeast lies a series of Archean sedimentary, volcanic and intrusive rocks, which include the large Bernic Lake pegmatite (Guthrie and Scott 1988).

Local Study Area

In the vicinity of the Whiteshell Laboratories (Figure 5.11), the Lac du Bonnet batholith is the dominant igneous body in the area, and forms part of the English River Subprovince of the Superior Province of the Precambrian Shield. The Lac du Bonnet batholith is a large, flat, sheet-like body with steeply dipping walls (Guthrie and Scott 1988), and where outcrops occur (mostly on the east side of the Winnipeg River), jointing is evident. The northern and southern contacts of the Lac du Bonnet batholith consist of granodioritic gneisses and undifferentiated grantitic rocks, respectively.

FIGURE 5.11

GEOLOGY OF LOCAL STUDY AREA



PALEOZOIC

ORDOVICIAN

- WINNIPEG FORMATION, BASAL SANDSTONE
- DOLOMITES, DOLOMITIC LIMESTONE, AND LIMESTONE

ARCHEAN

LATE INTRUSIVE ROCKS

- GRANITE, MINOR GRANODIORITE
- GRANODIORITE, MINOR TONALITE, AND MIGMATITE
- GREYWACKE, CONGLOMERATE, ETC.
- WHITESHELL LABORATORIES LICENCED PROPERTY STUDY AREA (APPROXIMATE LOCATION)

METAMORPHOSED EARLY INTRUSIVES, ETC.

- TONALITIC AND GRANODIORITIC GNEISS, MIGMATIC GNEISS, AND AUGEN GNEISS
- UNDIFFERENTIATED GRANITIC ROCKS

EARLY METAVOLCANIC AND METASEDIMENTARY ROCKS

- GREYWACKE, MUDSTONE, CONGLOMERATE, ETC.
- PYROCLASTIC VOLCANIC ROCKS
- BASALTS, MINOR ANDESITES, ETC.

5 0 5 10 15 20km

NOTE:

Modified from the Geological Map of Manitoba, 1:1,000,000 in Guthrie and Scott, 1988

Surficial Geology

Regional Study Area

The regional surficial geology comprises widespread deposits of till and glacio-fluvial and glacio-lacustrine materials. Tills of predominantly sandy and/or clayey composition are widespread in the western portions of the region, but are less widespread in the central and eastern portion, where they are generally confined to bedrock depressions between bedrock outcrops. End-moraine and outwash complexes (comprising mostly sand and gravel) are evident just west of the Winnipeg River. Extensive deposits of lacustrine clay, mud and silt, are found over the existing glacial deposits in the western portion of the region, but are less widespread in the central and eastern areas (Betcher et al. 1988). In general, the Winnipeg River divides the area into two basic subregions with regard to surficial geology: (i) calcareous tills to the west, and (ii) sandy tills and glacio-fluvial deposits to the east (Guthrie and Scott 1988). Finer glacio-lacustrine deposits are evident along the drainage depressions of the Winnipeg River and Pinawa Channel (Lee River).

Local Study Area

On either side of the Winnipeg River, extending for 2 to 3 km, a continuous surficial unit of clay is present, broken in only a few places by occasional bedrock outcroppings and slightly elevated and coarser materials overlying the clay unit (Figure 5.12). Further east of the Winnipeg River, the overburden soils become thinner, and the bedrock outcrops more numerous (Shawinigan Engineering Company 1960).

Project Study Area

In the immediate vicinity of the Whiteshell Laboratories, there are approximately 10 to 20 m of surficial overburden soils overlying the Precambrian bedrock. These overburden soils include glacial, glaciofluvial and alluvial deposits. A low alluvial terrace exists along the banks of the Winnipeg River comprising mostly silt material.

Two major silty clay horizons overlying clay till were noted in test boreholes undertaken at the site in the late 1950s (prior to development of the site). The upper silty clay horizon has been described as hard, while the lower silty clay horizon was noted to be stiffer and containing less silt. The upper silty clay sequence is approximately 4 to 6 m thick at the eastern portion of the site, but was noted to be thinner to the west, towards the Winnipeg River. There were also instances of fine sand lenses encountered in some test holes (Shawinigan Engineering Company 1960).

At the Waste Management Area (WMA) of the Whiteshell Laboratories, and where extensive test hole drilling has taken place prior to, and since site development, the overburden soils were found to comprise 0.5 m of organic-rich soil horizon overlying 1.5 m of silt, 2.5 m of clay, 5 m of clayey till, and 3 to 5 m of stratified sand (Cherry and Robertson 1988). The upper silt, clay and clayey till units are noted to thicken in an eastward direction. The upper silt, clay and clayey till units were also noted to be vertically fractured throughout, possibly due to both historically drier climates and lower water tables, and subsurface geochemical processes causing shrinking and swelling of clay minerals in the till. The surficial geology in the immediate vicinity of the WMA is shown in Figure 5.12 and

Figure 5.13 Stratigraphic cross-sections of the overburden geology at the WMA are presented in Figures 5.14.

Soil Characterization

The two major factors that influence soil formation are drainage and parent material. The surficial soil types in the Local Study Area are presented in Figure 5.15. In general, the surficial soil distribution in the low-lying areas to the northwest and west, and away from major streams, comprise peats in areas of poor drainage. Improved drainage conditions in these areas leads to the development of humic gleysols and brunisols, while underlying outwash sands and gravels lead to the development of brunisols. Soil development near the Winnipeg River includes peaty humic gleysols on lacustrine silts and clays, but the inherently more effective surface drainage at these locations generally retards peat development. Precambrian bedrock outcrops generally have only partial lichen and moss cover, although peat soil is common in depressions (Guthrie and Scott 1988).

5.4.4 Hydrogeology

Bedrock Aquifers

The Winnipeg and Red River Formations form important and extensive bedrock aquifers in the western part of the region, while Precambrian rocks form the main bedrock aquifer east of the Winnipeg and Whitemouth Rivers, where surficial deposits are generally thin and scattered (Betcher et al. 1988). The limestone and dolomites of the Red River Formation are generally well fractured and provide moderate to high well yields (up to 50 L/sec), while the sandstone sequences of the Winnipeg Formation will typically yield somewhat less. These two aquifers are effectively separated by shale sequences comprising the upper portion of the Winnipeg Formation. Groundwater in the Precambrian bedrock aquifer is obtained primarily from fracture zones in otherwise competent rock of very low permeability. Yields are highly variable, from effectively no groundwater at all, up to 5 L/sec (Betcher et al. 1988).

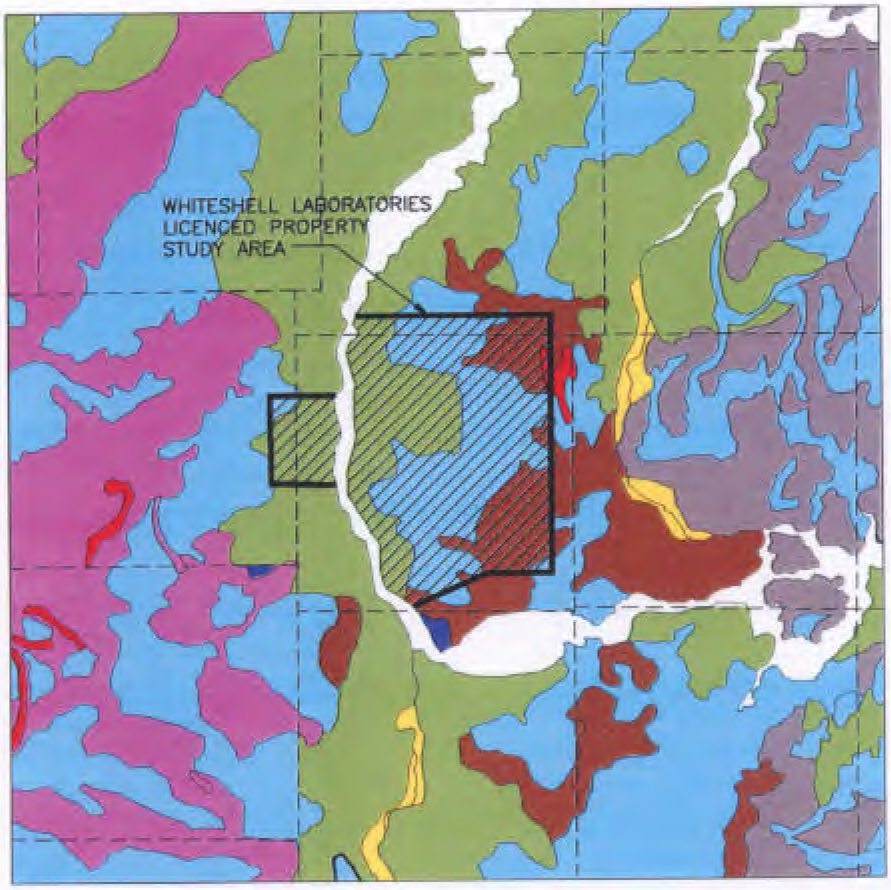
Shallow and Perched Aquifers

Regional Study Area

Carbonate-rich sand and gravel aquifers overlying Pre-Cambrian bedrock are widespread near the Milner Ridge moraine, at the centre of the Regional Study Area, and represent a major recharge area for the sedimentary bedrock aquifers underlying the western portion of the Regional Study Area. Elsewhere in the Local Study Area, localized sand and gravel aquifers are found (at the Waste Management Area, for example), but are generally interstratified with finer grained deposits within till sheets or at the bedrock-till contact. The till aquifers generally have low water-bearing capacities, although some sandy till zones are exploited through the installation of specially designed, large-diameter wells (Guthrie and Scott 1988).

FIGURE 5.12

SURFICIAL GEOLOGY OF LOCAL STUDY AREA



POSTGLACIAL

- SWAMP (PEAT)–INCLUDING STANDING WATER AND ALLUVIAL MUD
- ALLUVIUM–MAY INCLUDE SOME LACUSTRINE CLAY OR SILT

LATE GLACIAL & GLACIOLACUSTRINE

- BEACH RIDGES
- LACUSTRINE CLAY–SILT OR PEBBLE RICH
- LAKE MODIFIED MORAINE SANDY SURFACE

GLACIAL & GLACIOFLUVIAL

- OUTWASH AND ESKER SEDIMENTS
- CARBONATE RICH CLAY FILL

PRECAMBRIAN BEDROCK OUTCROPS

- WAVEWASHED OUTCROPS WITH MINOR LACUSTRINE CLAY OR CALCAREOUS CLAY TILL
- WHITESHELL LABORATORIES LICENCED PROPERTY STUDY AREA (APPROXIMATE LOCATION)

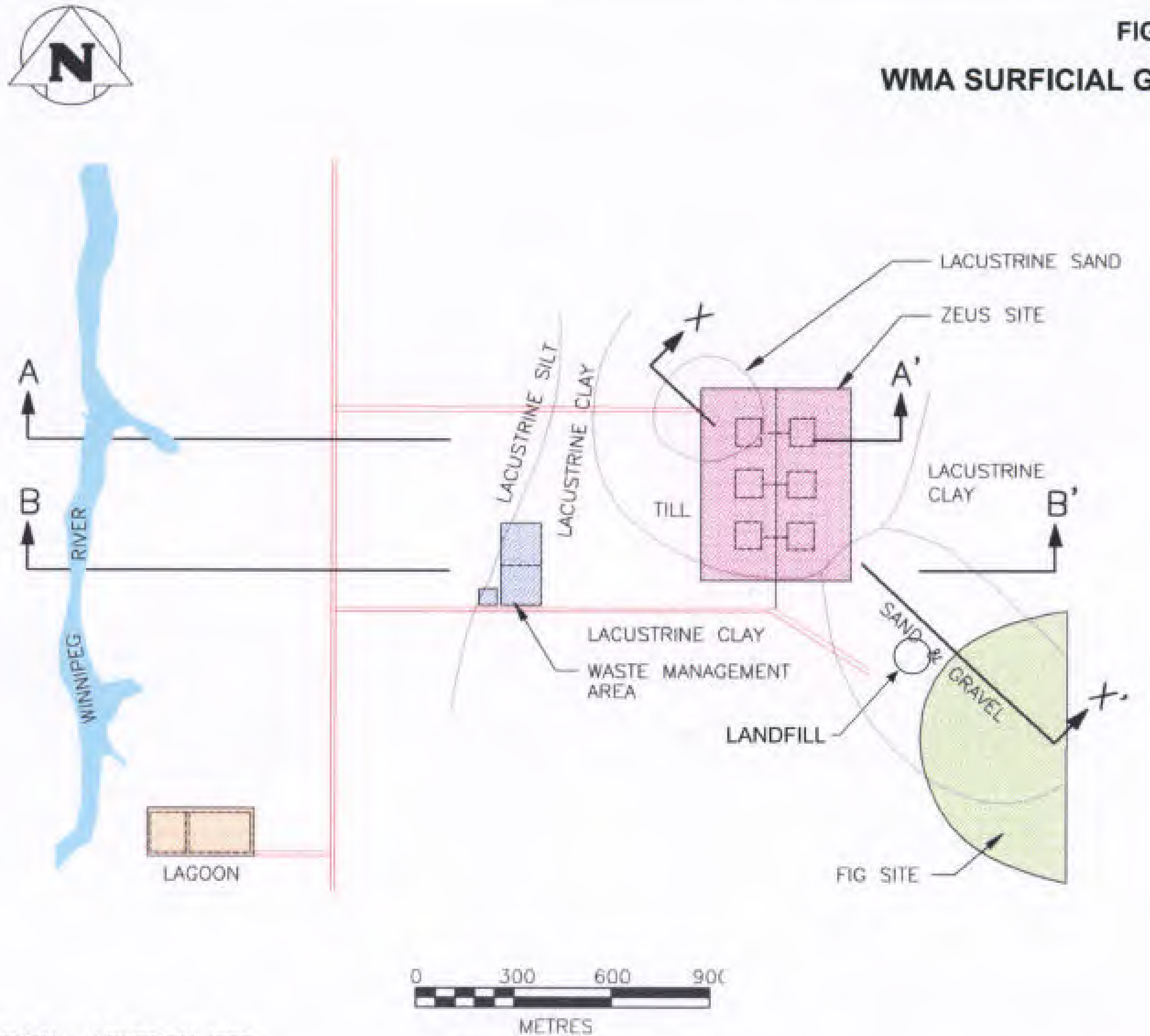
5 0 5 10km

NOTE:

Derived primarily from the maps in Guthrie and Scott, 1988

FIGURE 5.13

WMA SURFICIAL GEOLOGY



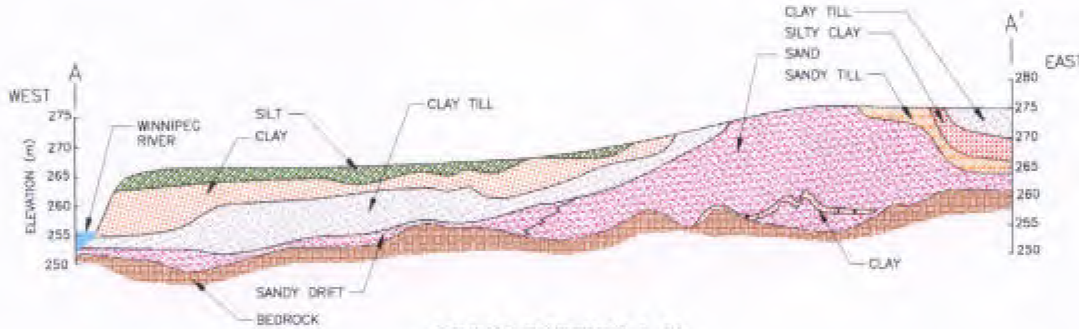
SOURCE: ROBERTSON and CHERRY, 1985

AECL EACL

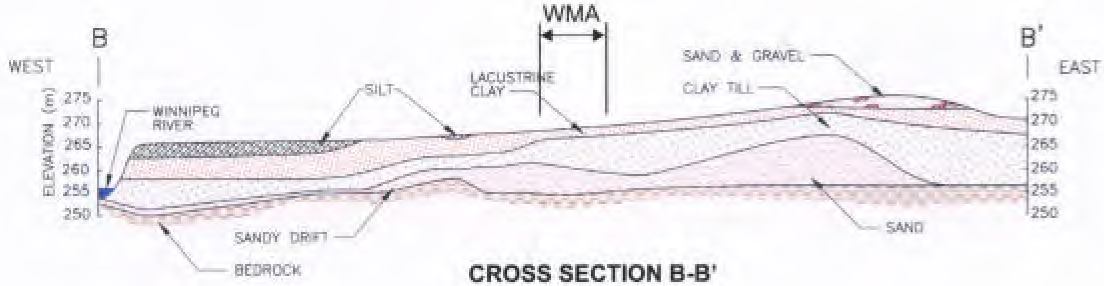
WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

FIGURE 5.14

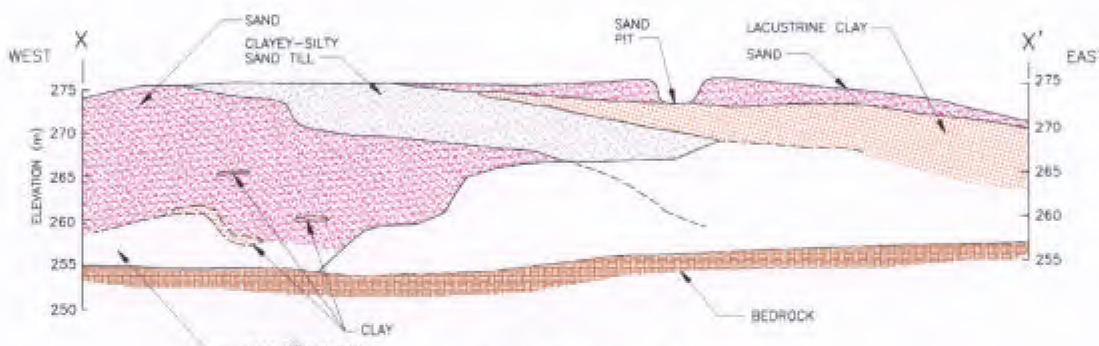
WMA SURFICIAL GEOLOGY CROSS-SECTIONS



CROSS SECTION A-A'



CROSS SECTION B-B'



CROSS SECTION X-X'

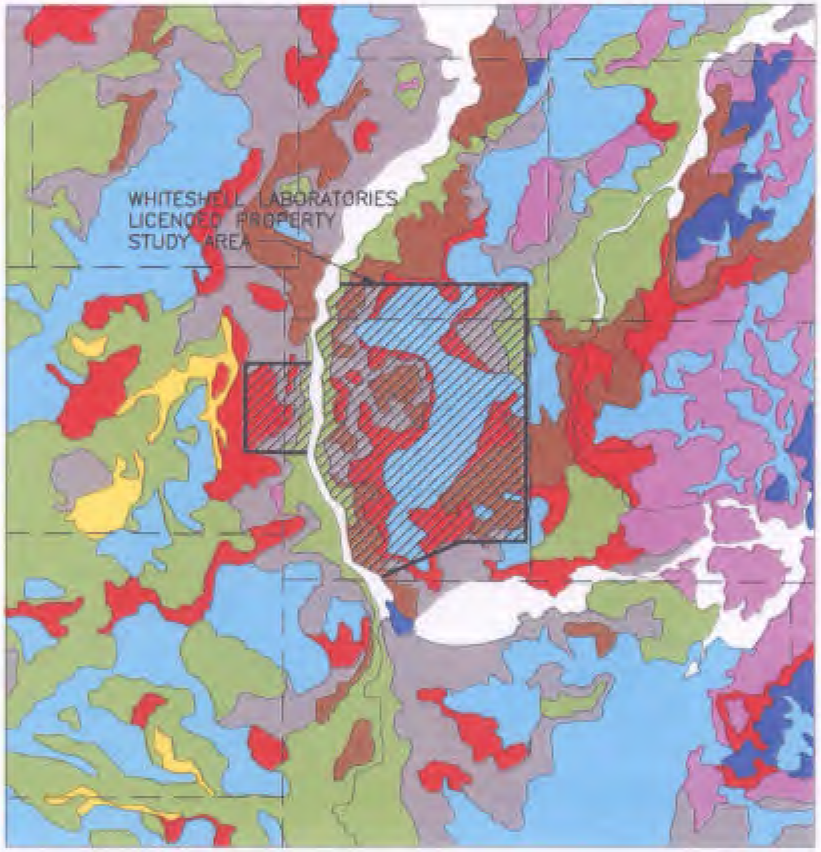
SOURCE: ROBERTSON and CHERRY, 1985

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

FIGURE 5.15

SURFICIAL SOILS OF LOCAL STUDY AREA



1977 TERMINOLOGY EQUIVALENT

- ROCK OUTCROPS (SOME TOPSOILS)
- GREY LUVISOLS GRLYSOLS AND TOLISOLS
- DYSTIC AND ENTRIC BRUNISOLS
- GREY LUVISOLS
- SOLONETZIC DARK GREY CHERNOZEMS
- PEATY HUMIC GLEYSOLS
- PEATY GLEYSOLS HBRISOLS AND MESISOLS
- FIBRISOLS AND MESISOLS

WHITESHELL LABORATORIES
LICENCED PROPERTY STUDY AREA
(APPROXIMATE LOCATION)

5 0 5 10km

NOTE:

Derived primarily from the maps in Guthrie and Scott, 1988

Whiteshell Laboratories – Project Study Area

The focus of the hydrogeological studies in the Project Study Area has been the Waste Management Area, the main storage area for the radioactive and hazardous waste at Whiteshell Laboratories. The area has been the site of intensive hydrogeological studies initiated in 1968. The area investigated is a strip of terrain 5 km by 2 km that extends from the FIG Site (Figure 5.13) to the Winnipeg River. Investigations included:

- Extensive test drilling and piezometer installation for delineation of the stratigraphy, groundwater flow conditions and hydrogeochemistry.
- Extensive monitoring of water levels (over 20,000 water level measurements were compiled).
- Estimation of hydraulic properties of the overburden deposits from several different methods including pumping tests, sediment grain size analysis, mass balance calculations and environmental tracer migration.
- 2-D and 3-D groundwater flow modelling to understand flow conditions at the site.
- Use of environmental isotope and geochemical data to investigate groundwater migration processes.

A comprehensive summary of the results from studies performed over the 17-year period 1968 to 1985 is given in Robertson and Cherry (1985). A brief summary of key results is provided here along with results from additional analysis performed in support of the CSR.

Hydraulic Parameters of the Stratigraphic Units

Groundwater flow rates and velocities are a function of the hydraulic conductivity and porosity of the stratigraphic units comprising the overburden. The stratigraphic units at the WMA from surface to bedrock as described in Section 5.4.3 comprise of approximately:

- 0.5 m of organic rich soil horizon;
- 1.5 m of lacustrine silt;
- 2.5 m of lacustrine clay;
- 5 m of clayey glacial till referred to as 'clay-till'; and
- 3-5 m of a relatively permeable sand aquifer referred to as 'basal sand' or 'basal sandy drift'.

The basal sands overlay the bedrock surface on top of the bedrock surface throughout the study area and have a maximum thickness of approximately 16 m (Figure 5.16).

The watertable in the WMA normally exists in the silt unit and fluctuates seasonally within a depth range of 0 to 3 m of ground surface. Hydraulic parameter estimation has focussed on the stratigraphic units in the saturated zone below the watertable. These are the lacustrine clay, clay-till and basal sand units. Recommended hydraulic parameter values for these units are summarized in Table 5.15. These values are best estimates and represent average values for the stratigraphic units.

Table 5.15
Hydraulic Parameters of the Stratigraphic Units

Stratigraphic Unit	Horizontal Hydraulic Conductivity K_x $cm\text{-}s^{-1}$	Vertical Hydraulic Conductivity K_z $cm\text{-}s^{-1}$	Porosity
Basal Sandy Drift in the vicinity of the WMA	[a]8E-04	[f]2E-05	[d]0.3
Basal Sand – Upland Recharge Area	[b]3E-03	[f]7.5E-05	[d]0.3
Lacustrine Clay And Clay Till	[g]<3E-07	[c]< 3E-07	[e]7E-04

a) Estimated from Pumping Tests.
b) Estimated from Mass Balance Calculations.
c) Estimated from Mass Balance Calculations and Flow Modeling.
d) Chosen Value (Robertson and Cherry 1985). Porosity of sands typically range from 0.25 to 0.5 (Freeze and Cherry 1979).
e) Estimated from average vertical fracture spacing of 6 cm and fracture aperture of 40 microns.
f) Based on ratio of horizontal to vertical conductivity of 40 (Robertson and Cherry 1985).
g) No continuous horizontal fractures were noted in the clays. Horizontal hydraulic conductivity is expected to be no greater than vertical conductivity.

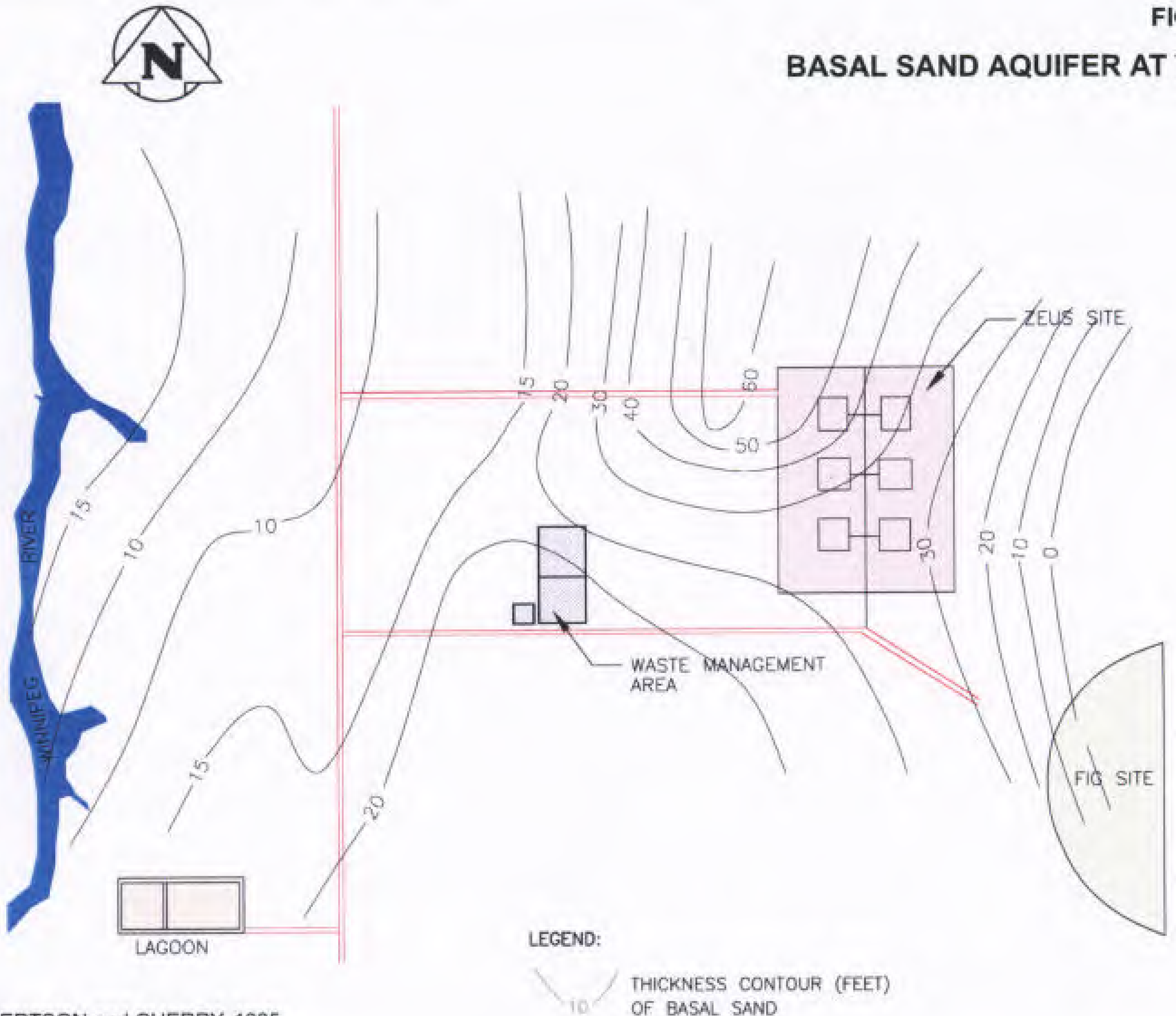
Lacustrine Clay and Clay-Till: Consolidation tests indicate that the intergranular hydraulic conductivity (K) of the lacustrine clay unit is in the range of 5E-10 cm s^{-1} to 3E-08 cm s^{-1}. Intergranular K of the clay-till is probably similarly low. However there is abundant evidence to indicate that these units are fractured and that the fractures impart a bulk permeability to this material much greater than the intergranular permeability. Because vertical fractures have been observed to cross the stratigraphic boundary between the lacustrine clay and clay-till these two materials may be considered to have similar hydraulic conductivities. The vertical hydraulic conductivity of these units is estimated to be greater than the intergranular permeability but less than 3E-07 cm-s^{-1}. The horizontal hydraulic conductivity is probably of similar magnitude.

Groundwater flow through the lacustrine clay and clay-till will occur primarily through the fractures as opposed to through the intergranular pore space. Fracture porosity is estimated from an average fracture spacing of 6 cm and fracture aperture of 40 microns and is approximately 7.0E-04.

Basal Sandy Drift: The horizontal hydraulic conductivity of the basal sands varies from approximately 1E-2 to 1E-4 cm-s^{-1}, Figure 5.17. The hydraulic conductivity in the periphery of the WMA is approximately 8E-04 cm-s^{-1} and increases to 3E-03 cm-s^{-1} as one moves eastward from the WMA to the upland recharge area located approximately 1.5 km east of the WMA. Vertical hydraulic conductivity of the basal sands is estimated to be at least a factor of 40 lower than horizontal conductivity. The porosity of the basal sands is between 0.25 and 0.5.

FIGURE 5.16

BASAL SAND AQUIFER AT THE WMA



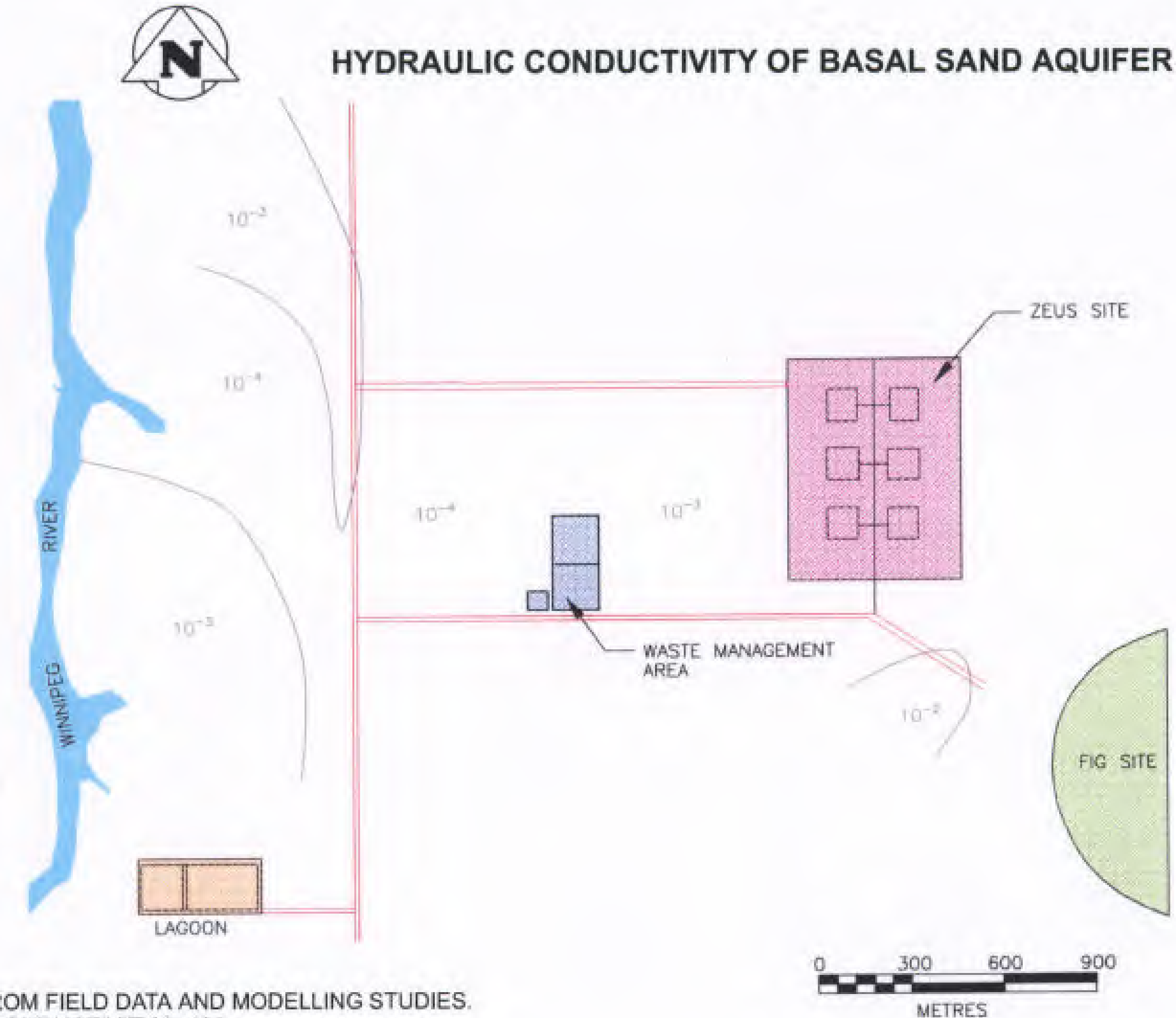
SOURCE: ROBERTSON and CHERRY, 1985

AECL EACL

WHITESHELL LABORATORIES DECOMMISSIONING
ENVIRONMENTAL ASSESSMENT

FIGURE 5.17

HYDRAULIC CONDUCTIVITY OF BASAL SAND AQUIFER AT THE WMA



NOTE:

INFERRED FROM FIELD DATA AND MODELLING STUDIES.
HYDRAULIC CONDUCTIVITY (cm/s)

SOURCE: ROBERTSON and CHERRY, 1985

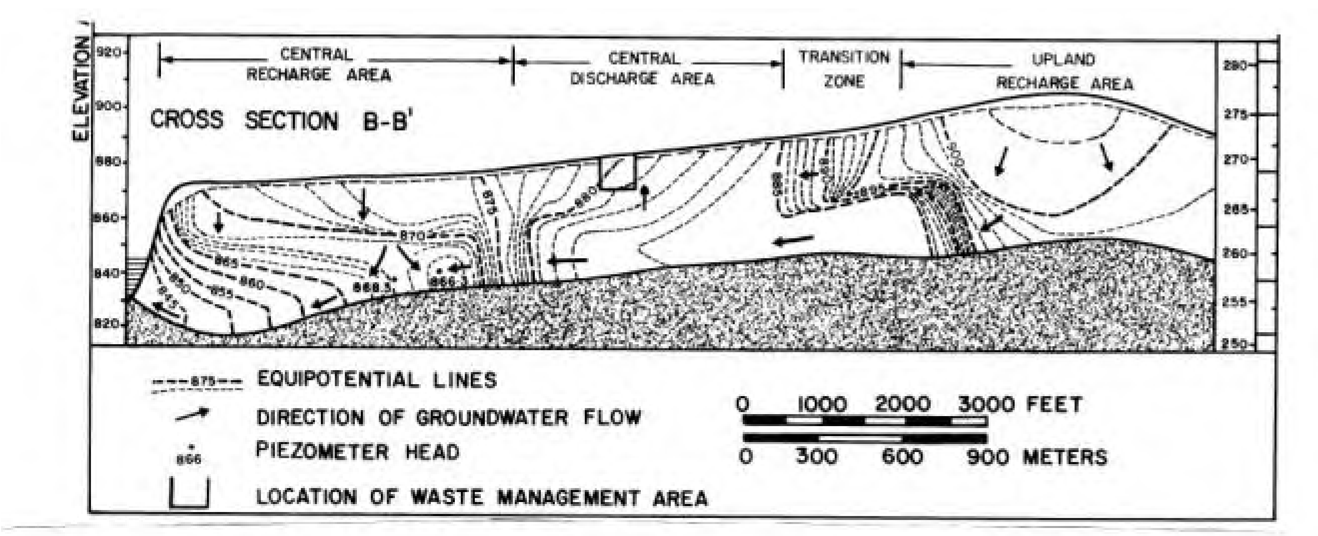
<u>*Groundwater Flow, Recharge and Discharge*</u>

Groundwater in the overburden is derived from rain and snow melt that infiltrates downward into the basal sands in a slight upland area of sand situated about 1 to 1.5 km east of the WMA. Recharge is estimated to be about 14% of the average annual precipitation of 57 cm (Robertson and Cherry 1985).

Water level measurements from monitoring wells in the study area provide a basis for understanding the groundwater flow patterns. Groundwater flows in the direction of decreasing water levels. Wells that are situated close to surface indicate the level of the water table. Water levels in deeper wells indicate whether there is upward or downward movement of water. If water levels in deeper wells are greater than in shallow wells there is upward movement. Conversely, if water levels in deeper wells are less than in the shallow wells, there is downward movement of water.

Figure 5.18 shows representative groundwater flow patterns along the vertical cross-section B-B'. Three distinct zones within the flow system are evident. These are from east to west an upland recharge area where groundwater moves downward from the water table into the basal sand aquifer; a central discharge area where water moves upward from the basal aquifer through the overlying clay-till and clay to the water table, and a central recharge area where groundwater migrates downward through the clay and clay-till units to the basal sandy aquifer. The boundaries between recharge and discharge zones are transient, primarily in response to water table fluctuations. Figure 5.19 shows the percentage of time recharge and discharge conditions to the basal sandy aquifer occur over the period 1968 to 1983 and the width of the transition zones between the discharge and recharge zones. To the west the width of the transition zone is approximately 300 m, to the east it is approximately 500 m.

Figure 5.18
Sketch of Hydrology and Water Flow Pattern



The WMA is located in the middle of the central discharge area. Groundwater flow in the silt, clay and clay-till units has been upward on almost all occasions during the monitoring period 1968 to 1983. These units are sufficiently fractured that flow occurs through them. The clay-till and clay units are an integral part of the flow system.

The fact that the WMA is located in a groundwater discharge zone has positive benefits. Chemical or isotopic constituents solubilized from any waste materials released at the WMA site do not move downward to the sandy zone, and thus this zone does not act as a transmission zone for contaminants from the WMA into the Winnipeg River.

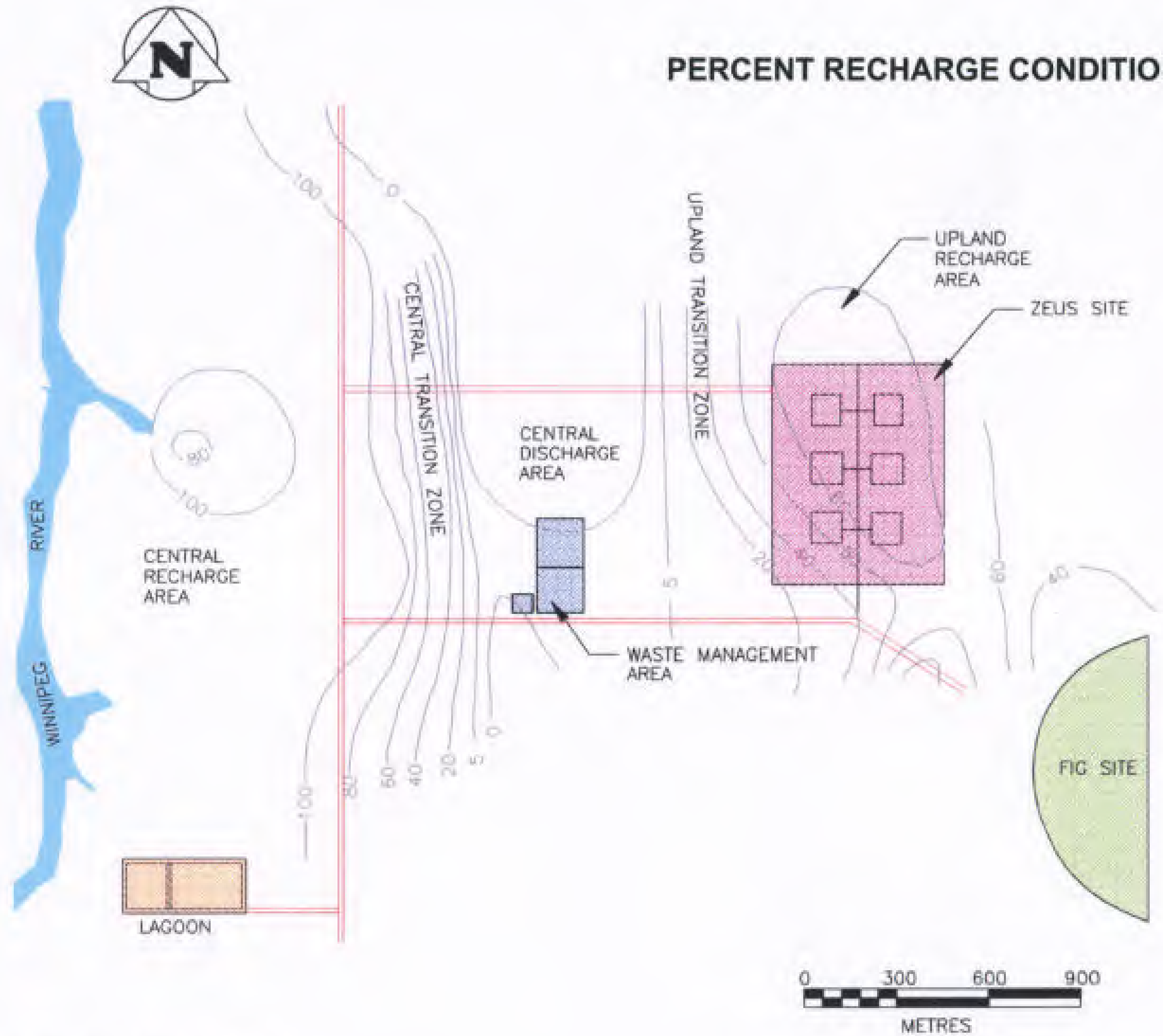
To provide more recent data on the hydrological conditions at the WMA and to confirm that hydrological conditions have not changed, groundwater monitoring data from two well nests in the WMA for the period 1984 to 2000 were analyzed; well nest RW5 located on the western boundary of the WMA and well nest RW1 located in the centre of the WMA. The analysis is reported in Appendix C.5. Records for the RW5 well nest showed a distinct upward gradient, representative of discharge conditions and in compliance with findings of earlier studies. Data for well nest RW1 were inconclusive, showing no gradient. Water elevations in the clay unit were the same as in the underlying basal sands.

The similar water level elevations in the sand and clay units for well nest RW1 is probably due to leakage between the two stratigraphic units due to poor well construction rather than to a change in hydrological conditions at the site. Both RW1 and RW5 are in a region where upward hydraulic conditions existed for more than 95% of the time over the period 1968 to 1983. The two well nests are separated by only 100 m and it is unlikely that hydrological conditions have changed such that discharge conditions exist in one well and recharge in the other. In fact, of the two well nests, RW5, for which upward hydraulic gradients were observed, is located closest to the central recharge zone.

The hydraulic head distribution and groundwater flow directions in the basal sands are shown in Figure 5.20. Groundwater flow is to the west over most of the study area and discharges to the Winnipeg River. However, a flow divide does exist in the general vicinity of the topographic high in the upland recharge area located approximately 1.5 km east of the WMA. Flow originating west of the divide migrates westward via the sand aquifer toward the Winnipeg River. Flow originating east of the divide travels eastward towards the Pinawa Channel. All nuclear facilities are located to the west of the divide. The only facilities in the immediate vicinity of the divide are the inactive landfill, the FIG site and the ZEUS site.

FIGURE 5.19

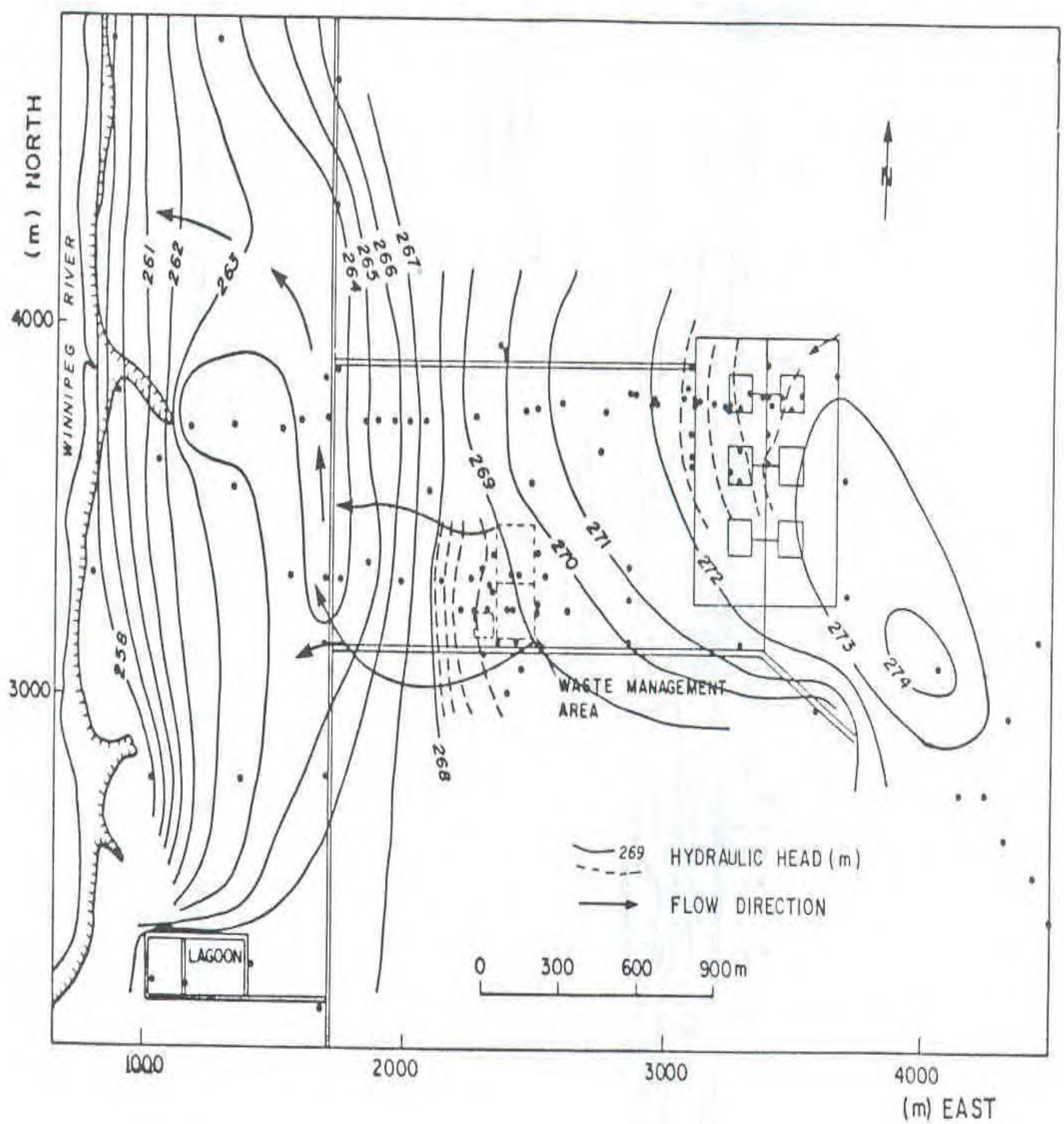
PERCENT RECHARGE CONDITION, 1968 - 1983



SOURCE: ROBERTSON and CHERRY, 1985

AECL EACL

Figure 5.20
Potentiometric Surface and Approximate Groundwater Flow Directions in the Sandy Zone



There is the potential for lateral flow in the vicinity silt, clay and clay-till units. Lateral flow in the vicinity of the WMA is influenced by permeability of the soil zone, drainage ditches, and local scale effects from waste trenches. As a result, there may be significant lateral components to flow in the clay, clay till and silt zones in the vicinity of the WMA.

Groundwater Velocities, Flow Rates and Transit Times

Groundwater velocities represent the rate at which non-reactive contaminants move through the flow system. The estimates are derived from application of Darcy's Law and make use of the representative hydraulic conductivity and porosity values and measured hydraulic gradients. Flow rates represent the volume of water discharge per unit aquifer area.

Average horizontal groundwater velocities in the basal sand in the WMA are estimated to be 1.6 m a^{-1}. These are derived from an average horizontal hydraulic gradient of approximately 0.002, an effective porosity of 0.3 and hydraulic conductivity of 8.0E-04 cm s^{-1}. Velocities in the basal sands are highly variable due to the heterogeneous nature of the unit. Velocities to the east of the WMA where sands are more permeable are probably an order of magnitude greater than at the WMA. The flow rate through the basal sand aquifer in the vicinity of the WMA is estimated to range from 3000 to 50,000 L per year per meter of aquifer width. The groundwater transit time for water recharging in the upland recharge area to the WMA is of the order of 100 to 1000 years.

Groundwater flow in the clay and clay-till unit is predominantly through the fractures in these units. The average vertical hydraulic gradient across the clay and clay till unit is 0.2 which occurs commonly in discharge and recharge areas. Assuming vertical hydraulic conductivity of 3E-07 cm s^{-1}, and porosity of 7E-04 gives vertical groundwater velocities of several meters per year. The groundwater flow rate through the clay and clay till units are very low owing to the low hydraulic conductivity of these units. The vertical flow rate is in the range of a few cm per year (few hundred m^3-ha^{-1} per year). Water seeping to surface is lost by evaporation from the soil and transpiration from plants. The transit time for upward flow from the base of the clay till unit to surface is of the order of a few months to a few years.

Groundwater Quality

Local Study Area

The groundwater quality in the Local Study Area varies considerably, but in general is considered potable (Rutulis 1982). This includes groundwater from both overburden and bedrock aquifers. The quality of groundwater appears to be slightly better, with respect to hardness and total dissolved solids, in or near the main recharge areas of the western portion of the Local Study Area, namely the Milner Ridge area. With respect to domestic purposes, groundwater quality generally degrades east of the Winnipeg River.

Several groundwater sampling and laboratory analyses programs have been initiated by AECL prior to, and since facility start-up. In general, the laboratory, engineering and statistical analyses indicates groundwater in the bedrock and overburden aquifers to be within the statistical norms for groundwater quality. Although anomalous (elevated) concentrations of uranium were detected in groundwater samples collected from primarily the Pre-Cambrian bedrock aquifer, the concentrations were comparable to other anomalous samples measured world-wide. These elevated concentrations in the bedrock aquifer are attributed to leakage from uraniferious groundwater from overlying clays (Betcher et al. 1988).

It has been determined that the potential for on-site or off-site groundwater resources to be contaminated, including those that may be tapped for livestock watering or domestic use adjacent to the site, is negligible. The location of wells off-site is not relevant to the discussion since the groundwater flow direction as determined by Cherry and Robertson (1988) precludes them from being affected.

Project Study Area - WMA

Radioactivity of deep wells and water-table wells at the Waste Management Area (WMA), is routinely monitored. Measurements are taken once a month between March and October. Results of total-beta analyses for 1999 for the water table and deep wells shown in Table 5.16.

Table 5.16
Total Beta Activity in Wells at the WMA, 1999

	Maximum	**Minimum**	**Average**
	Beta, Bq/L		
Water-Table Wells	0.7	0.13	0.34
Deep Wells	0.73	0.04	0.26

The average values for 1995 to 1999 for total beta activity in water-table wells and deep wells are shown in Table 5.17. Based on the conservative assumption that the total-beta activity is caused entirely by the most restrictive radionuclide (^{90}Sr, for which the Maximum Acceptable Concentration (MAC) in drinking water is 5 Bq/L), the data presented shows that the average concentrations were below MAC in all wells. Table 5.17 confirms for the low average concentration for the period 1995 to 1999.

Table 5.17
Average Total Beta Activity in Waters at the WMA

	1995	**1996**	**1997**	**1998**	**1999**
	Beta, Bq/L				
Water-Table Wells	0.5	0.43	0.35	0.41	0.34
Deep Wells	0.28	0.24	0.38	0.2	0.26

Inactive Landfill

Operating protocols for the landfill site exclude the disposal of radioactive wastes and all wastes are monitored prior to emplacement. There was one recorded incident of an inadvertent placement of low-level radioactive waste in the landfill. The material was subsequently removed and the area surveyed to ensure there was no residual contamination remaining. The area is routinely monitored for gamma radiation to ensure that storage practices are effective in ensuring that only non-radioactive wastes are emplaced.

A groundwater monitoring program at the landfill has been in operation since 1993. Annually, groundwater is collected from several points at the landfill and a control point 300 m to the north. The groundwater is analyzed for gross alpha and gross beta activity. The analysis results for 1999, which are representative of other years, are presented in the following table.

Table 5.18
Gross Alpha & Beta Activity for Landfill Groundwater

ILS Pond Sample Location	Sample Date	Gross Alpha Bq/L		(2s)	Gross Beta Bq/L		(2s)
=======	========	=======		=======	=======		=======
5	04-May-99	0.03	+/-	0.03	0.11	+/-	0.02
11	04-May-99	0.21	+/-	0.07	0.41	+/-	0.03
14	04-May-99		< 0.08		0.35	+/-	0.04
15	04-May-99	0.07	+/-	0.06	0.29	+/-	0.04
21	04-May-99	0.14	+/-	0.07	0.30	+/-	0.04
22	04-May-99		< 0.11		0.22	+/-	0.04

For comparison, the Maximum Acceptable Concentration (MAC) for gross beta (assumed to be due to ^{90}Sr) in drinking water is 5 Bq/L.

Sewage Lagoons

Radioactive contamination is present in the lagoon sludge with a higher concentration in the primary pond than in the secondary pond. The activity appears to increase with depth at the inlet to the secondary lagoon, while it is level or decreases with depth in the surrounding areas.

Lagoon sediment sampling indicates very low levels of contamination, less than 3 Bq/g for ^{137}Cs and trace quantities of ^{60}Co, and shows no evidence of migration into the underlying clays.

5.4.5 Hydrology

Drainage Patterns

Regional Study Area

The regional hydrology or surface water drainage regime is primarily determined by the slope, thickness and texture of surficial deposits, and the proximity and permeability of bedrock (Guthrie and Scott 1988). Three regional drainage categories include: (i) thick glacial ridge-depression areas to the west of the Winnipeg River, (ii) bedrock outcrops and thin glacial deposits over impervious Precambrian bedrock to the east, and (iii) low-lying but drainable lacustrine deposits along the Whitemouth and Winnipeg Rivers and along parts of the Pinawa Channel. Drainage and surface water flow patterns have been extensively modified within southern Manitoba over the past hundred years through the development of hydroelectric dams on the Winnipeg River as well as the draining of marshes and swamps to improve or develop agricultural land.

The Regional Study Area comprises 5% of the Lake Winnipeg Drainage basin, and 50% of the Winnipeg River Drainage basin. These basins drain areas 1,000,000 km^2 and 150,000 km^2, respectively (Betcher et al. 1995).

Winnipeg River

The Winnipeg River is classified as a medium-sized lowland river. The total drainage basin of the Winnipeg River is approximately 150,000 km^2, although only about 4,000 km^2 are below the junction of the English River in the Province of Manitoba proper. A descent in ground elevation of 83 m from the Manitoba-Ontario border to Lake Winnipeg through a series of falls and rapids has resulted in extensive hydroelectric exploitation of this river. Six electric generating stations are present on the Winnipeg River, whose discharge rate is now largely controlled by these hydroelectric dams, which precludes any short-term correlation between precipitation and river flow.

At the Whiteshell Laboratories site, the river is approximately 0.3 km wide, 7 m deep and flows in a northerly direction at a velocity of approximately 0.3 m/s. Flow rates as high as 2,000 m^3/s have been measured during flood conditions (Guthrie 1964). At the Whiteshell Laboratories site, flow velocities measured in the Winnipeg River were noted to be greater on the west bank, with no backwater noted. Additional data on currents and flow volume at the Whiteshell Laboratories outfall are found in Ireland et al. (1973).

Lake Winnipeg

Lake Winnipeg is one of the largest freshwater lakes in the world, with a direct drainage basin that includes much of the central-eastern portion of the province. Indirectly, drainage into Lake Winnipeg includes the Lake Manitoba and Saskatchewan River basin to the west, the Assiniboine and Red River Basin drainage basins to the south and southwest, and the Winnipeg River basin to the southeast. Drainage from Lake Winnipeg is into the Nelson River system, which discharges into Hudson Bay and ultimately the Arctic Ocean.

Local Study Area

In the western portion of the Local Study Area, surface drainage is discouraged in the Milner Ridge area due to rapid entry through coarse-textured ridge materials, and/or slowly through finer sediments in local depressions. Therefore, few streams are found in this area. Except for bogs in low-lying areas, there are few lakes (Guthrie and Scott 1988). To the east, surface drainage is encouraged due to Precambrian outcrops with their thinner glacial deposits. Here, drainage is primarily by surface streams, which flow into the Pinawa Channel and the Winnipeg River. To the south, the Whitemouth river basin drains into the Winnipeg River at Seven Sisters Falls/Natalie Lake. The Whitemouth and Winnipeg Rivers flow through the glaciolacustrine deposits in the centre of the region. Although these fine-textured deposits exhibit little variation in relief, they are of sufficient thickness that postglacial incision by these major rivers encourages east-west drainage towards them.

Project Study Area

Surface water run-off at the Whiteshell Laboratories site drains into the Winnipeg River (Figure 5.21). Water quality is discussed in the next section.

5.4.6 Water Quality

Sampling and laboratory analyses of water from the Winnipeg River near the Whiteshell Laboratories has been undertaken by AECL. In general, the studies conclude no significant anomalous concentrations of various parameters analyzed, including radionuclides. The primary source of liquid radioactive effluents at the Whiteshell site is the process water outfall. Discharges include storm run-off, miscellaneous cooling water, and holding tank discharges from the Active Liquid Waste Treatment Centre. These discharges are designed to remain within regulatory guidelines and the DRLs, however there has been some accumulation of radionuclides in sediments near the outfall that is discussed later in this section.

The on-site sewage lagoon also discharges into the Winnipeg River. Studies conducted by Manitoba Environment to assess water quality in the vicinity of Lac du Bonnet from 1997 to 1998, did not indicate any water quality problems in terms of nutrient loading from upstream sources. Thus it is believed that the lagoon discharges have not had a negative impact on the river water quality in terms of nutrient loading. (Ralley 1999).[1]

The Winnipeg River Task Force (1995) looked at potential sources of Winnipeg River water quality degradation near the community of Sagkeeng. The Task Force found that Whiteshell Laboratories has not had an adverse effect on water quality in the Winnipeg River for downstream communities.

Similar sampling and analyses has been undertaken for water samples collected from Lake Winnipeg. In general, the laboratory analyses and interpretation indicates no anomalous concentrations of routine water quality parameters.

[1] Sampling locations include three sites near the town of Lac du Bonnet on the Winnipeg River, roughly 10km downstream of AECL's Whiteshell Laboratories, and a number in the lake of Lac du Bonnet. Locations were sampled for ammonia, nitrate/nitrite, nitrogen, phosphorus, fecal coliform and chlorophyll. Concentration of nutrients in the Winnipeg River were found to be within normal ranges for waterbodies in eastern Manitoba and generally below water quality guidelines.

FIGURE 5.21

TOPOGRAPHY AND DRAINAGE IN LOCAL STUDY AREA

SOURCE: GUTHRIE AND SCOTT, 1988

Radioactivity in the Winnipeg River

As outlined in Niemi and Soonawala (1999b), five radiological parameters (including three radionuclides) are currently monitored in the Winnipeg River at the Whiteshell Laboratories site by AECL. Monthly composite samples of Winnipeg River water are collected from four locations: about 17 km upstream of the process outfall (at Pinawa); 2 km downstream at the Whiteshell Laboratories boundary; 10 km downstream at the Lac du Bonnet water intake; and, 28 km downstream at the Great Falls generating station. Monitoring of downstream concentrations to date have not been found to vary significantly from upstream sampling. For example, between 1962 and 1972 the average annual concentrations of ^{137}Cs in river water downstream (28 km) were similar to upstream concentrations. It is believed that the major contributor of ^{137}Cs was atmospheric nuclear weapons testing occurring during that time. After 1972, nuclide concentrations found in the river were thought to be most affected by Whiteshell Laboratories (Dunford et al. 1983). Recent (1994-1998) concentrations of nuclides found in the Winnipeg River are given in Table 5.19. Concentrations in 1998 were comparable to those in previous years. The measured concentrations were very small fractions of the Maximum Acceptable Concentrations (MACs) for radioactivity in drinking water in Canada, specified by Health Canada. The 1998 concentrations at the sampling points downstream of Whiteshell Laboratories were not much different from the concentrations at the upstream sampling point.

Table 5.19
Radioactivity in Winnipeg River Water

Location	**Mean Concentration (Bq/L)**				
	1994	**1995**	**1996**	**1997**	**1998**
Pinawa (upstream from Whiteshell Laboratories)					
^{137}Cs	0.002	0.002	0.002	0.002	0.003
^{40}K	NA	NA	NA	NA	0.046
^{90}Sr	0.015	0.016	0.016	0.011	0.014
Location K11 (2km downstream)					
^{137}Cs	0.014	0.003	0.004	0.003	0.004
^{40}K	NA	NA	NA	NA	0.068
^{90}Sr	0.022	* 0.021	0.018	0.011	0.015
Lac du Bonnet (10km downstream)					
^{137}Cs	0.004	0.001	0.001	0.001	0.002
^{40}K	NA	NA	NA	NA	0.045
^{90}Sr	0.017	0.017	0.015	0.011	0.012
Great Falls (28 km downstream)					
^{137}Cs	0.003	0.002	0.002	0.001	0.003
^{40}K	NA	NA	NA	NA	0.039
^{90}Sr	0.017	0.017	0.015	0.014	0.013

MAC Values: ^{137}Cs: 10 Bq/L
^{40}K: no standard
^{90}Sr: 5Bq/L

* Mean excluding two results considered to be outliers.
Source: Niemi and Soonawala 1999b.

Within the Whiteshell Laboratories Site

Radioactivity was monitored in surface waters of two ditches (one flowing west to the Winnipeg River and the other flowing north) located near the Waste Management Area (WMA). Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing ditch and into the Winnipeg River. The other ditch, running north to the Whiteshell Laboratories boundary, drains the land north of the WMA up to the site boundary.

The results for both ditches, for years 1994 to 1998, are shown in Table 5.20 and in Figures 5.22 and 5.23. Data show a slight increase in the gross beta activity in the north ditch, otherwise, the activity is stable over the five-year period.

The radioactivity results from an accidental spill in the late 1980s and is not indicative of routine releases from the area. Very low levels of contamination can be detected in the ditch system (about 0.13 GBq of radioactivity was estimated to be deposited in the drainage system in the public domain) and analysis of the condition following initial remediation indicated negligible effect of leaving the contamination in place.

Table 5.20
Annual Mean Gross Beta and Gross Alpha Radioactivity in Ditches Near WMA, 1998

LOCATION	Activity (Bq/L)				
	1994	**1995**	**1996**	**1997**	**1998**
9 – Ditch From Waste Management Area					
West to Winnipeg River					
Gross Beta	0.27	0.20	0.16	0.25	0.33
Gross Alpha	0.03	0.03	0.02	0.04	0.03
8 – Ditch From Waste Management Area					
North to Whiteshell Laboratories boundary					
Gross Beta	0.62	0.55	0.33	0.43	0.83
Gross Alpha	0.07	0.10	0.01	0.04	0.03

Figure 5.22
Gross Alpha Activity in Surface Water from Streams Flowing from the Whiteshell Laboratories WMA, 1994-1998

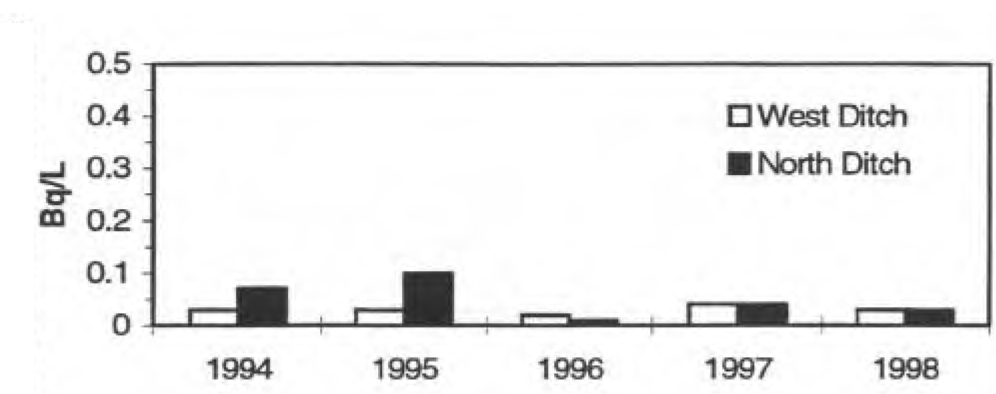
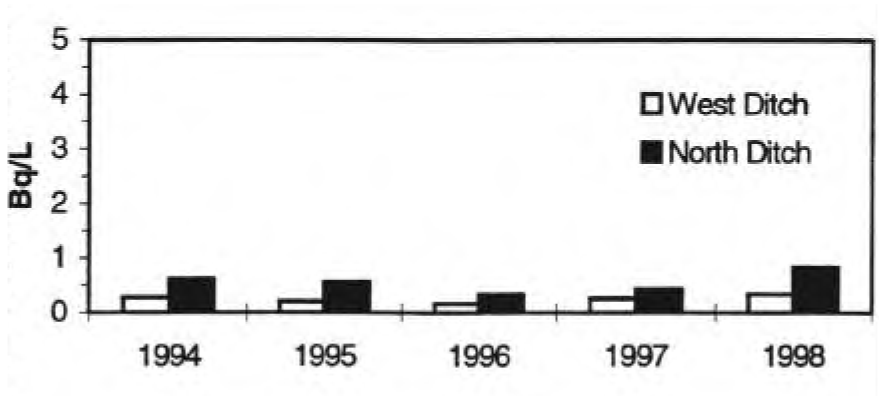


Figure 5.23
Gross Beta Activity in Surface Water from Streams Flowing from the Whiteshell Laboratories WMA, 1994-1998



5.4.7 Sediment Quality

Lacustrine clay is the predominant component of both water-borne and deposited sediments in the Winnipeg River and Lake Winnipeg. Coarser-grain materials are present in the Winnipeg River bed sediments, including gravel, sand and silt, although less gravel was observed upstream than downstream of the Whiteshell Laboratories site (Guthrie and Scott 1988).

Sampling and laboratory analyses of riverbed sediments along the Winnipeg River near the Whiteshell Laboratories have been undertaken. Similar sampling and analyses has been undertaken for the lakebed sediments of Lake Winnipeg, including Traverse Bay, the location of the Winnipeg River discharge into the lake. In general, the data indicate that the chemical history of the lakebed sediments correlates well with parameter maxima in other North American lakebed sediments since European settlement (Lockhart et al. 1994).

Radioactivity in Sediments

Sediment contamination has been examined through several studies from the early 1960s until more recently. It extends from the Whiteshell Laboratories outfall to Lake Winnipeg. Peak activity for ^{137}Cs occurred during the 1960s and was accredited to peak nuclear bomb testing activity during the time. The source of elevated levels in the 1970s and 80s is less clear. A study of deeper sediment samples (Soonawala 2000) concluded that Whiteshell Laboratories could not have contributed to the ^{137}Cs deeper in the sediment column. These elevated levels are, in fact, attributed to the residual effect of global fallout. Regardless, evidence exists through monitoring that ^{137}Cs concentrations in the Winnipeg River surface sediments are elevated downstream of Whiteshell Laboratories, compared to upstream values. This radionuclide is present as a result of the accumulation of solids which could settle from the ALWTC discharges (and possibly leaks from WR-1). The International Atomic Energy Agency (IAEA) clearance levels for unconditional clearance levels of mildly contaminated solids to the public domain is 300 Bq/kg for ^{137}Cs. Table 5.21 shows radioactivity found in the first centimetre of Winnipeg River sediment at various locations up and downstream from Whiteshell Laboratories.

Table 5.21
Radioactivity in Sediment Samples from the Winnipeg River

Distance from Outfall (km)	Year	^{137}Cs (Bq/kg)
0.76 Upstream	1994	10.1
	1995	7
	1996	3
	1997	13
	1998	16
0.37 Upstream	1994	4.37
	1995	8
	1996	3
	1997	8
	1998	8
0 (At Outfall)	1994	75500
	1995	2285
	1996	20604
	1997	499
	1998	206
0.15 Downstream	1994	206
	1995	94
	1996	59
	1997	114
	1998	41
0.52 Downstream	1994	440
	1995	508
	1996	111
	1997	139
	1998	157
0.79 Downstream	1994	49.2
	1995	25
	1996	73
	1997	142
	1998	79
2.56 Downstream	1994	93.6
	1995	95
	1996	96
	1997	82
	1998	76
3.48 Downstream	1994	116
	1995	44
	1996	42
	1997	36
	1998	38
4.78 Downstream	1994	123
	1995	124
	1996	123
	1997	230
	1998	63
13.06 Downstream	1994	110
	1995	79
	1996	26
	1997	54
	1998	28

(Adapted from Niemi and Soonawala 1999b)

River-bottom sediments were collected from 12 locations along the Winnipeg River, ranging from 0.76 km upstream to 13.06 km downstream of the process outfall.

Table 5.22 shows the gross beta and gross alpha activities (in Bq/kg dry weight) of the river-bottom sediments from the 12 locations along the Winnipeg River for the years 1994 to 1998.

Table 5.22
Radioactivity in River-Bottom Sediments, 1995 – 1998

LOCATION		ACTIVITY (Bq/kg Dry Weight)									
		1994		1995		1996		1997		1998	
Name	**Downstream, Distance & Outfall**	**Gross Beta**	**Gross Alpha**	**Gross Beta**	**Gross Alpha**	**Gross Beta**	**Gross Alpha**	**Gross Beta**	**Gross Alpha**	**Gross Beta**	**Gross Alpha(1)**
J04	-0.76	662	11.2	334	33	377	150	659	135	506	< LLD(2)
J02	-0.37	519	1.05	500	41	410	169	609	112	503	< LLD
OFL	0	5740	27.9	1168	105	1628	230	20751	717	663	< LLD
K01	+0.15	694	18.9	659	152	712	155	684	164	736	< LLD
K03	+0.52	1210	11.2	1518	157	637	216	667	204	721	< LLD
K05	+0.79	549	13.1	551	186	542	197	678	192	699	495
K14	+2.56	838	12.0	675	209	480	181	498	185	550	583
K19	+3.48	754	11.2	291	200	381	124	386	242	393	< LLD
K22	+4.63									694	< LLD
K23	+4.78	881	19.9	874	211	790	188	860	198	802	538
K24	+4.93									510	503
K30	+13.06	778	21.2	772	183	832	219	673	161	686	< LLD

(1) The gross alpha data for 1998 are based on a revised efficiency factor. Previous years values would have been higher if the revised efficiency factor had been applied two those years.
(2) Less than Lower Limit of Detection.

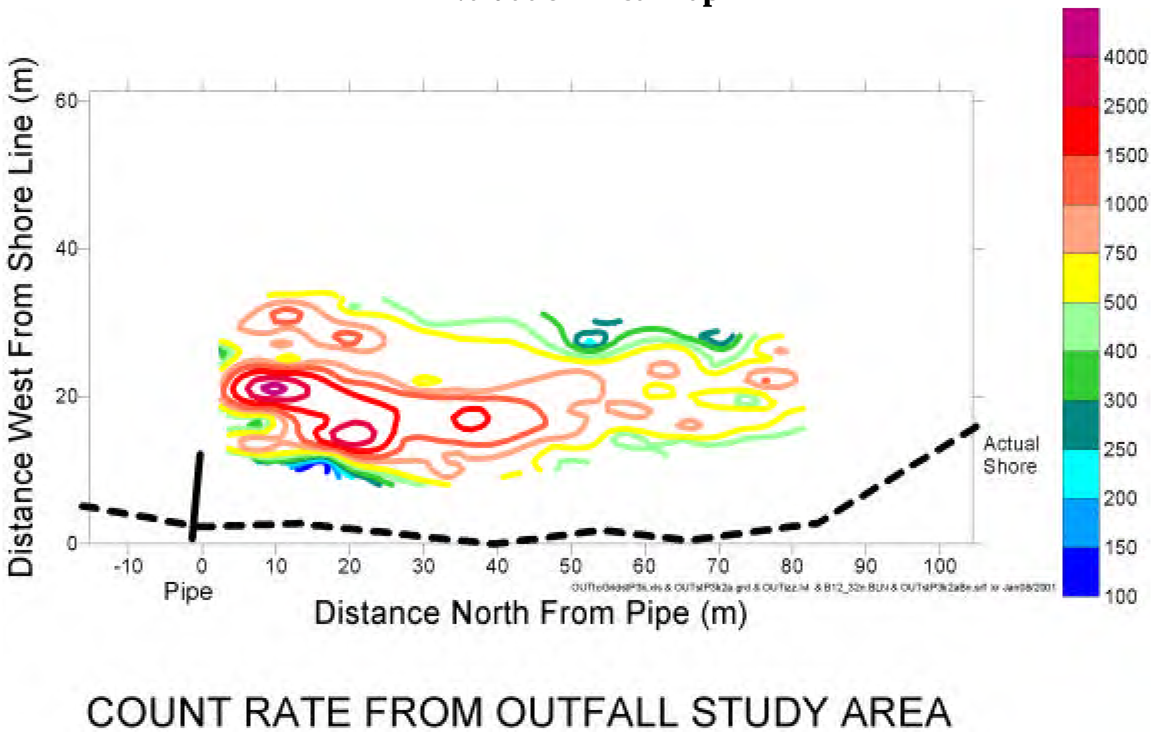
<u>*Sediment Contaminant Levels at the Outfall*</u>

To evaluate the impact of contaminated sediments at the outfall, a detailed assessment of the contaminated inventory was taken to support in-situ abandonment of the contaminated outfall area. A detailed field study to assess the potential impact of the sediment contamination on aquatic biota and humans was completed in the summer of 2000 and is documented in Appendix B. The study included:

- A detailed gamma survey of the riverbed in the contaminated area having sediment activities 5-fold above background.
- Measurement of contaminant levels in sediment cores and grab samples collected from the riverbed.

A 2-D contour plot of the gamma activity is shown in Figure 5.24. The gamma survey showed a region of elevated activity (10 times greater than background) extending a distance 80 m downstream of the outfall and 20 m in width.

Figure 5.24
Evaluation Area Map



The gamma survey results were plotted with software that allows definition of isopleths. These were used to compute an inventory of contaminant in the sediment of the evaluation area (Table 5.23). The observed activity at the isopleth line (counts per second or cps) was corrected for background, converted to dose rate (nGy/h) using the calibration developed for the sediment survey, and converted to concentration of ^{137}Cs Bq/g. Assuming a sediment density of 1500 kg/m^3, consistent with the dense clay observed, and a contamination depth of 5 cm, the contamination per unit area was computed. This multiplied by the corresponding area between this isopleth and the next gives an amount as Bq (Further details are given in Appendix B.1).

These values were summed for all the isopleths, resulting in an estimate of total inventory of 1.3 GBq. It is relevant to note that this is substantially less than the annual releases of ^{137}Cs prior to 1985 when the reactor was operating.

Table 5.23
Estimate of the Inventory of Cs-137 in Sediments in the Study Area Just Downstream of the Outfall
Areas are Computed From Measured Count Rate (Cps) Isopleths.

Isopleth (cps)	Net Count Rate (ncps)	Isopleth Equivalent Area (m^2)	Net Area (m^2)	Isopleth Dose Rate (nGy/hr)	Activity Concentration (Bq/g)	Total Activity (GBq)	Bkg (cps)
100	0	1598.71	6.8	8	0.27	0.000	100
150	50	1591.90	3.9	23	0.81	0.000	
200	100	1587.99	15.6	38	1.34	0.002	
250	150	1572.39	44.3	54	1.88	0.006	
300	200	1528.14	50.1	76	2.69	0.010	
400	300	1478.03	193.6	107	3.76	0.055	
500	400	1284.44	244.9	161	5.65	0.104	
750	650	1039.54	556.1	237	8.34	0.348	
1000	900	483.45	204.2	352	12.37	0.189	
1500	1400	279.21	159.3	581	20.44	0.244	
2500	2400	119.92	89.1	963	33.88	0.226	
4000	3900	30.81	28.7	1346	47.33	0.102	
5000	4900	2.15	2.1	1560	54.86	0.009	
		Total=	1598.706		Total =	1.295	

5.4.8 Aquatic Habitat and Biota

Local Study Area

The primary aquatic habitat found in the Local Study Area is the Winnipeg River, which passes directly through the licensed property area. In addition to this, there are several small isolated ponds on the Whiteshell Laboratories' site that are fed by local runoff and intermittent streams that run primarily during the spring. The streams are associated with gullies that dissect the clay plains along the banks of the Winnipeg River. They provide ideal beaver habitat, and as a result, beaver ponds are a common feature on the site. Ponds formed by beaver dams are seldom more than a few years old before they are drained and thus are not considered good aquatic habitat. There are also two sewage lagoons that are over 20 years old and that harbour a number of aquatic plants and animals. Man-made ditches carry water during spring runoff, but are generally dry in summer. Some become saline seeps in summer, as groundwater discharges into the dry ditches and the salts accumulate.

Fish

Of the 177 endemic fish species present in Canada, 94 species are found in the Hudson Bay Drainage System, which includes the Winnipeg River, and 79 species are present in Manitoba (Scott and Crossman 1973). Most of these species are forage fish such as carp and other minnow species. Predator fish in the area include walleye, northern pike, smallmouth bass, mooneye and lake trout. Populations of the fish, with the exception of sturgeon are considered stable.

Lake Sturgeon considered a species at risk due, in part, to over fishing during the first half of the century, is also found in the Winnipeg River. It is being studied because of concerns that the population may be declining as a result of the extensive hydroelectric developments on the river. The sturgeon is known for living upwards of 70 years, attaining weights of over 100 kg and reaching maturity at 20 years of age. Sturgeon feed on insect larvae, molluscs and crayfish. It has been suggested by locals that an area favoured by sturgeon is located at the outfall of the Whiteshell Laboratories.

Radioactivity in the Winnipeg River Fish

Fish consumption is the dominant exposure pathway of ^{137}Cs for people in the local area. Within the Winnipeg River, dominant fish species are walleye, pike, red sucker, white sucker and whitefish. In the past, variations in ^{137}Cs in fish flesh was not statistically significant between the fish downstream and upstream during the decade from 1962 to 1972; however marked increases of ^{137}Cs were observed in fish downstream between 1976 and 1982. These levels decreased to those observed between 1962 to 1972 after construction of the ALWTC in 1982 (Dunford et al. 1983). Table 5.24 to 5.26 gives a summary of the ^{137}Cs, potassium-40 and gross beta activity found in fish flesh at three locations on the Winnipeg River, from 1992 to 1998.

It is evident from data collected between 1992 to 1998 that fish in the downstream locations generally have higher concentrations of ^{137}Cs. Pickerel, common sucker and pike showed elevated concentrations in 1996 at 0.5 km downstream of the outfall. Otherwise, concentrations are uniform over the seven years except for a slight decline in 1997 and 1998 (Niemi and Soonawala 1999b).

Table 5.24
Average Radioactivity in Winnipeg River Fish Flesh Upstream of Whiteshell Laboratories (Pinawa)

Year	Cs-137 (Bq/kg, wet weight)	K-40 (Bq/kg, wet weight)	Gross Beta (Bq/kg, wet weight)
White Sucker			
1992	0.56	125	92
1993	0.42	116	91
1994	0.45	110	97
1995	0.33	100	92
1996	0.4	124	98
1997	0.37	126	100
1998	0.57	162	97
Pickerel (Walleye)			
1992	1.11	105	87
1993	1.32	121	96
1994	1.22	113	94
1995	0.76	112	93
1996	0.99	132	97
1997	1.03	141	102
1998	1.44	119	89
Whitefish			
1992	1.29	118	99
1993			
1994	0.17	118	95
1995	0.28	108	105
1996	0.58	134	105
1997	0.26	135	105
1998	0.24	159	100
Pike			
1992	2.26	122	98
1993	0.16	115	90
1994	0.69	114	98
1995	0.63	98	91
1996	0.66	116	90
1997	0.76	135	98
1998	1.74	132	89

(Adapted from Graham et al. 1998)

Table 5.25
Average Radioactivity in Winnipeg River Fish Flesh 0.5 km Downstream of Whiteshell Laboratories

Year	Cs-137 (Bq/kg, wet weight)	K-40 (Bq/kg, wet weight)	Gross Beta (Bq/kg, wet weight)
White Sucker			
1992	1.65	115	87
1993	1.84	122	96
1994	1.81	112	104
1995	2.18	99	93
1996	2.87	120	92
1997	1.31	130	96
1998	1.03	109	87
Pickerel (Walleye)			
1992	3.66	110	90
1993	2.04	117	90
1994	2.35	116	101
1995	2.21	112	99
1996	3.26	136	103
1997	1.88	133	98
1998	1.96	150	108
Whitefish			
1992	4.28	127	87
1993	0.53	112	96
1994	0.55	111	102
1995	1.96	95	97
1996	1.56	121	90
1997	0.38	122	96
1998	0.45	140	115
Pike			
1992	2.54	115	90
1993	2.53	118	94
1994	2.62	103	100
1995	1.72	99	99
1996	4.63	114	99
1997	1.42	125	103
1998	1.94	118	98

(Adapted from Graham et al., 1998)

Table 5.26
Average Radioactivity in Winnipeg River Fish Flesh 5 km Downstream of Whiteshell Laboratories

Year	Cs-137 (Bq/kg, wet weight)	K-40 (Bq/kg, wet weight)	Gross Beta (Bq/kg, wet weight)
White Sucker			
1992	1.22	117	88
1993	1.56	120	96
1994	0.93	108	90
1995	1.41	102	93
1996	1.56	121	90
1998	1.36	154	117
Pickerel (Walleye)			
1992	2.69	118	92
1993	2.46	122	100
1994	1.80	114	96
1995	1.90	109	97
1996	1.30	130	104
1998	1.73	131	106
Whitefish			
1992	0.79	120	90
1993	0.66	120	100
1994	0.6	111	105
1995	0.51	91	91
1996	0.72	120	92
1998	0.35	116	91
Pike			
1992	2.07	112	86
1993	1.32	62	91
1994	2.08	99	86
1995	1.53	99	95
1996	1.62	118	101
1998	1.10	116	88

(Adapted from Graham et al., 1998)

Invertebrates

Studies on benthic species have been undertaken on the Winnipeg River by Guthrie and Iverson (1970) and Ireland et al. (1973). More recent studies have been undertaken by Wong et al. (1996) downstream near Pine Falls and in Whiteshell Provincial Park (McKillop 1996).

Among the many species of zooplankton in Winnipeg River, rotifers, cladocera and copepoda are usually dominant. The benthic fauna include protozoa, ostracods, nematodes, oligochaetes, leeches, mysids (the opossum shrimp), crayfish, amphipods, mollusks (snails), bivalve clams (e.g. mussels) and aquatic insects. The latter include Diptera larvae such as Chironomid and Chaoborus larvae, dragonflies, mayflies (e.g. Hexagenia) caddisflies, true bugs and aquatic beetles (Guthrie and Iverson 1970).

Diversity and production of the benthos is generally greater in the littoral (shallow) area than in the profundal (deep water) area. However, production in profundal areas may be high as attested by the large emergence of mayflies from Lac du Bonnet each summer. Blackfly larvae are present in fast water reaches of connecting channels. Chironomidae and tubificids were particularly numerous in the early operational survey carried out by Ireland et al. (1973). These authors provide benthic abundance data for the Winnipeg River upstream and downstream of the Whiteshell Laboratories liquid effluent outfall. The benthic fauna has been investigated in more detail downstream in the Winnipeg River near Pine Falls (Wong et al. 1996). The distribution of aquatic snails and their association with aquatic plants in nearby Whiteshell Provincial Park has been documented (Pip 1978; Pip 1979; McKillop 1996).

In the summer 2000 study, ^{137}Cs levels in clamshells and tissue were found to be slightly elevated. There was considerable variation in levels with slight trends to higher tissue concentrations close to the outfall and higher concentrations in larger (older) clams. Additional details are provided in Appendix B.1.

Macrophytes (Aquatic Vegetation) and Phytoplanton (Algae)

Emergent macrophytes such as bullrushes, cattails and wild rice are found to a depth of about 1 m along the shores of the Winnipeg River. Phytoplankton of the Winnipeg River consists of a diverse assemblage of nearly all major algal taxonomic groups. Wild rice is harvested in the region, with harvesters reporting individual takes in the order of 5,000 kg. Almost all of this is concentrated on smaller water bodies than the Winnipeg River, including some seeded lakes. There are no water bodies suitable for wild rice on the Whiteshell Laboratories site.

5.4.9 Terrestrial Biota and Habitat

Regional Study Area

The Regional Study Area falls almost entirely within the Boreal Shield Ecozone, existing in Ecoregion 90 and Ecoregion 91, specifically the Lac Seul Upland and Lake of the Woods area, respectively. A very small portion of the Boreal Plains Ecozone, represented by a portion of Ecoregion 155 or the Interlake Plain, is also within the Regional Study Area (Environment Canada 1999). Lac Seul Upland makes up approximately 38% of the Regional Study Area, Lake of the Woods makes up approximately 56% of the area, and the Interlake Plain makes up approximately 6% (Manitoba Conservation Data Centre 1998).

The Regional Study Area is on the interface between aspen parkland and boreal forest. The local relative dominance of tree species depends largely on the underlying soils. The calcareous poorly drained clay soils, if not covered by organic deposits, support aspen parkland, whereas sandy soils and organic soils tend to support species typical of boreal forest (e.g. black spruce, white spruce, tamarack, jack pine, balsam fir). The confluence of these two major habitat types results in complex local associations. The region is also the eastern boundary of the range of many western species, and the western boundary of the range of many eastern species. The river has an additional influence on this combination of habitats. The riparian zones along the shore of the Winnipeg River are first footholds for species not normally found in the area. For example, the ironwood tree is at the northern boundary of its range, and occurs in the region almost exclusively along the riverbanks.

Of the listed species of concern outlined by the Manitoba Conservation Data Centre, the Lake of the Woods ecoregion maintains vegetation that is widespread throughout North America; however, 20% of species are ranked as being very rare within Manitoba. In Lac Seul Upland, 19% of the species of vegetation listed are very rare throughout their range in the province, but are common elsewhere. In the Interlake Plain, 30% of the listed vegetation is rare within the province. Within this ecoregion, the Western Prairie Fringed Orchid and the Western Silvery Aster are listed as endangered and threatened, respectively (Manitoba Conservation Data Centre 1998).

Local Study Area

Figure 5.25 shows vegetation cover in the local area. The aspen and balsam poplar forest on the clay plains has associations of willow, rose, alder, currant and dogwood. The mixed deciduous forest and the river forest include ash, aspen, birch, oak and fir, with associations of cranberry, willow, rose and strawberry. The black spruce in the bogs to the east is associated with Labrador tea, moss, tamarack, horsetail, blueberry and willow. The upland mixed conifers on the sandy soils include jack pine and poplar stands, with spruce, fir and birch and associations of Labrador tea, hazelnut, plum and blueberry. The wetlands contain manna-grass, cattail, sedge, and bullrush. The old-field areas and other areas where vegetation is controlled contain types of grass, bluegrass, sedge, strawberry, clover and aster.

Project Study Area

The terrestrial habitat in the Project Study Area is diverse over short distances. Large tracts of wetland cover the easterly portions of the site, with black spruce common. Within this area is a ridge of well-drained sandy soils with jack pine as the notable species. Further to the west are poorly drained clay plains, some forested with species such as ash and poplar, and some as abandoned farm fields vegetated with grasses and shrubs. Near the FIG (Field Irradiator Gamma) site are upland mixed conifers including jack pine and poplar stands, with spruce, fir and birch and associations of Labrador tea, hazelnut, plum and blueberry. This is shown in Figure 5.26. Close to the Winnipeg River are gullies or ravines where beaver dams are common. The gullies and the riparian environments along the Winnipeg River occasionally harbour species not common to the region.

Mammals

Over 50 species of mammals can be expected to occur around the Whiteshell Laboratories site (Banfield and Brooks 1974). More detailed regional data are available from Manitoba Natural Resources through hunting and trapping statistics. Many of the mammals, such as the snowshoe hare, American red squirrel, meadow vole, red fox and white-tailed deer, are common and widespread. Others, such as the American water shrew, Franklin's ground squirrel, southern bog lemming, fisher and moose are only locally common where suitable habitat is available. Still others, such as the grey fox, wolverine and mountain lion are rare.

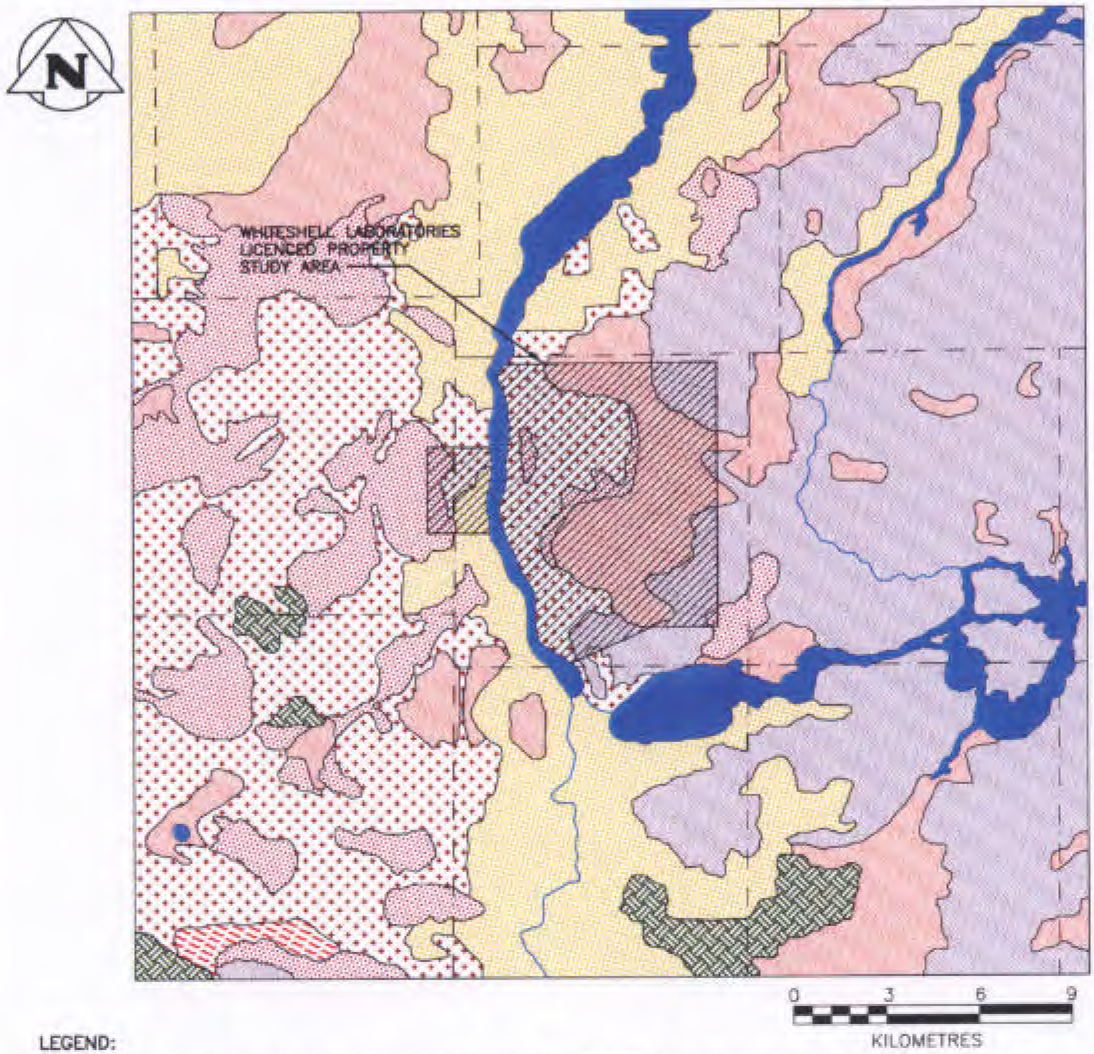
The Committee on the Status of Endangered Wildlife in Canada produced an annual Canada wide list of species designated at risk (e.g. extinct, extirpated, endangered, threatened and vulnerable) for 1997. No mammals species in the area were listed as endangered while the grey fox and the wolverine were listed as vulnerable.

White-tailed deer successfully colonized Manitoba at the turn of the century with the settlement of the province. These deer have become an important ecological component and are considered important for aboriginal peoples, as well as a game species. Deer inhabit the Whiteshell Laboratories site and have established wintering areas on the site. A capability map for ungulates (which include deer) is provided in Figure 5.27.

Mammals common to the Whiteshell Laboratories area, generally have a range that extends well beyond the facility. This range is of similar habitat to the Whiteshell Laboratories site.

FIGURE 5.25

VEGETATION COVER IN LOCAL STUDY AREA



LEGEND:

- AGRICULTURAL, GRAZING AND MODIFIED COVER
- HARDWOODS (PRIMARILY ASPEN)
- MIXED FOREST (HARDWOODS & CONIFERS)
- JACK PINE
- CONIFERS (PRIMARILY WHITE & BLACK SPRUCE)
- CONIFERS (PRIMARILY BLACK SPRUCE, SOME TAMARACK)
- MARSHLAND (OPEN TO THINLY TREED)
- WHITESHELL LABORATORIES LICENCED PROPERTY STUDY AREA (APPROXIMATE LOCATION)

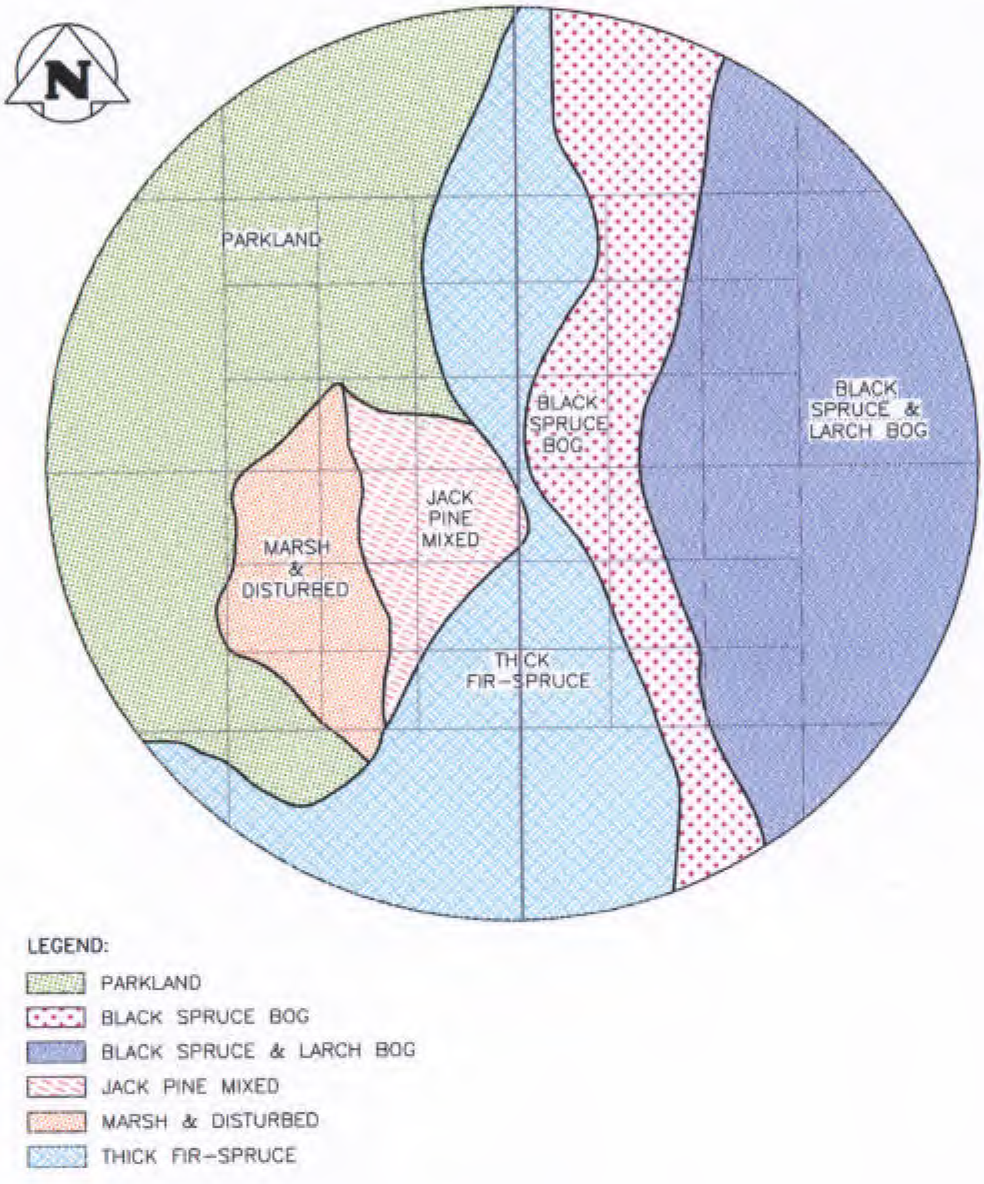
NOTE:

VEGETATION COVER INCLUDING THE WHITESHELL SITE (CENTRE OF THE MAP) AND PARTS OF THE LOCAL STUDY AREA. THE VARIETY OF HABITAT NEAR THE SITE IS EVIDENT, AND THIS DIVERSITY OVER A SMALL AREA DESIGNATED AS A TERRESTRIAL VALUED ECOSYSTEM COMPONENT (VEC).

SOURCE: GUTHRIE AND SCOTT, 1988

FIGURE 5.26

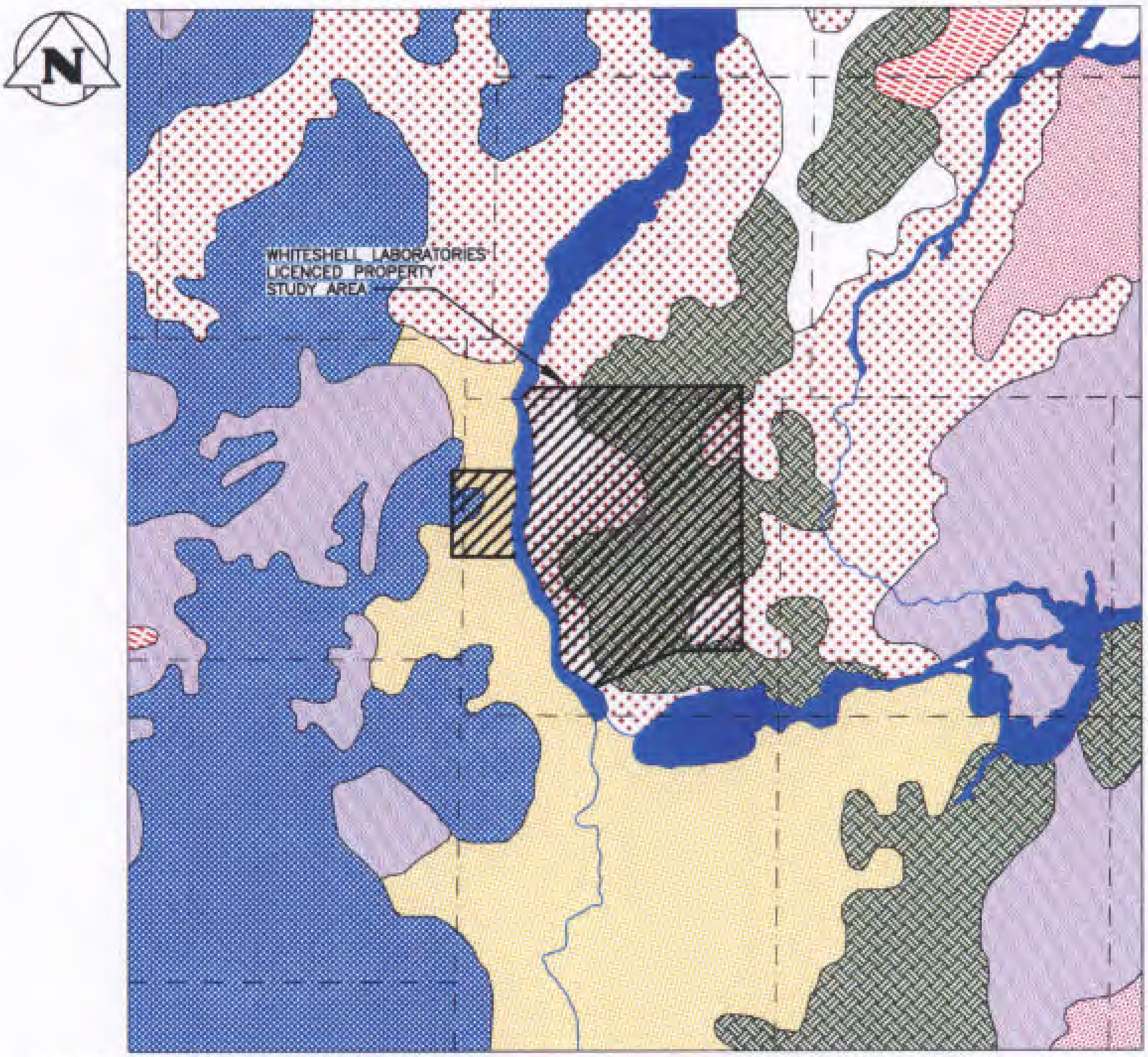
VEGETATION MAP FOR THE FIELD IRRADIATOR GAMMA (FIG) SITE



SOURCE: GUTHRIE AND SCOTT, 1988

FIGURE 5.27

LAND CAPABILITY FOR UNGULATES



LEGEND:

- NO SIGNIFICANT LIMITATIONS
- VERY SLIGHT LIMITATIONS
- SLIGHT LIMITATIONS
- MODERATE LIMITATIONS
- MODERATELY SEVERE LIMITATIONS
- SEVERE LIMITATIONS
- ALMOST NO PRODUCTION
- MODERATE/MODERATELY SEVERE/SEVERE LIMITATIONS
- WHITESHELL LABORATORIES LICENCED PROPERTY STUDY AREA (APPROXIMATE LOCATION)

NOTE:

LAND CAPABILITY FOR UNGULATES AT THE WHITESHELL SITE (CENTRE OF THE MAP) AND PARTS OF THE LOCAL STUDY AREA. THERE IS, IN CERTAIN YEARS, A LARGE POPULATION OF DEER AND SOME MOOSE IN THE AREA, AND THOSE WERE DESIGNATED AS A VALUED ECOSYSTEM COMPONENT (VEC).

SOURCE: GUTHRIE AND SCOTT, 1988

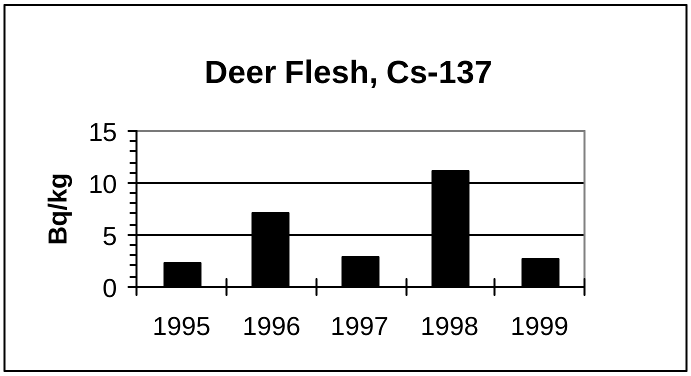
Radioactivity in the Flesh of Wildlife

Niemi et al. 2000 presents data on radioactivity in flesh of roadkills from the vicinity of Whiteshell Laboratories and trapped animals from Crowduck Lake, about 60 km northeast of Whiteshell Laboratories on the Winnipeg River system. The data are presented in Table 5.27. The trend for years 1995 to 1999 for ^{137}Cs concentration in deer flesh from the vicinity of Whiteshell Laboratories is shown in Figure 5.28.

Table 5.27
Radioactivity in Flesh of Roadkills

Month	Species	Approx Age (Year)	Gross Beta			Gross Alpha			Cs-137			K-40		
Crowduck Lake (60 km northeast of WL)														
99 March	Fox	1 to 2	104.7	+/-	7.3	9.0	+/-	7.0	13.7	+/-	0.4	122.4	+/-	5.4
99 March	Fox	< 1	105.5	+/-	7.2	7.0	+/-	5.0	39.0	+/-	1.3	107.6	+/-	12.8
99 March	Fox	1 to 2	71.7	+/-	4.9	7.0	+/-	5.0	8.9	+/-	0.7	84.2	+/-	8.5
99 March	Otter	1 to 2	80.6	+/-	5.5	16.0	+/-	6.0	9.4	+/-	0.5	93.5	+/-	6.5
99 March	Otter	1 to 2	294.2	+/-	20.0	78.0	+/-	24.0	1.9	+/-	0.5	380.5	+/-	11.6
99 March	Otter	1 to 2	78.4	+/-	5.5	22.0	+/-	8.0	1.2	+/-	0.4	99.2	+/-	7.3
99 March	Otter	1 to 2	90.2	+/-	6.2	13.0	+/-	7.0	20.7	+/-	0.7	122.4	+/-	8.3
99 March	Otter	1 to 2	64.5	+/-	4.5	7.0	+/-	5.0	0.9	+/-	0.3	80.4	+/-	4.8
Whiteshell Labs (Licensed property and vicinity)														
99 Feb	Deer	3	94.3	+/-	6.5	<7			2.4	+/-	0.2	125.0	+/-	5.7
99 Feb	Deer	3	27.8	+/-	1.9	<2.4			2.9	+/-	0.1	38.2	+/-	2.5

Figure 5.28
Radioactivity in Flesh of Deer
(Bq/kg, fresh weight)



Radioactivity in Vegetation

Radioactivity in native vegetation, in units of Bq/kg fresh weight, is reported from 6 locations at Whiteshell Laboratories in Table 5.28.

Table 5.28
Radioactivity in Native Vegetation at
Whiteshell Laboratories – 1998
(Bq/kg Fresh Weight)

Location	**Gross Beta[(1)] (Bq/kg)**
ARMS 1, North	87
ARMS 3, South-southeast	209
ARMS 4 West	150
ARMS 5, Northwest	152
West of WMA (standpipe 83 spill area)	450[(2)]
North of Canisters	234[(2)]

[(1)] ARMS locations are yearly averages.
[(2)] Stations sampled once (during spring) known to yield elevated results.

Birds

A large variety of bird species can be expected to occur in the vicinity of the Whiteshell Laboratories site based on general distribution data (Godfrey 1986). The birds of the region have been studied in detail by Taylor (1983) and Seabloom (1975). Taylor's surveys continue and data for the area includes breeding bird and owl surveys as well as Christmas bird counts. Zach (1982) has studied the breeding biology of house wrens and tree swallows on the site itself, so data exists on parameters such as brood size, hatching success and growth rates (Zach 1982; Zach and Mayoh 1982a, 1982b, 1986).

There are important bird migration staging areas on or near the site. The most important physical feature related to migration routes of birds is the Winnipeg River. It represents a migratory corridor for several species that move into central Manitoba and beyond from the Great Lakes and/or the Mississippi River in spring and back in the fall. The most important species include the common loon, red-necked grebe, horned grebe, double-crested cormorant, American white pelican, Bonaparte's gull, common tern, Caspian tern, lesser scaup, greater scaup and bald eagle. The Winnipeg River can become an important staging area for a variety of waterbirds each spring (e.g. common loon and red-necked grebe).

The Committee on the Status of Endangered Wildlife in Canada annual Canada-wide list of species designated at risk for 1997 indicates that the area may support several endangered species including: peregrine falcon, burrowing owl, piping plover and loggerhead shrike. Vulnerable species in the area may include the least bittern, short-eared Owl, Caspian tern and red-headed Woodpecker.

Amphibians and Reptiles

A wide diversity of amphibians is present in the vicinity of the Whiteshell Laboratories site, despite the generally harsh winter conditions. About 10 species of amphibians can be found (Froom 1982; Cook 1984). Most are frogs such as the spring peeper, grey tree frog, striped chorus frog, wood frog and northern leopard frog are common and widespread. However, some species, such as the green frog and the mink frog are less common and widespread (Taylor 1990).

Only four reptile species can be found on-site; two turtle and two snake species (Preston 1982; Cook 1984). Both are common and widespread. The common garter snake is widely distributed and prevalent in the region, but little is known about the exact status of the redbelly snake found in the area. All the reptile species hibernate to survive the harsh winters and hibernacula are a potentially important ecological feature in the Whiteshell region. None are known to exist on the Whiteshell Laboratories site. In spring, the reptiles become active and enter their breeding cycle, which may involve special areas for egg-laying; none are known to be located in the Whiteshell Laboratories' controlled area.

5.4.10 Regional Land and Resource Use

Agriculture

In the regional area, some of the best farmland is along waterways and on upland lighter-textured soils (Canada Land Inventory 1968, 1975). Consistent with the regional area, in the local area better farm land is found along the Winnipeg River. The land capability map (Figure 5.29) identifies classes of crop land for the local area. Agricultural operations in the region include cereal production, hay, flax, canola and alfalfa crops, and dairy and livestock production. Alfalfa seed production and the attendant leaf-cutter bees is a specialty in the area. Early data for comparison to present-day production, cultivation and harvest is available for cereal, flax, alfalfa and hay (Guthrie and Scott 1988). These data are broken out by township and farm size. The early census data show that less than half of the cattle in the area are dairy animals. Poultry, eggs and swine are also produced. Specialty operations in the area include goat herding, emu and ostrich farming, and leaf cutter bee operations. Farmers lease land from AECL on the west side of the Winnipeg River, in the area catagorized as unaffected.

Forestry

Forestry is a strong industry in the regional area, although little if any forestry has occurred in the local area. Aspen, black spruce and jack pine are the dominating natural stands of timber in the region (Dugle et al. 1974; Canada Land Inventory 1974). There are extensive and potentially productive softwood and hardwood forests close to Whiteshell Laboratories (Guthrie and Scott 1988). The Province's Agassiz Forest Reserve is just to the west of the Whiteshell site. Considerable softwood stands (black and white spruce, balsam fir and jack pine) in the region have been and are presently being logged to supply pulp to Pine Falls Pulp and Paper Co. newsprint operation at Pine Falls. Guthrie and Scott (1988) give regional commercial forestry harvest statistics for the 1960s. However, maps from Canada Land Inventory (1974) indicate that the area in the immediate proximity of the Whiteshell Laboratories site shows moderate to moderately severe limitations to commercial forestry and the land due east of the plant site (primarily bog) has either severe limitations or commercial forest growth is completely precluded. The site is within the Manitoba Model Forest boundary presenting some restrictions or oversight to large-scale forestry operations at present.

Recreation

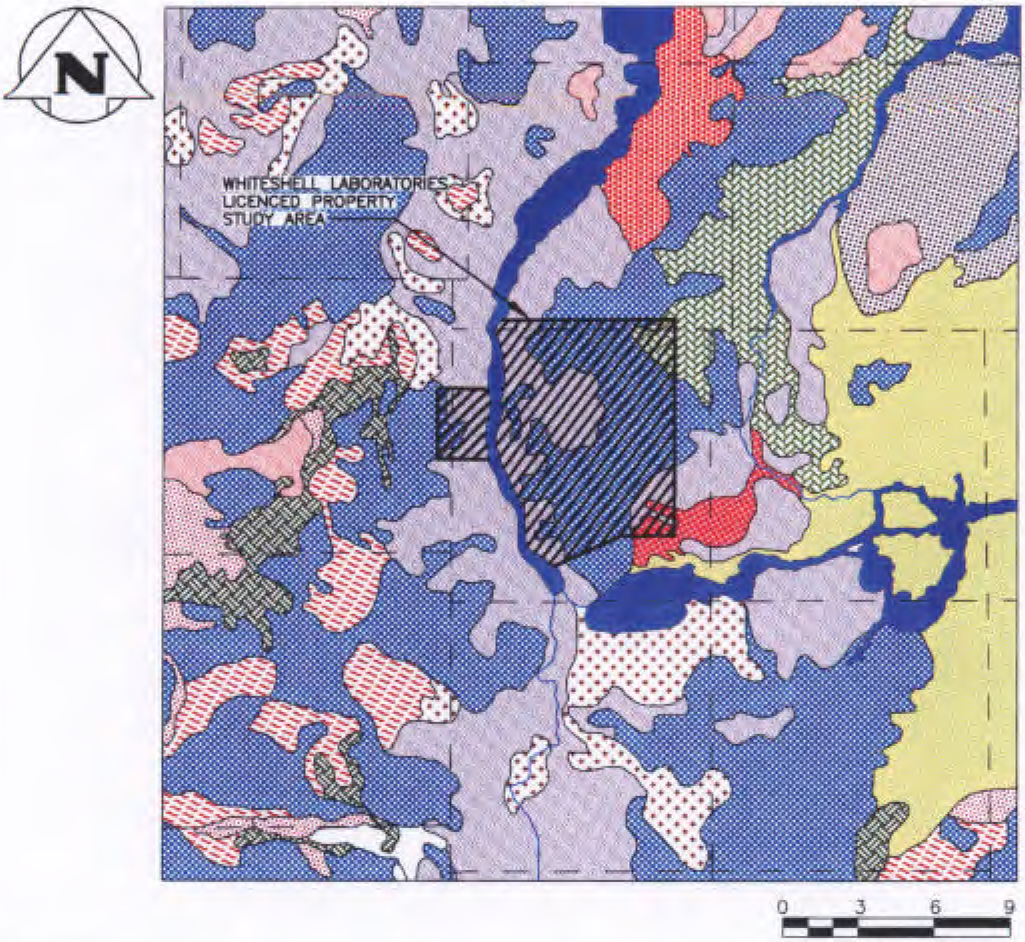
Recreation is a major land and water use. The Whiteshell Laboratories' site is located just a few kilometres northwest of the Whiteshell Provincial Park boundary and southwest of the Nopiming Provincial Park, both of which are prime outdoor recreation areas in eastern Manitoba. The Trans-Canada Trail follows the dyke along Natalie Lake just south of Highway 211 and the Whiteshell Laboratories' controlled area. Home and cottage development along the west side of the Winnipeg River indicates that waterways, scenery, trails and wildlife of the region are attracting vacationers and weekend campers. The area to the north affords great vistas and interesting hiking terrain as well as heritage and cultural points of interest (such as the Bannock Point petroforms, the Old Pinawa Dam, voyageur routes along the Winnipeg River). Explore Magazine and Going Places, the magazine of the Canadian Automobile Association (CAA), recently featured Pinawa as one of the birding meccas of Manitoba, with some 20 km of maintained hiking trails in summer. This area also has considerable recreational resource use in winter with 30 km of groomed cross-country ski trails and access to hundreds of kilometres of snowmobile trails (directly linked to the U.S.).

Hunting and Trapping

Hunting and trapping is popular in the region (Canada Land Inventory 1971, 1972a, 1972b). The principle game animals are deer and moose, although bear hunting is becoming more popular. Wolf, coyote, fox, beaver, muskrat, mink, weasel, otter, fisher, martin and squirrel are the most commonly trapped species on the twenty to thirty traplines in the Whiteshell game hunting area. Both open areas and registered traplines exist and Manitoba Natural Resources maintain records of game and fur-bearing species harvested. No registered traplines are within the controlled area of the Whiteshell Laboratories site (it is designated restricted). However, trapline number 23 is located along the southern and eastern boundary of the controlled area (Lac du Bonnet Natural Resources Officer 1999).

FIGURE 5.29

LAND CAPABILITY FOR AGRICULTURE



LEGEND:

- MODERATE LIMITATIONS FOR CROPS
- MODERATE TO SEVERE LIMITATIONS FOR CROPS
- SEVERE LIMITATIONS FOR CROPS
- VERY SEVERE LIMITATIONS FOR CROPS
- PERENNIAL FORAGE CROPS ONLY
- NO CAPABILITY FOR AGRICULTURE
- ORGANIC SOILS; NOT RELATED
- MODERATE/MODERATE TO SEVERE/NO CAPABILITY
- MODERATE TO SEVERE/SEVERE/NO CAPABILITY
- MODERATE TO SEVERE/ORGANIC SOILS
- NO CAPABILITY/ORGANIC SOILS
- NO CAPABILITY/MODERATE TO SEVERE/ORGANIC SOILS
- WHITESHELL LABORATORIES LICENCED PROPERTY STUDY AREA (APPROXIMATE LOCATION)

NOTE:

LAND USE (LAND CAPABILITY FOR AGRICULTURE) AT THE WHITESHELL SITE (CENTRE OF THE MAP) AND PARTS OF THE LOCAL STUDY AREA.

SOURCE: GUTHRIE AND SCOTT, 1988

Water Use

The primary use of water from the Winnipeg River is for domestic purposes. The Winnipeg River serves as the drinking water source for the downstream towns of Lac du Bonnet, Great Falls, St. George and Pine Falls. Water treatment varies for each municipality and includes a range from chlorination only, to chlorination, filtration, sedimentation and coagulation (Pine Falls).

Some irrigation water is also taken and the province keeps records of irrigation permits. The entire length of the Winnipeg River is used for boating and water skiing. Owners of private property with river frontage have docks and use the river for swimming. The closest beach for public swimming is on the west shore of Lac du Bonnet in the town's centre.

Fishing

No commercial fishing is carried out on the Winnipeg River. Commercial fishing takes place at the mouth of the river in Traverse Bay at the south end of Lake Winnipeg. The major species are northern pike, walleye, lake sturgeon, smallmouth bass, burbot and yellow perch.

Sport fishing, however, is very popular in the Winnipeg River. In this respect, the Whiteshell Laboratories site is in management area No.3 (Guthrie and Scott 1988). Major sports fish in the area are walleye, northern pike, smallmouth bass, mooneye, and lake trout. Mooneye is a relatively small fish prized for consumption when pickled and smoked. The aforementioned species are common in the region and although they are thought to have stable populations, capture limits have been designated by Manitoba Conservation. Local knowledge suggests an area favoured by sturgeon is located near the outfall of the Whiteshell Laboratories. Sturgeon is a protected species that must be released if caught.

5.5 BASELINE CONDITIONS: SOCIO-ECONOMIC

5.5.1 Population

Whiteshell Laboratories is part of the Pinawa LGD. In 1996, the population of the communities around Whiteshell Laboratories was approximately 18,700, up about 400 from 1991 (Table 5.29). According to the Community/Provincial Leaders Committee on the Closure of Whiteshell Laboratories, approximately half of the workforce at Whiteshell Laboratories has tended to live in the Pinawa-Whitemouth Region. In 1996, the two communities (Pinawa LGD and Whitemouth RM) had a combined population of 3,311, down from 3,520 in 1991 and 3,847 in 1981. The population of Pinawa where the Whiteshell facility is located was down from 2011 in 1981 to 1672 in 1996.

Table 5.29
Population Data for Communities Around Whiteshell Laboratories

Community	1981	1986	1991	1996
Alexander	N.A.	N.A.	2399	2555
Town of Beausejour	2465	2535	2636	2712
R.M. of Brokenhead	3021	3175	3325	3495
Fort Alexander	N.A.	N.A.	1579	1690
Village of Lac du Bonnet	1030	1021	1088	1070
R.M. of Lac du Bonnet	2194	2189	2219	2280
L.G.D. of Pinawa	2011	2078	1806	1672
R.M. of Whitemouth	1836	1820	1714	1639
Pine Falls	N.A.	N.A.	800	794
Powerview	N.A.	N.A.	736	759
Total			**18302**	**18666**

Source: The Whiteshell Laboratories Community/Provincial Leaders Committee April 30, 1999.

5.5.2 Employment and Economic Base

General

Employers such as government, schools, shops and some new services and industries have evolved since downsizing of the Whiteshell Laboratories began. Historically, however, the Whiteshell facility has been the dominant employer in the area (Table 5.30). Estimates prepared for the Community/Provincial Leaders Committee's report indicate that the workforce at Whiteshell Laboratories peaked at about 1168 in the fall of 1984, and was fairly constant at around 1100 until June 1992. Thereafter, employment fell off to 802 in February 1998 and, following the layoffs of March 1998, has fallen to 349. The decommissioning workforce will be about 150. Ultimately, once the first phase of decommissioning is complete, total employment at the site will be approximately 30 people. The number of staff in addition to those involved in the decommissioning is not clear. AECL records indicate that at present, approximately 50% of the employees who have been laid off from Whiteshell continue to live in Pinawa.

Table 5.30
Employment by Sector

Sector	Manitoba	Lac du Bonnet (Rural Municipality)	Alexander	Pine Falls	Pinawa	Lac du Bonnet (Village)	Powerview	Fort Alexander
Total Population 15 yrs & over	855880	1850	1960	625	1300	840	600	1125
Participation Rate	66.3%	62.7%	56.6%	64.8%	69.6%	53%	67.5%	43.1%
Unemployment rate	7.9%	6.3%	6.8%	2.5%	3.9%	13.5%	4.9%	38.1%
All industry divisions	553875	1130	1095	405	905	415	395	380
Agricultural and related service industries	39660	125	75	0	0	10	0	0
Fishing and trapping industries	1015	0	0	0	0	0	0	10
Logging and forestry industries	1940	15	10	0	0	0	0	20
Mining/manufacturing	67095	165	185	160	10	65	115	15
Construction	27310	90	55	0	20	15	0	20
Transportation and Storage	30490	85	80	10	15	20	0	10
Communication & other utilities	19755	100	75	0	20	20	10	10
Education Service	42470	30	100	30	120	30	75	60
Health and Social Service	65015	55	130	60	55	45	65	100
Retail/wholesale trade & hospitality	129385	315	215	75	95	105	55	20
Personal & financial & other	90030	100	100	40	525	35	45	20

Sources: Statistics Canada, 1996 census.
Interviews with Manitoba Industry, 1997 data.

In the past, this employment brought significant amounts of income into Pinawa and the area. AECL's 1991 Whiteshell Laboratories' payroll was approximately $54 million. Half of that amount went to employees living in Pinawa. Downsizing has reduced AECL's income contribution. The current (early 1999) payroll is about $18 million and the average annual salary is now $51,576 down from the 1991 level of $53,138, (not counting inflation).

Other Activities

Mining

Mining activity in the eastern region includes tantalum mining in the Lac du Bonnet area. The Tanco mine produces high grade spodumene for ceramic and specialty glass industries. Mining operations restarted in 1995. There are also quarry leases for granite in the area. In addition, silicon sand leases are pending in the area.

Forestry

Forestry is an important industry in the area. There are extensive and potentially productive softwood and hardwood forests close to Whiteshell Laboratories. Several of the softwood stands in the region are logged to supply pulp to Pine Falls Pulp and Paper Co. newsprint operation at Pine Falls.

A Federal/Provincial Program designed to create a sustainable forest environment is now underway in the area. The model forest is a large-scale working model of sustainable forest management. The Manitoba Model Forest covers a large area, which extends just south of Pinawa northward, including the southern portion of Atikaki Provincial Wilderness Park, east to the Manitoba-Ontario border and west to Lake Winnipeg.

Agriculture

As discussed in Section 5.4.10, cereal, flax, alfalfa and hay are grown in the Whiteshell area. Specialty operations in the area include goat herding; emu and ostrich farming; and alfalfa seed production and leaf cutter bee operations.

Gross farm receipts by municipality in the regional area are provided in Table 5.31.

Table 5.31
Agriculture Gross Farm Receipts

Rural Municipality	# of Farms	Total Gross Farm Receipts	Receipts per Farm	$50,000+ Reporting	Under $50,000 Reporting
Lac du Bonnet	126	$9,537,662	$75,696	49	94
Whitemouth	155	18,161,139	117,169	126	87
Alexander	83	2,554,093	30,772	17	71
Brokenhead	362	19,760,520	54,587	187	245
Manitoba Total	**24,383**	**2,970,070,722**	**121,809**	**20204**	**12205**

Note: These figures do not include expenses, but are strictly gross receipts for farm operations in these rural municipalities. They are given as indication of the economic activity associated with farming in the area.

Source: Statistics Canada, 1996 Census.

Tourism

Tourism in the south east area of Manitoba is a significant industry (Table 5.32). According to a 1998 survey, 12% of American visitors to Manitoba visited the south east area of the province. This area extends north to just past Victoria Beach, east to the Manitoba – Ontario border and south to the American border and includes approximately the eastside of the Red River. Expenditures by American tourists average $188 per visit for the province and for the south east region the expenditures are over $200 per visit.

Table 5.32
Tourism Activity in South East Manitoba

Visits	Manitoba	South East Region	Percent of Manitoba Total
Total American Visits	824500	96500	12%
Total Domestic Visits	6306	1097	17%
American Visitors' Expenditures			
Average Reported Spending per Visit	$187.77	$86.97	
Average Reported Spending per Night	$132.84	$138.46	

Housing (Cottages)

Home and cottage development along the west side of the Winnipeg River indicates that waterways, scenery, trails and wildlife of the region are attracting vacationers and weekend campers.

Cottages and cottage lots have shown a steady demand over the last few years. The current price for river lots ranges from $35,000 to $50,000 depending on the location. Cottage lots on the Winnipeg River are in demand with the increase of retirees in southern Manitoba.

Sport Fishing

As discussed in Section 5.4.10, there is no commercial fishing in the Winnipeg River. However, sport fishing is popular.

The Whiteshell/Nopiming area represents about 20% of the total sport fishing activity in Manitoba, based on figures from sport surveys undertaken by Fisheries Branch, Province of Manitoba.

Table 5.33 is a summary of some indicators that establish the relative importance of sport fishing in Manitoba. Twenty percent of the sport fishing activity of the province takes place in the Whiteshell/Nopiming area. On a provincial basis, expenditures directly attributable to sport fishing totalled $28,755,591 for non-residents and $49,191,732 for Manitoba residents in 1995. This indicates the substantial impact sport fishing has the general area which includes the study area.

Table 5.33
Sport Fishing in Manitoba

Sport Fishing Indicator		1985	1990	1995
Whiteshell/Nopiming				
Percentage of Provincial Angler Days Expended by Anglers		18.7%	19.8%	20.4%
Non-resident		7.2%	8.8%	6.4%
Resident		20.0%	21.1%	22.4%
Total Province				
Non-residents	Average days per angler		7	7
	Trips – all reasons	159,880	176,212	180,997
	Fishing trips	64,759	96,748	105,031
	Days spent fishing	291,193	251,536	267,493
Non-residents (Continued)	Expenditures directly attributed to sport fishing- Manitoba		$23,503,144	$28,755,591
	Expenditures relating in hole or to sport fishing- Manitoba		$1,377,433	$3,661,591
Residents	Average days per angler		16	16
	Expenditures directly attributed to sport fishing –Manitoba		$68,046,453	$49,191,732
	Expenditure relating in whole or part to sport fishing – Manitoba		$115,883,175	$123,907,154
Daily Average – Resident and Non-Resident Licence				
Expenditure directly attributed to sport fishing per day			$38.60	$35.48

Notes: * Includes food, lodging, travel cost, fishing supplies, household-owned boat costs, other costs and packages.
** Includes fishing equipment, boats and related equipment, camping equipment, special vehicles, land/buildings, and other expenditures.

Trapping and Hunting

The value of the traplines in the local area is unknown, but a general trend across Canada has been a reduction in the economic value of trapping in recent years, due to the falling price of furs. Hunting remains a popular activity in the area, but the economic impact is unknown.

5.5.3 Infrastructure

Roads

The primary access to Whiteshell Laboratories from Winnipeg is via Highway 44 east, Highway 11 north, and Highway 211 east. The road between Winnipeg and Beausejour (46 km) is a four lane divided highway. Highway 11 connects the area to Lake Winnipeg to the north and the Trans-Canada Highway to the south. The remaining 90 kilometres are two lane, paved roads. There are several unpaved through roads – Highway 520 between Pinawa and Lac de Bonnet via Highway 307 and Highway 406 south of Seven Sisters connecting to Highway 11. Municipal roads in towns are paved. There are numerous unpaved interior access roads. Within the Whiteshell Laboratories' site, the main access roads to the facility are paved, although roads accessing facilities outside of the main complex, for example the waste management facility, are generally unpaved.

During most of the year, there are no load restrictions on any of the paved roads in the area. There are some load restrictions in the spring, particularly on unpaved roads. The bridge over the Winnipeg River at Highway 211 just of Highway 11, has no load restrictions.

In addition to serving the area's local permanent population, the roads to the Whiteshell area serve a large number of cottagers in and around Whiteshell Provincial Park.

Water Supply and Sewers

The Winnipeg River is the source of water for most of the people living in the area. The Town of Lac de Bonnet and the LGD of Pinawa draw water from the river and treat it at their water treatment plants. Water co-ops (there are five in the RM of Lac de Bonnet alone) also draw water from the river and provide it directly through local piped systems or haul it to individual homes or systems away from the river.

Sewer systems exist in several communities, including the Town of Lac de Bonnet and the LGD of Pinawa, and include treatment at lagoons. The RM of Lac de Bonnet has no sewerage system but has a lagoon in which local septic tank maintenance contractors as well as travellers using RV's can dispose of their wastes.

5.5.4 Community Services

Apart from the availability of a considerable variety of outdoor recreational opportunities (see Section 5.4.10), most notably the Winnipeg River and the Nopiming and Whiteshell Provincial Parks, the area is well served with recreation and community services, Pinawa is particularly well serviced. It has both a high school and a public school. It has a 17-bed hospital, a community hall, and numerous other facilities including baseball and soccer fields, tennis courts, artificial ice arena as well as a popular golf course. These facilities are in part an outcome of the relatively high per capita expenditures on recreation. The Community/Provincial Leaders Committee on the Closure of Whiteshell Laboratories noted that, on a per capita basis, recreation and cultural expenditures were twice the Manitoba average even excluding the $250 annual costs of cable television.

5.5.5 Municipal Finance

Notwithstanding the high level of services available to residents of Pinawa, taxes on a standard bungalow (defined as 102 m^2, built around 1975) are on a par with communities elsewhere in the area but substantially lower than in Winnipeg (Table 5.34).

Table 5.34
Property Taxes in Manitoba Communities

Community	1997	1999
Pinawa	$1922	$1779
Beausejour	$1718	$1680
Lac du Bonnet	$1791	$1690
Winnipeg St. James	$2523	$2783

Note: Data adjusted to reflect different charges (cable TV, water and sewer).

Source: The Whiteshell Laboratories, Community/Provincial Leaders Committee (April 30, 1999).

The provision of a high level of community services in conjunction with relatively low property taxes was planned by AECL for Pinawa. The grant-in-lieu of taxes paid by AECL to Pinawa was designed to ensure that the Town had services at least comparable to those elsewhere, if not better. The grant-in-lieu has recently been in excess of $1.9 million and has effectively amounted to half the revenue spent on schools and municipal services. Without the grant, the Leaders Committee estimated that the owner of a typical bungalow would have to pay $4,569 in property taxes, assuming that the Provincial policy of not providing the same educational funding assistance that it provides to other municipalities in Manitoba continues.

5.5.6 Historical and Archaeological Features

A comprehensive archaeological and historical record for the Licensed Property Study Area is not available. The lack of archaeological data for this area is not an indication of low potential for archaeological site, but rather is due to the fact that no formal archaeological field investigations have occurred within this study area. Only two archaeological sites within the area are presently recorded in the Provincial Archaeological Site Inventory: EaLa-6, the Sweet Creek Petroform Site, and EaLa-7, the Boat Launch Site (Figure 5.30). The first site was an ancient ceremonial site, which was destroyed during agricultural activities. The second is a pre-European-contact campsite. The present condition of this site is not known.

Two archaeological studies were conducted during the 1970s, one on each side of the reach of river where AECL property is located. These studies revealed high concentrations of pre-European-contact and fur trade sites. Of particular importance were the sites at the confluence of the Whitemouth and Winnipeg Rivers, where large settlements and burial mounds were recorded. These sites occur several kilometres south of the Licensed Property Study Area.

Archaeological Sites

Throughout history, rivers have played a vital role in the lives of people around the world. Aside from being a source of food and water, rivers are also important in transportation, communication, commerce and religion. The Winnipeg River is no exception, and has been used as an artery in east-west movements from as early as 5000 BC (Steinbring 1980).

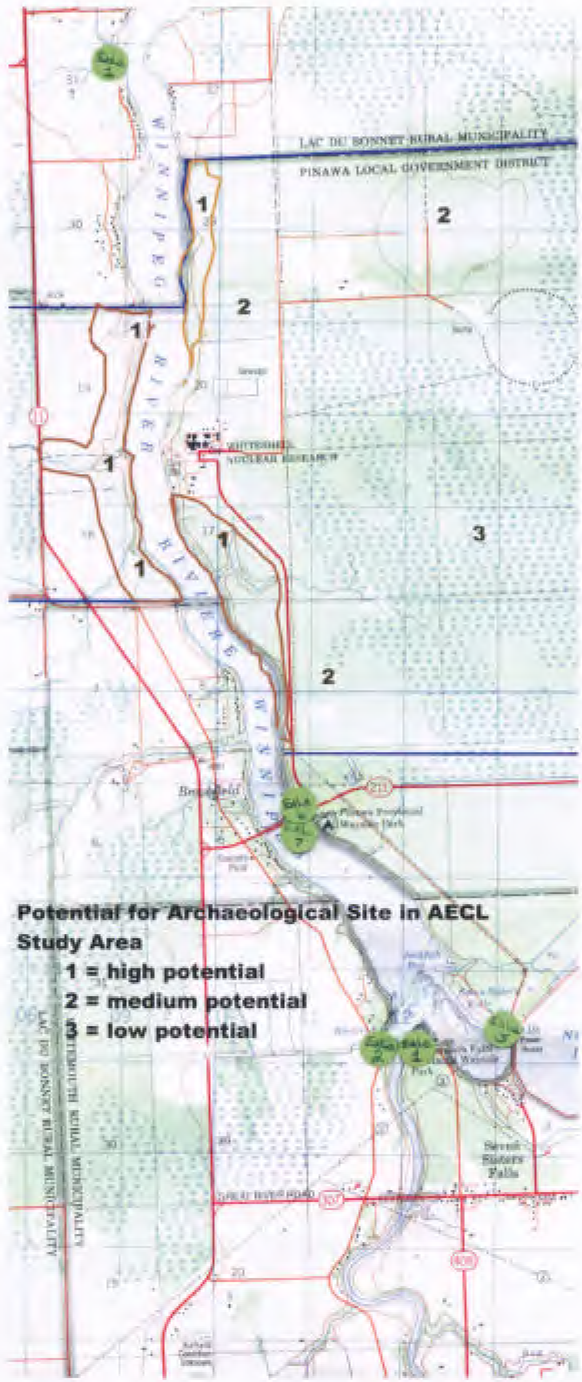
The Winnipeg River has a rich and varied history ranging from the earliest Transitional (Shield-Archaic) populations to the Laurel peoples and the Blackduck, Selkirk and other pre-European-contact cultural groups terminating with the introduction of European fur traders and, eventually, white settlers. Evidence of early human occupation along the Winnipeg River has been found in a large number of archaeological sites located along the length of the waterway. Many of these sites were identified during the Winnipeg River Archaeological Project (1980-1982). This project was undertaken when Manitoba Hydro announced in 1979 that repairs to the Great Falls and Seven Sisters Dams would lead to the lowering of water levels in their forebays for three years. This project focused on two areas: from Great Falls to McArthur Falls and from Seven Sisters Falls to Sturgeon Falls (Buchner 1982).

The Regional Study Area is characterized by a concentration of archaeological sites along the banks of the Winnipeg, Whitemouth and Brokenhead Rivers. No sites are registered for the Project Study Area. However, because no sites are currently registered does not mean that there are no sites present in this area.

The Regional Study Area contains 638 known archaeological sites, and encompasses a vast area. The Local Study area contains 97 of the above numbered sites, and most are located between Otter Falls and Seven Sisters Falls. The locations of the two sites, which are found within the Project Study Area, are not precise due to poor data.

FIGURE 5.30

POTENTIAL ARCHAEOLOGICAL SITES IN THE AECL STUDY AREA



AECL EACL

Local Study Area

While the section of the river represented as the Local Study Area was left out of the early assessment, some sites are known, including some of the most prolific sites in Manitoba. The Whitemouth Falls (EaLa-1) and Bjorklund (EaLa-3) sites located at the confluence of the Whitemouth and Winnipeg Rivers, for example, show evidence of occupation spanning several millennia. In addition to the large number of artifacts found, the sites in this area are also notable for their rare finds of considerable cultural significance.

Petroform sites are abundant in the Winnipeg River area, compared to the rest of Canada and may represent a localized cultural phenomenon. These sites consist of boulders that have been aligned in a particular fashion to produce various figures. Ranging from lines and ellipses to easily recognizable zoomorphic figures, these sites are considered very important by both archaeologists and the descendants of their creators. The Anishinabe inhabitants of the area consider "*the teachings inherent in the petroforms. … necessary for [their] present and future physical, emotional, and spiritual well-being*" (Pettipas 1990). One such site has been located in the Local Study Area, on the east-side of the Winnipeg River. The Sweet Creek Petroform site consisted of a linear feature, a circle and a snake before plowing destroyed the alignments.

Another significant find in the Local Study Area consists of a large burial mound located near the Bjorklund site. Such large mounds are characteristic of the Laurel Culture whose people may have immigrated into the Winnipeg River area from the east nearly two thousand years ago (Steinbring 1980). The mound cult developed in large centres in Ontario and the midwestern United States and terminated, with this exception near Seven Sisters, on the Rainy River (Steinbring 1980). This lone mound on the Winnipeg River, known as the Porth Mound, measures approximately 10 m long, 5 m wide and 3.5 m high (Steinbring 1980).

Historical Sites

Within the Regional Study Area, only one provincially recognized site, the Pinawa Dam Provincial Heritage Park, is found. This park is under the management of Manitoba Conservation (former Natural Resources). During the construction of the amphitheatre Historic Resources Branch staff conducted some archaeological investigations, and a cultural component related to the dam construction was identified. The site was assigned an archaeological Borden Number EbKx-5.

5.5.7 First Nation and Aboriginal Interests

The Regional Study Area includes lands covered by the terms of both Treaty 1 and Treaty 3. The Treaty 1 Ojibway communities of Sagkeeng First Nation (also known as Fort Alexander, Manitoba) and Brokenhead Ojibway Nation (also known as Scanterbury, Manitoba) are located within the Regional Study Area.

Lands within the Regional Study Area are part of the historic traditional territories of both Sagkeeng Fist Nation and Brokenhead Ojibway Nation. The Regional Study Area is also located within the historic traditional territory of the Wabaseemoong Independent Nation which is a Treaty 3 First Nation whose Reserve is located in Ontario.

Consultations with the First Nations have confirmed that First Nations participate in traditional activities within the Regional Study Area. The Sagkeeng First Nation participates in traditional activities of wild rice harvesting, sturgeon fishing, berry picking and gathering of plants and medicines. The Brokenhead First Nation has not identified specific activities. However, it has a Treaty Land Entitlement and is in discussions with the Province regarding a petroform site in Whiteshell Provincial Park located east and south of Pinawa. Contact with 7 Treaty 3 First Nations confirmed that the Wabaseemoong Independent Nation has interests in the Regional Study Area and cultural activity occurs frequently and regularly. Two of the First Nations contacted indicated that they had no concerns with the decommissioning program and did not have traditional lands or aboriginal interests in the Regional Study Area. Four First Nations contacted did not provide confirmation of their interests.

The Sagkeeng First Nation also uses the Winnipeg River as its water supply and considers the river to be a valued social component.

5.6 SUMMARY OF VECS AND VSCS

5.6.1 Definition

Valued ecosystem components (VECs) are features of the environment selected to be a focus of an environmental assessment because of their ecological value and their potential vulnerability to the effects of the project. Project components are assessed with respect to their interaction with the natural and social environment and based on this assessment, a determination is made of residual environmental effects and the impact on the VECs. VECs are considered to be valuable because they are:

- legally recognized and afforded specific protection by law, policy or regulation; and/or
- recognized by the scientific or professional communities as important due to their abundance, scarcity, endangered status or role in the ecosystem.

Attributes that may be selected as VECs include: habitats, species, populations, communities, organisms, significant sites etc.

Valued social components VSCs are a subset of VECs and generally refer to those items recognized by the public as being important because of their social importance, commercial or economic value, or their role in maintaining quality of life within the community. They are generally environmental components, such as a river or a sport fishery but they may also be cultural or heritage components such as archaeological or traditional First Nations sites.

5.6.2 Assessment of VECs

VECs were selected by various means:

- expert professional opinion (e.g. ecologists, biologists, naturalists, etc.);
- interviews with knowledgeable lay persons (e.g. trappers, bird watchers, hikers, local residents);
- consultation with appropriate government staff (e.g. Manitoba Natural Resources);

- input from public consultation program; and
- lists of endangered, threatened and vulnerable species (e.g. Committee on the Status of Endangered Wildlife in Canada).

Using information collected from the sources above, the VECs and VSCs were assessed according to their ecological and social importance, spatial extent and species abundance. None of the wildlife species selected as VECs were considered to be endangered. While all VECs and VSCs were weighted equally, the assessment concluded that the Winnipeg River and the aquatic features of the waterway were the area's most important VEC and VSC.

The Winnipeg River and its Shoreline

The Winnipeg River provides drinking water to the area either through municipal systems or co-ops. Its waters are the basis of a sports fishery, which in turn is a major component of the tourist industry as well as the growing retirement home and cottage communities. It is highly valued, and is susceptible to effects related to contamination, sediment loading and sediment and shoreline disturbance. It also serves as a migratory route for many birds and as such, is susceptible to disturbance, due to human presence on the water and along the shores. Because the river is large and flows throughout the region, effects on the river have regional implications.

The shorelines of the Winnipeg River have provided locations for the homes or cottages of aboriginal and European peoples for centuries. The shorelines are traditional first nations lands and may contain important archaeological sites and artefacts. Their location next to the water make them desirable locations for year-around homes, cottages and tourism facilities. The access to water also makes the lands of the Winnipeg River desirable locations for industries requiring large amounts of water (e.g. Pine Falls). Finally, the shorelines are adjacent to some of the best farmland in the region.

Other VECs and VSCs considered during the project include:

Sturgeon, Walleye, Northern Pike and Mooneye

Sturgeon, walleye, pike and mooneye are valued fish species in the Winnipeg River. Sturgeon, a protected species, must be released if caught. As an illustration of their valued status, they are used in advertising campaigns for the downstream community of Lac du Bonnet. As a very long-lived bottom feeder, they are particularly susceptible to contaminated sediments and bone-seeking radionuclides such as ^{90}Sr. Anecdotal evidence suggests sturgeon continue to be common near the Whiteshell Laboratories' outfall. They were netted in the area prior to the start-up of the Whiteshell site, and two small ones were captured in the fall 1999 AECL fish monitoring campaign. Walleye, northern pike and mooneye are preferred sportfishing species; walleye and northern pike are top predators and mooneye feed heavily on invertebrates. They are common in the region and although they are thought to have stable populations, capture limits are applied to the sport fishery.

Whitetail Deer and Moose

Whitetail deer and moose are valued by both subsistence hunters and sport hunters and by the general public as interesting and visible signs of the natural environment. Whitetail deer are very common throughout the region, supporting a large hunting effort and populations of wolves and perhaps mountain lions. They aggressively invade and feed in disturbed areas, and will graze contaminated vegetation even where access is physically restricted. They also consume soil in the saline-seep ditches common near the site, which makes them susceptible to groundwater discharges of contamination. Moose are present but not common. They require large tracts of undisturbed lands with a predominance of wetlands and small water bodies.

Gullies and Ravines

The gullies and ravines along the river offer a unique habitat. They provide habitat to locally rare species such as the woodland jumping mouse. As riparian features with specific microclimates, the gullies provide habitat for species not endemic to the region. Beavers frequently build dams in the gullies, and this introduces new habitat for other organisms. Beaver activity on the site is restricted to the gullies. The gullies are susceptible to contamination because any overland runoff or groundwater flows from inland areas travel through the gullies toward the Winnipeg River.

Coniferous Forest

The coniferous forest on the site includes both wetland areas dominated by black spruce, and well-drained areas populated by jack pine. Both types of trees are found in the FIG (Field Irradiator Gamma) research area (Figure 5.26). Black spruce in particular is very slow growing, and stands on the site may be over 100 years old. The conifers provide cover for a large number of undergrowth plant species as well as for birds and mammals listed as potential VECs. The FIG area was intensively studied for over 10 years, and has the potential to serve as a benchmark site for conifers and boreal environments in Canada.

Habitat Diversity

The diversity of habitats is an important attribute of the site. Upland sandy soils, clay plains, peat-filled wetlands, beaver ponds and a major river contribute to the diversity on the site. The confluence of aspen parkland and boreal forest ecosystem types and the overlap of the ranges of eastern and western species result in interesting combinations in the region. Agricultural and forestry practices also merge with large undisturbed areas in the region.

The Sport Fishery

The Sport Fishery is a major component of the local economy. Nopiming and Whiteshell Provincial Parks provide 20% of the total annual sport fishing days in Manitoba.

Provincial Park and Natural Forest Areas

Natural recreational areas include the Nopiming and Whiteshell Provincial Parks and the Agassiz, Whiteshell and Sandilands Provincial Forests. These areas attract both local residents and tourists and include a full range of recreational potential and activities such as cottaging, canoeing, hiking, hunting, fishing, and snowmobiling.

The Model Forest

Forestry is a major industry to the north of the area. A Federal/Provincial Program designed to create a sustainable forest environment is now underway in the area.

The FIG

There is an area within the Whiteshell boundaries known as the Field Irradiated Gamma (FIG). This facility, intentionally irradiated over an approximately fifteen-year period, represents a historical research area that has attracted researchers worldwide.

6.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

6.1 OVERVIEW AND APPROACH

6.1.1 Overview

This section discusses potential effects on the environment from activities associated with the decommissioning of the Whiteshell Laboratories. The objective of this section is to identify residual effects (after mitigation) as a basis for the later determination of the *CEAA* environmental assessment requirement of whether or not the project has any significant adverse effects on the environment (Section 7.0). The baseline condition is that of autumn 2000, a point in time in which substantial portions of the facility have already been placed in operational shutdown state.

The analysis addresses the effects of decommissioning activities on the environment throughout the decommissioning project. It only incidentally considers the overall effect of decommissioning itself, which will in all likelihood generate substantial positive benefits. Thus:

- Decommissioning will lead to improvements to the environment as the overall risk posed by the facilities is progressively reduced.
- The achievement of operational shutdown will dramatically reduce any current discharges.
- Natural radioactive decay will reduce radioactivity on site.
- There will be no new sources of contamination.
- As the decommissioning of each facility is completed, the land on which it is located will be restored to a more "natural" condition, that is, the land will be seeded with natural grasses and left to develop as nature allows.

6.1.2 Approach

The analysis of effects is organized into an analysis of the effects of:

- Air Quality.
- Noise.
- Surface Water.
- Groundwater and Soils.
- Terrestrial Biota.
- Aquatic Biota including biota living or feeding in sediments.
- Worker Health and Safety.
- Public Health.
- Socio-Economic Effects:
    - Cultural and Physical Heritage;
    - Archaeological Features;
    - Land and Resource Use; and
    - Aboriginal Interests.
- Accidents and Malfunctions.

- How the Environment itself might affect Decommissioning.
- Sustainable Use of Renewable Resources.
- VECs and VSCs.

The effects were determined by:

1. reviewing decommissioning activities on a facility by facility basis and assessing the sources and amounts of emissions;
2. indicating the primary pathways for these emissions (air, soils, biota, surface water and groundwater);
3. identifying the receptors (especially VECs and VSCs) that could be affected along the pathways;
4. assessing whether there could be any environmental effects;
5. determining whether or not mitigation is required;
6. applying appropriate mitigative measures; and
7. assessing the possibility of residual effects.

The actual analysis involved the following steps.

Consultation with Experts and the Public

There were two types of consultation to obtain information relevant to the decommissioning project. The first was a formal and on-going program of consultation with the community. The second part was an interchange of ideas between the consultants and expert and interested groups and individuals on a less formal basis. This involved discussions on particular issues, such as the identification of VECs. A full discussion of the public consultation program is given in Section 10.0.

Effects Workshop and Initial Screening

A technical workshop attended by the consulting team and the AECL decommissioning team was held to identify potential effects from decommissioning activities associated with particular facilities that warranted further review and analysis. At the workshop, environmental screening tables were developed to show how different activities associated with the project might affect environmental components such as air, surface water, etc. All facilities were discussed at the workshop although tables were not prepared for all of them. The screening tables were used as the starting point, not the end point, of the analysis. Appendix E presents the initial screening tables prepared for each facility.

Review of Literature and Data

The literature and data were reviewed to determine if there was adequate support for the analysis.

Data Supplements

Because Whiteshell Laboratories is a highly regulated facility, there is substantial data for baseline conditions for most environmental components. In some areas, however, specifically, with respect to the river sediments and the low-level waste trenches, more data was collected.

Environmental Interaction Analysis

Interactions with environmental components were determined and environmental effects estimated using various analytical tools, models, and professional judgement.

Application of Mitigation Measures

Mitigation measures were applied to reduce the level of environmental effect as appropriate. Many of these measures are applied during the normal course of operation to meet licensing requirements. Other measures, not necessarily related to AECL's current policies are applied in accordance with good environmental practice.

Estimation of Residual Environmental Effects -VECs

Once mitigation has been applied the residual effects on the VECs and VSCs outlined in Section 5.0 could be estimated. These effects form the basis for the analysis of significance (Section 7.0) and cumulative effects (Section 8.0).

6.1.3 Organization of Section 6

The remainder of this chapter is organized into six main sections:

1. Environmental Mitigation Measures currently applied at Whiteshell.
2. The assessment of Potential Environmental Effects by Environmental Component.
3. Effects of Accidents and Malfunctions.
4. Effects of the environment on Decommissioning.
5. Effects on the Sustainable Use of Renewable Resources.
6. Summary of Effects on VECs and VSCs.

6.2 MITIGATION MEASURES

6.2.1 Compliance Programs

A number of compliance programs are in place that translate legal and related requirements into processes or program requirements appropriate for AECL. The compliance programs establish a common set of work practices and procedures to ensure work is performed consistently across all AECL sites. At Whiteshell Laboratories, these programs were initially designed for an operating nuclear facility with control systems to handle a much larger (several orders of magnitude) radioactive inventory than are expected from the decommissioning program. Equivalent programs and control systems will remain during the entire decommissioning project and will be augmented as necessary according to the Detailed Decommissioning Plans (DDPs) to ensure that any effects from decommissioning activities would be handled in a controlled and effective manner.

6.2.1.1 Radiation Protection

The AECL Radiation Protection Requirements Implementation Plan outlines the requirements for radiation protection. These requirements are implemented through the Radiation Protection Manual. Alternate protocols are provided where a specific procedure has not been outlined in the manual.

All decommissioning work will be conducted in accordance with requirements of the AECL Radiation Protection Program using approved procedures and work plans, ALARA reviews and pre-job briefings to minimize the exposure to personnel and ensure that regulatory and site limits are not exceeded. If a specific job presents hazard potential, an ALARA review that includes a dose assessment will be performed and engineering controls will be implemented to minimize the dose to personnel (e.g. incorporate shielding, limit exposure time, rotate personnel).

6.2.1.2 Occupational Health and Safety

AECL's Occupational Safety and Health Program is defined by the requirements contained in AECL's Occupational Safety and Health Program Manual and AECL's Work Permit System.

The decommissioning work will be conducted in accordance with the manual's requirements using approved procedures and work plans and/or implementation of AECL's Work Permit System. The primary safeguard against industrial hazards is the use of qualified staff following approved procedures. This includes the Work Permit System, which provides a systematic approach to identifying hazards and ensures that staff are properly qualified and equipped for the workplace.

6.2.1.3 Environmental Protection

The Environmental Protection Program at Whiteshell Laboratories is designed to ensure protection of the environment and the public with respect to environmental aspects that result from operation of AECL's facilities. Requirements are outlined in AECL's Environmental Protection Program Manual.

Decommissioning work will be conducted in accordance with the requirements of AECL's Environmental Protection Program. The Whiteshell Laboratories Monitoring Program will be maintained throughout the decommissioning project to monitor the effect of decommissioning activities and verify that the requirements and objectives of the Environmental Protection Program are met.

6.2.1.4 Emergency Preparedness

Whiteshell Laboratories site and facility-specific emergency plans are a contingency measure designed to address an accident or malfunction scenario. The requirements are contained in an Emergency Preparedness Program Requirements Manual and Whiteshell Laboratories Emergency Plan.

Decommissioning work will be carried out in accordance with these plans and the plans will remain in effect until the hazards associated with each activity are removed or mitigated. These plans deal with accidents, malfunctions or other non-routine events, such as a spill of a hazardous substance.

6.2.1.5 Security Program

A company-wide Security Program is described in the Physical Security Program Manual. A site-specific plan is also in place at the Whiteshell Laboratories.

The Security Force provides access control, visual monitoring and patrolling, and operates an extensive surveillance system to detect and deter unauthorized entry to the Laboratories and/or any diversion of materials and equipment. A progressive system of zones is used to provide increasing levels of security to specified areas of the Laboratories, in accordance with the *Nuclear Security Regulations* issued pursuant to the *Nuclear Safety and Control Act*.

The security program will continue to apply throughout the decommissioning program.

6.2.1.6 Quality Assurance

The Quality Assurance (QA) programs at AECL apply to all staff and external contractors who participate in, or support, projects and activities at AECL sites.

The AECL Management Manual (AECL 1999) describes how AECL manages its business and how it attains quality. It provides employees with direction on the business and management systems. Quality programs and procedures within AECL must meet the requirements, principles and practices described in the Management Manual.

For nuclear safety-related activities, the QA programs and supporting procedures meet the requirements and practices described in the Canadian Standards Association CAN/CSA-N286 series of standards. All activities defined as nuclear safety-related are carried out under quality assurance programs meeting the requirements of the standards.

6.2.1.7 Other Applicable Compliance Programs

In addition to the programs described in the preceding sections, other compliance programs applicable to the decommissioning activities include:

- Operational Experience.
- Nuclear Materials Management.
- Transportation of Radioactive Materials.
- Nuclear Operations.

Internal assessments and audits are conducted to assess the adequacy and effectiveness of the compliance programs. Independent reviews of proposed activities at AECL sites are also carried out by the Safety Review Committee on behalf of the President and CEO of AECL.

6.2.2 Application of Policies and Guidelines

As noted in Section 6.2.1, since Whiteshell Laboratories is an existing licensed facility, there are many key support programs in place to deal with radiation protection, occupational health and safety, environmental protection and emergency preparedness. There are also numerous policies, and guidelines that are adhered to at the facility (examples are given in Table 6.1). All of these programs and policies help to ensure that effects on health, safety and the environment are controlled at source and thus effectively mitigate against environmental effects. In addition, Detailed Decommissioning Plans (DDPs) are being developed for each facility and will provide detailed measures to mitigate environmental effects. These mitigative measures will be consistent with AECL policies, procedures and programs. The DDPs will be subject to review and approval by the CNSC. An important part of the mitigation program is the maintenance of detailed records on the progress of the decommissioning. Such records support later analysis and the identification of required follow-up procedures.

Table 6.1

Policies or Guidelines Related to Mitigation

Policy or Guideline	Title/Topic	Comment
AECB-R-85	Radiation Protection Requisites for the Exemption of Certain Radioactive Material from Further Licencing Upon Transferral for Disposal.	Provides guidance to determine which material can be exempted from regulatory control based on a deminimis risk.
CNSC R-104	Long-Term Radioactive Waste Disposal	Regulatory basis for judging the acceptability of waste disposal facilities.
CNSC G-219	Decommissioning Planning Guideline for Licensed Activities	Provides guidance for the preparation of decommissioning plans.
CNSC 1049, Rev. 2	Accountability Procedures	Accountability records necessary for the Non-Proliferation Treaty and the NSCA.
CNSC Licence NRTEOL-2.00-2002	Whiteshell Laboratories Site Licence	
CAN/CSA-N286	Quality Assurance	Standard for the nuclear life cycle. Quality assurance of work done for decommissioning.
CAN-Z299	Procurement Standards	Non-nuclear standard covering manufacturing, procurement and supply of services.
IAEA Tech Doc 716	Decontamination and decommissioning of nuclear facilities	
IAEA Safety Standard Series WS-G-2.2	Decontamination of medical, industrial and research facilities	
RC-2000-633-0	AECL Research's Radiation Protection Requirements and Implementation Plan	Radiation protection methodology within AECL.
W-SPP-#1.1 to 11.1	AECL Policies and Procedures	Basic structure for management of AECL activities and personnel, including: safety, dosimetry, radioactive waste management and security.
AECL 40101	Corporate Management Policy Manual: Health Safety and Environmental Review	Elements of the health, safety and environmental review program, including Safety Review Committee.

Policy or Guideline	Title/Topic	Comment
AECL 40501	Corporate Management Policy Manual: Protection of Environment	Key elements of the environmental protection policy.
RC-2000-060-500	Whiteshell Laboratories Emergency Plan	Emergency response plan which provides a mechanism to minimize the effect of an emergency on AECL employees, the public, the site and the environment.
RC-2000-060-000	Emergency Preparedness Program Requirements	
RC-2000-633-1	AECL Radiation Protection Manual (Draft)	
SRC-R-4/00-832	AECL Requirements for Independent Review of the Decommissioning of Buildings Facilities and Sites	
RC-2000-021-0	Environmental Protection Program Manual	Provides in-depth description of the key elements of AECL's environmental protection program.
RC-2000-101-01-0810	Working Draft AECL's Work Permit System Procedure	A work permit is a mechanism for controlling and co-ordinating work to protect workers. A work permit informs a person of hazards and safety measures, so the work can be done safely.
Emergency Procedures	Emergency Procedures Whiteshell Laboratories	An on-line document covering basics of Whiteshell Laboratories emergency signals and the required sections by staff.
Policy 00-003 Rev 0	Security	Policy covering personnel security, protection of information systems and data, and physical security.
WNRE-659	Radiation Protection Manual	

All decommissioning work will be conducted in accordance with AECL's approved policies, programs and procedures to ensure the safety of workers, the public and the environment. For this reason, it is expected that most of the possible environmental effects from the decommissioning project can be mitigated through adherence to the AECL's programs. Few additional mitigative measures will be required.

Due to the fact that the decommissioning program is essentially a process of managing waste streams, a comprehensive program for the management of wastes arising from decommissioning work at the site is being developed by AECL. As detailed in Section 4.5, existing waste facilities will be modified and new facilities will be constructed to process and manage wastes which cannot remain in existing storage structures until waste disposal becomes available. This enables the decommissioning process to handle all waste streams on site, thereby providing a key mitigative measure. These facilities will remain operational until no longer required and will then be decommissioned.

The Whiteshell Laboratories was originally designed with protection systems to handle a much larger (several orders of magnitude) radioactive inventory than exists now. These protection systems will remain in effect entirely during the first phase of decommissioning, and similar measures will routinely be applied to subsequent phases to ensure that any process streams or malfunctions from decommissioning activities would be handled in a controlled and effective manner.

Where measures outlined above were not deemed adequate to mitigate potential environmental effects, additional measures were proposed. Following the application of these measures, an assessment was made to determine whether or not an effect would remain. If an effect could not be fully mitigated, it was considered a residual effect. Note that the classification of an effect as "residual" is not a statement of the significance of the effect. That analysis is carried out in Section 7.0.

6.3 ASSESSMENT OF POTENTIAL ENVIRONMENTAL EFFECTS

6.3.1 Air Quality

Air quality refers to the quality of atmospheric air. It is typically assessed at a site's property boundary. For the Whiteshell Laboratories site, this would normally be the licensed property area. However, to accommodate the potential for the early release of certain lands within the licensed property area, air quality effects are evaluated at the boundary of the Project Study Area.

Air quality effects have been categorized as:

(a) airborne radioactive emissions - particulate bound emissions which are distinct from conventional airborne emissions;
(b) airborne non-radioactive emissions - particulate emissions which are not radioactive (e.g. solvents, mercury, lead and asbestos);
(c) nuisance dust - this is typically represented by TSP (total suspended particulate) and is an indicator of soiling, visibility, and in high enough concentrations, health effects; and
(d) fine particulate - this is typically represented by PM_{10} (particulate matter less than 10 microns in diameter) and is an indicator of health effects associated with respirable particulates (e.g. asthma).

In a typical air quality assessment, concentrations at a particular point (usually the property boundary or a sensitive receptor) are either measured or estimated and compared against existing provincial or federal air quality guidelines or standards. These standards are usually reflective of the most stringent effect whether it be on human, terrestrial or aquatic species.

Although it is theoretically possible to develop predictive models for concentrations of emissions at the boundary, the episodic nature of the activities that would generate the emissions as well as the distance of the activity from the boundary make modelling highly speculative. As a result, there is reliance on professional judgement. Note that in Section 9.0, a monitoring program calling for studies of air emissions from various activities which are expected to confirm our professional judgement, has been outlined. The approach considers:

- the potential for emissions to enter the atmosphere;
- the type of emissions (as defined above);
- the potential magnitude (concentration) of emissions;
- the potential lareal extent of the emissions;
- the frequency and duration of emissions; and
- the predominant meteorological conditions (particularly wind direction).

6.3.1.1 Potential Project/Environment Interactions

Physical works/activities resulting in 1) the release of airborne radioactive emissions 2) airborne non-radioactive emissions and 3) nuisance dust, are summarized below.

Physical works/activities leading to the release of airborne radioactive emissions:

- operation of the WMA, including operation of the baler during compaction of wastes, constructing new storage space, retrieval and repackaging of waste from existing storage facilities and decontamination activities and site restoration;
- operation of building ventilation systems for nuclear facilities (B300, Decontamination Centre, ALWTC, B100);
- retrieval and recovery of fuels from the CCSF and exterior decontamination of the canisters. The risk is associated with the possible release of airborne radioactive particles during canister demolition;
- decontamination of nuclear/radioisotope facilities (Shielded Facilities, Active Liquid Waste Treatment Centre, WR-1, B300, Decontamination Centre);
- disconnecting of nuclear facility services; and
- remediation of contaminated soils/sediments (buried services, affected lands and sewage lagoons).

Physical works/activities leading to the release of airborne non-radioactive emissions include:

- disconnecting of nuclear facility services and maintenance of buildings;
- removal of hazardous materials from facilities; and
- methane pollution from organic material that may be in the inactive landfill.

Physical works/activities leading to nuisance dust and fine particulates include:

- retrieval and repackaging of waste from existing storage facilities and construction of new storage area;
- demolition of facilities and disposal of rubble as clean fill; and
- site restoration.

6.3.1.2 Likely Environmental Effects

Air quality effects range from the release of very small amounts of radioactive airborne particulates to nuisance dust. Several observations may be made about likely environmental effects from the project:

1. The nature of the decommissioning process means air emissions are likely to be limited to intermittent releases. Thus, air quality standards could be exceeded over short averaging periods such as twenty-four hours, but are very unlikely to exceed weekly DRLs.

2. Airborne radioactive emissions are controlled to be below DRL's and are kept As Low As Reasonably Achievable (ALARA) through the use of mitigation measures.

3. The area affected by nuisance dust is expected to be small. Recent work (Watson and Chow 1999) suggests that most fugitive PM_{10} dust (for example, dust generated by construction-type activities) will remain in the lowest 2 m of the atmosphere and that the local deposition losses and impaction losses (trees) will reduce the amount transported beyond a few hundred metres by over 50%.

4. The bi-directional character of the prevailing wind pattern in a south-southeast north-northwest direction and predominantly low wind speeds (on average less than 14 km/hour over the year), would normally limit the geographical extent of any air quality effects to within the boundaries of the Project Study Area. Only on particularly windy days, would air quality effects be observed beyond the Study Area.

5. Deposition of radioactive particulates to ground surface could occur in areas identified as VECs (gullies, ravines and coniferous forest). However, since emissions are expected to be well below applicable limits, no effect on these areas is expected.

6.3.1.3 Identified Mitigation Measures

Mitigation measures to minimize air quality effects from the project fall into the following categories:

- Use of enclosures and HEPA filters to control airborne radioactive emissions. HEPA filters used during decontamination will remove a high level of radioactively contaminated dust (99.7%).
- Use of dust control measures (e.g. containment and suppression) to control generation of non-radioactive airborne emissions and nuisance dust.
- Curtailment of activities during periods of adverse meteorological conditions (e.g. during periods of very high winds).
- Maintenance of on site access routes.

Special enclosures to cover large areas may be required to contain airborne emissions from decommissioning activities in some cases (for example decommissioning of the WMA, Buried services and larger buildings on site). Enclosures covering large areas are available. Portable enclosures can and are being used to control dust in road repair and removal and cover areas of up to 800 square feet. The need for such enclosures will be identified in the DDPs.

6.3.1.4 Residual Effects

The expected residual effects are:

- Release of airborne radioactive particulates from the following project activities:
  - disconnecting services;
  - decontamination of facilities;
  - retrieval and repackaging of materials; and
  - remediation of WMA's, buried services and affected lands.
- Nuisance dust and fine particulates from building demolition and site restoration and rehabilitation.
- Production of methane gas from the inactive landfill.

The spatial extent of residual effects is expected to be limited to the Project Study Area.

6.3.2 Noise and Vibration Assessment

In a typical noise vibration assessment, sound levels from the source are either measured or estimated and compared against the existing sound levels at the closest residence or other sensitive receptor (e.g. campground, school or church). In this assessment, specific recent and relevant noise level data at the closest residence or sensitive receptor is not available. Excessive noise has been documented to have a negative influence on wildlife breeding, migration and feeding patterns (Canter 1996). During decommissioning activities, noise is expected to be short-term and sporadic and will be confined to daytime activities. Those wildlife species identified as VECs (deer and moose) have a range that extends beyond the site and can temporarily relocate to other suitable habitats nearby if the noise is too disruptive.

Potential noise effects prior to mitigation are evaluated based on professional judgement. This approach considers, as a minimum, for each activity:

- the origin and type of noise emissions and vibrations;
- the potential magnitude of noise and vibration emissions;
- the potential areal extent of the noise emissions;
- the frequency, duration, and time-of-day of the noise emissions;
- the distance to the nearest residence and/or sensitive receptor; and
- the presence of existing (e.g. building envelope) and/or natural (e.g. trees) sound barriers.

6.3.2.1 Project/Environment Interactions

Project physical works and activities likely to generate noise and vibrations are building demolition, site remediation and restoration activities. Decommissioning activities will include little or no blasting.

6.3.2.2 Likely Environmental Effects

The noise generated may have significant magnitude, but is expected to be short-term and sporadic and will be confined to daytime activities. The preservation of the dense tree coverage across the site will provide a natural noise barrier between site activities and potential noise receptors within the Project Study Area. Furthermore, because of the natural dissipation of noise energy with distance, the impact of noise on offsite residences will be limited. Vibration effects would likely only be of concern within the Project Study Area to adjacent buildings and structures.

Wildlife living near the site boundaries may be exposed to the noise generated by decommissioning. However, due to the nature of the decommissioning generated noises (dismantling, using little if any blasting) none of the wildlife species affected will experience habitat loss as a result.

No residual effects from noise and vibration are expected.

6.3.2.3 Identified Mitigation Measures

No mitigation measures for noise and vibration will be required.

6.3.3 Hydrology

Surface water flows include all surface water flow on site (streams, surface water runoff and flow through storm sewers) and the Winnipeg River – the ultimate destination of surface water discharges from the site and the most important surface water body in the area.

Surface water quality effects have been categorized as:

a) Effluent discharges to the Winnipeg River.
b) Effluent discharges to ground-surface which have the potential to migrate via surface runoff to the Winnipeg River.
c) Contaminated groundwater discharges to the Winnipeg River.

Surface water quality is generally assessed at locations where surface water leaves the site's boundary and in water-bodies affected by discharges. Concentrations of radiological and non-radiological parameters are measured and compared against existing provincial or federal surface water quality guidelines or standards. These standards are usually reflective of the most stringent effect, whether it be on human, terrestrial or aquatic species.

The potential for surface water quality effects prior to mitigation is evaluated using existing data, data collected specifically for the CSR (See Appendix B and C) and professional judgement. The approach considers:

- The potential for effluent discharges.
- The receptors potentially affected by the discharges.

6.3.3.1 Likely Project/Environment Interactions

Physical works/activities with the potential to affect surface water quality are listed according to each effect category.

Physical works/activities resulting in discharges to the Winnipeg River are:

- Operation of the Active Liquid Waste Treatment Centre (ALWTC). Effluents from the ALWTC are discharged to the process sewer which in turn discharges to the Winnipeg River via the outfall. Releases will continue to be controlled within compliance guidelines through Phases 1 to 3.
- Bi-annual operational releases are expected to continue through Phases 1 to 3 from the sewage lagoons.
- Surface water runoff from the site collected by storm sewers and drained via the Process Sewer.
- Intermittent discharges from ditches draining the WMA (Phase 1 to 3 and beyond).

Physical works/activities with the potential for discharges to ground-surface and migration via surface runoff to the Winnipeg River are:

- Operation and Passive Operation of the WMA (Phase 1 to 3) and In-situ Disposal of LLW at the WMA (Phase 3 and beyond).
- Remediation of buried services and affected lands (Phase 1 and 3).

Physical works/activities with the potential for leachate migration to groundwater and discharge to the Winnipeg River are:

- Operation and passive operation of WMA in-situ trenches (Phase 1 to 3).
- In-situ disposal of LLW in WMA (Phase 3 and beyond).
- Operation of the inactive landfill and sewage lagoon (Phase 1 to 3).

6.3.3.2 Likely Environmental Effects

General comments about likely effects from decommissioning on water quality of the Winnipeg River, the ultimate discharge location for all effluent from the site are listed below:

- The water quality of the Winnipeg River has met drinking water standards throughout the operation of Whiteshell Laboratories. Effluent emissions during decommissioning will decline from operational levels and no adverse effect on water quality is expected.

- Residual contamination on river sediments from past operations is not expected to affect water quality. The radionuclide inventory in the most contaminated region of the sediments is 1.3 GBq, a small fraction of total releases to the Winnipeg River

(See Appendix B). Even if the complete sediment radionuclide inventory was released to water by de-sorption and re-suspension in a short period of time (for example, one year) the increase in concentrations would only be 6.5 E-05 Bq/L. This value is derived from the estimated sediment inventory of 1.3 GBq divided by the average annual flow rate of 19.9 E+09 m^3/a. The increase in the radionuclide concentration is a small fraction of the maximum acceptable concentration (10 Bq/L) for ^{137}Cs (the most abundant radionuclide in the sediments) in drinking water (Canadian Council of Ministers of the Environment 1999a).

- Discharges to the Winnipeg River from the ALWTC and sewage lagoon will be intermittent and controlled. The discharges are currently well below accepted standards (Niemi, Soonawala and Ross 2000) and will gradually diminish to zero by the time decommissioning is complete;

- Radioactivity levels in ALWTC effluent discharges are monitored to ensure compliance with release criteria. Liquid waste above release criteria is processed to a solid form for storage at the WMA's. The sewage lagoon water is monitored during release periods (Niemi, Soonawala and Ross 2000);

- Non-radiological contaminants are monitored at the Process Sewer outfall and sewage lagoon outlets and documented in AECL MISC-390 series. AECL guidelines have not been exceeded at the outfall or sewage lagoon outlets. Current operational control levels will be maintained throughout the decommissioning program and because operations will decline, even lower emissions will result;

- The largest potential source for groundwater leachate is the WMA. The WMA is situated in a groundwater discharge zone which effectively limits contaminant migration from the WMA to the river (Section 5.4.4 and 6.3.4); and

- The travel time from the WMA to the Winnipeg River through the most permeable hydrogeologic unit for the most hazardous radionuclides, ^{90}Sr and ^{137}Cs, is probably several hundred years (Cherry, Grisak and Clister 1973). This is sufficient time for the ^{90}Sr and ^{137}Cs to decay to background. Therefore, even if leachate from the WMA's entered the permeable sands, the impact on the Winnipeg River would be small.

6.3.3.3 Identified Mitigation Measures

Mitigation measures to minimize water quality effects from the project fall into the following categories:

- Continued compliance with release limits at the ALWTC and sewage lagoon.
- Groundwater monitoring at the WMA, sewage lagoons and inactive landfill to indicate potential contaminant migration from these facilities to the river.
- Construction of containment barriers where necessary to ensure collection, control of and treatment of contaminated water (for example at the WMA).

- Use of effluent containment procedures including use of rain barriers (berms and coverings) to minimize surface water runoff during remediation of buried services and affected lands.

6.3.3.4 Residual Effects

Effluent emissions from decommissioning are not expected to result in an increase in conventional or radionuclide concentrations in the Winnipeg River as effluent emissions during decommissioning are expected to decrease from current operational levels. However, as noted above, some discharges to the River will occur. Residual effects on the Winnipeg River and surface water from decommissioning include:

- Discharges of treated flows to the Winnipeg River from the ALWTC and the sewage lagoon.
- Surface water contamination in the Project Study Area and potential migration to the Winnipeg River from the WMA, buried services and affected lands.
- Potential for groundwater contaminant migration to the Winnipeg River from the WMA, sewage lagoons and the inactive landfill.

Effects on surface water are expected to be limited to the Project Study Area and the Winnipeg River. Selected fish species in the river and Sport Fishing have been identified as VECs/VSCs (Section 5.6).

6.3.4 Geology and Hydrogeology

The analysis of the potential for soil and groundwater contamination was based on an understanding of the site geological and hydrogeological conditions described in Section 5.0. The nature and amount of possible contamination was considered. Containment methods were reviewed and special note taken of any previous incidents and the experience gained from them. The effect of project activities on the groundwater flow regime was also assessed.

Groundwater quality is assessed by collecting groundwater samples from monitoring wells and measuring concentrations of radiological and non-radiological parameters. The measured concentrations are compared against existing provincial or federal water quality guidelines or standards.

6.3.4.1 Project/Environment Interactions

Physical works/activities with the potential to cause groundwater contamination are:

- Continued operation and passive operation of the WMA (Phases 1 through 3).
- In-situ disposal of LLW waste at WMA (Phase 3 and beyond).
- Operation of the inactive landfill (Phase 1 through 3).
- Operation of the sewage lagoons (Phase 1 through 3).
- Buried services and affected lands (Phases 1 to 3).

Physical works/activities with the potential to affect the groundwater flow regime are:

- Stabilization and closure of the inactive landfill and sewage lagoon: reduced infiltration of surface water as a result of covering, capping these facilities and site re-establishment including grading and ditching around the facilities has the potential to affect groundwater flow (Phase 3).

6.3.4.2 Likely Environmental Effects

Groundwater contamination effects are related to the operation and decommissioning of five facilities/areas:

1. WMA;
2. inactive landfill;
3. sewage lagoons;
4. buried services; and
5. affected lands.

The WMA is the main waste management facility on site and contains low, intermediate and high level waste (Section 4.5). Contaminant migration from this facility is the main hydrogeological issue and is the focus of this section.

The alteration of groundwater flow regimes from the decommissioning activities is not expected to be significant and will not affect the VECs. No mitigation measures are required. Alteration of groundwater flow regimes will not be discussed further.

WMA

There is the potential for groundwater contamination during operation of the WMA and from in-situ disposal of LLW at the site. The potential impact of the WMA on groundwater during continued operation of the WMA is limited by:

- Existing engineered barriers.
- Short half-life of active waste in WMA trenches.
- Groundwater flow regime at the WMA.

These are discussed followed by comments on likely effects from in-situ disposal of LLW at the WMA.

WMA - Engineered Barriers

All high and intermediate level waste, with the exception of high-level waste in trench 6 is stored in engineered structures (concrete standpipes, concrete bunkers, storage tanks). These structures provide a barrier between the waste and the natural environment until these wastes are transferred to disposal facilities in Phase 3.

Other waste which cannot stay in existing storage structures, for example, irradiated fuel waste in standpipes, will be moved to new interim engineered storage facilities in Phase 2.

WMA – In-Situ Disposal of Trench Waste

Low-level radioactive waste and some conventional waste will be managed in-situ. The final safety case for the in-situ end state will be made near the end of Phase 3. For the project period (60 years), the WMA remains under regulatory control. This provides a mechanism to respond to any changes detected in the storage environment that could affect contaminant migration. Also, this period will be utilized to develop fully the safety case leading to a confirmation and approval of in-situ disposal as a final end state. The opportunity for additional environmental assessment is also retained.

The nature of groundwater flow in the area around the WMA limits contaminant migration away from the WMA. The WMA is located in a groundwater discharge zone. Groundwater flow is upward through the sands and continues upward through fractures in the overlying silts and clays. The groundwater then exits the groundwater zone by evaporation and evapotranspiration. There is no downward movement of groundwater flow from the WMA to the underlying permeable sandy zone which has the potential to act as a transmission zone to the Winnipeg River (Cherry and Robertson 1988).

The waste contained in trenches, is located to a depth of 4 m below ground-surface and 1 to 2 m below the watertable. The upward groundwater flow will cause some upward migration of constituents toward the biosphere. It is expected that many of the solubilized constituents will be rendered relatively immobile due to sorption on clay minerals and organic materials (Cherry and Robertson 1988). However, there is the potential for some contaminant migration through the clay fractures because there is a long-term accumulation of sulfate salts on the fractures that may reduce sorption tendencies. Once the water table zone is reached the constituents could migrate laterally towards the periphery of the WMA and ultimately to the Winnipeg River (Cherry and Robertson 1988).

A review of hydrological data collected over the past 20 years has confirmed our understanding of the groundwater flow regime at the WMA (See Appendix C.5).

A detailed evaluation to support the in-situ disposal approach was conducted in the autumn of 2000 and is detailed in Appendix C.1. The evaluation was based on:

- a review of the trench inventory;
- existing environmental monitoring and ground water well data;
- sampling of trench cover material and soil adjacent to the trenches;
- confirmation of the ground water flow model; and
- modelling of contaminant transport mechanisms.

The evaluation found that:

- The WMA remains a water discharge zone consistent with the original hydrogeological model.
- The clay soils around the trenches provide a natural attenuation (retards contaminant transport).
- The upper bound of the radionuclide inventory is 40 TBq of initial radioactivity. The majority of radionuclides in the inventory have relatively short half-lives. There are non-radiological contaminants of concern which will likely require selective remediation.
- There is no indication of significant upward or lateral migration in the near trench zone.
- Migration of radioactive contaminants occurs at a rate slower than radioactive decay.
- Trenches 1, 6, 10 and 16 were determined to be unsuitable for in-situ disposal.
- Institutional control will be required beyond the project period to confirm the performance of the disposal environment.

In-situ disposal of LLW is subject to regulatory review and approval and must address all the basic requirements applicable to the long-term aspects of radioactive waste disposal. Those aspects are currently documented in CNSC Regulatory Policy R-104. The basic requirements emphasize minimizing the burden on future generations and protecting the environment and human health. The maximum acceptable risk is 10^{-6} fatal cancers and serious genetic effects in a year over a period of up to 200 years (the period required for ^{90}Sr and ^{137}Cs to decay to background). AECL will develop a safety case to demonstrate compliance with those requirements to confirm in-situ disposal of LLW as a final end state.

Inactive Landfill

There is the potential for contaminant migration to groundwater from the landfill (Phases 1 to 3). Operating procedures for the landfill have been in place to ensure only non-radiological and non-hazardous waste were placed in the landfill (Barnard et al. 1985). Therefore contaminant levels in leachate from the landfill are expected to be low. This will be verified through the implementation of an enhanced monitoring program (See Section 9.5.3).

Sewage Lagoon

There is a potential for contaminant migration to groundwater during operation of the lagoon. The lagoons are constructed of low permeability clay embankments placed on a prepared clay surface, with no additional lining (Section 4.3.3). The clay embankments and underlying clay are barriers to groundwater flow and it is unlikely that there has been any release of contaminants to groundwater. This will be verified through the implementation of an enhanced monitoring program (See Section 9.5.4).

Buried Services

Ultimately, the effects of shutdown and decommissioning of the buried services is minimized by first flushing the pipes and by removing the internal contaminated piping before removal of external piping. Removing and remediating the lines will reduce the contaminating potential of the drain lines and consequently soil and groundwater composition is improved.

There is the potential of soil contamination from past leaks and from migration of contaminants to groundwater. The extent of any groundwater contamination is expected to be limited to the Project Study Area.

Affected Lands

There is a potential for groundwater contamination from contaminated soils within the affected lands project component. Ultimately, remediating affected land will reduce the contamination potential of the area and consequently soil and groundwater composition is improved. The only areas with the potential for ground water contamination are the cesium ponds and laboratory site contaminated areas (ALWTC).

6.3.4.3 Mitigation Measures

Remediation plans and mitigation measures will be developed for the affected land areas discussed in this section. Mitigation measures which will be used to control groundwater contamination are:

- Ground-surface radiation surveys to monitor potential surface contamination for cesium ponds and active area soil contamination.
- Effluent containment procedures including the use of rain barriers (berms and coverings) to minimize the spread of contamination during remediation of cesium ponds and active area contaminated soils.
- Continued control of wastes deposited in the inactive landfill.

6.3.4.4 Residual Effects

Groundwater flow in the Project Study Area is towards the Winnipeg River. Potential groundwater contamination from the affected lands is therefore expected to be limited to the Project Study Area.

VECs which may be effected by contaminated groundwater discharges to surface and soil contamination are:

- Winnipeg River and selected fish species (Sturgeon, Walleye, Pike and Mooneye).
- Winnipeg River Shoreline and Gullies and Ravines on site.
- Deer and moose – the risk is that these may graze in areas affected by groundwater contamination.
- Coniferous Forest on site.

6.3.5 Terrestrial Biota

The following discussion provides a qualitative assessment of likely effects on vegetation and mammals in the Project Study Area.

6.3.5.1 Likely Project/Environment Interactions

Physical works/activities affecting air, soils, groundwater and surface water have the potential to affect terrestrial biota. These physical works/activities were discussed in the preceding sections (6.3.1, 6.3.3 and 6.3.4).

6.3.5.2 Likely Effects on the Environment

Vegetation

Vegetation in the area includes forested areas and fields vegetated with shrubs and grasslands. Coniferous forest in the area has been identified as a VEC. No vegetation species in the Project Study Area is identified as a rare or protected species.

Contaminant exposure pathways for vegetation are by contaminants in air, contaminated soil, groundwater and surface water. Airborne emissions from decommissioning activities are likely to be less than in the past and no effect from this exposure pathway is expected.

There is the potential for exposure from contaminated soils, contaminated groundwater and surface water within the Project Study Area, in particular near WMA. However, any effects are expected to be limited to the Project Study Area.

It is expected that the natural vegetation will re-establish itself in released areas.

Mammals

Over 50 species of mammals can be expected to occur around the Whiteshell Laboratories site. These include squirrels, the meadow vole, fox and larger mammals such as deer and moose. No mammal species in the area is an endangered species however the grey fox and wolverine are listed as vulnerable. Mammals selected as VECs are deer and moose. It should be noted that they are valued because of their value to subsistence and sport hunters and the general public. They are neither endangered nor vulnerable species.

Contaminant exposure pathways for mammals are by contaminants in air, soil, surface water and vegetation. Airborne emissions from decommissioning activities are likely to be less than in the past and no effect from this exposure pathway is expected. There is the potential for exposure from contaminated soils and surface water, in particular near WMA. No effect on the population of mammals is expected because:

- The geographical extent of areas affected by residual contamination is expected to be limited to the Project Study Area.
- Mammals are mobile and will also feed and graze outside contaminated areas.

No effects from noise on wildlife are expected (Section 6.3.2).

6.3.5.3 Identified Mitigation Measures

No mitigation measures are warranted to protect terrestrial biota.

6.3.5.4 Residual Effects

No residual effects on terrestrial biota are expected.

6.3.6 Aquatic Biota

Aquatic biota considered include fish and benthic organisms in the Winnipeg River. This section provides a discussion on the maximum dose aquatic biota might receive from decommissioning activities and contaminated river sediments. The discussion is based on the detailed evaluation on contaminated river sediment impacts is presented in Appendix B.1.

6.3.6.1 Likely Project/Environment Interactions

Physical works/activities affecting aquatic biota are effluent emissions to the Winnipeg River, potential contaminated surface runoff and groundwater discharges to the river and contaminated river sediments. These emissions were discussed in detail in Section 6.3.3.

6.3.6.2 Likely Effects on the Environment

Exposure pathways to aquatic biota include radiation from nuclides in the water and sediment and from radionuclides accumulated in the body. Decommissioning activities have the potential to affect radionuclide levels in water and sediment and the discussion is limited to these exposure pathways. The radio-sensitivity of aquatic organisms was reviewed by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR 1996). UNSCEAR concluded that the reproductive viability of aquatic populations would not affected at dose rates below 10 mGy/d.

Exposure from nuclides in water is not expected to affect aquatic biota. No decrease in water quality is expected from the project as effluent emissions to the river are expected to decline from present levels (Section 6.3.3). Re-suspension of contamination in sediments was discussed in Section 6.3.3.2 and is also not expected to lead to a decrease in water quality.

The effect of exposure from radionuclides in sediments on aquatic biota was estimated by Sheppard (See Appendix B.1) and is briefly summarized here. Many organisms may interact with the contaminated sediments, despite the fact they are in a 3 to 4m depth of water. Clams are an obvious endpoint for the calculation of likely effects from the sediments because they are present, long-lived and relatively sessile, and they dwell in or on the sediment. Benthic invertebrates may be important, but are short-lived and emergent species and are only seasonally present.

Exposures to predators of the clams were not estimated because:

- the possible predictors are quite mobile and will feed outside the contaminated area, thus diluting their ingestion of contamination by some unknown amount; and
- most radionuclides do not biomagnify, and are at their highest concentration in biota most closely associated with the contaminated media.

The scenarios to assess the dose to clams from sediments assume the clams are located in an area where concentrations are greater than 99th and 99.9th percentile values of the sediment concentrations one might observe in the most contaminated region. It should be noted that these concentrations were not observed in the sediment survey.

The doses for the 99th and 99.9th percentile scenarios were 1.06E-04mGy/d and 4.65E-02 mGy/d, a small fraction of the UNSCEAR limit of 10 mGy/d and the limit at which no effect on aquatic populations is expected.

In conclusion, no effect on aquatic species is expected from decommissioning activities or the contaminated sediments. Therefore, likely radiation effects on aquatic biota do not warrant further attention.

6.3.6.3 Identified Mitigation Measures

No mitigation measures are required.

6.3.6.4 Residual Effects

No residual effects on aquatic biota are expected.

6.3.7 Worker Health and Safety

As operator of the facility, AECL is responsible for ensuring the health and safety of its employees. AECL's health objective is that no worker shall be subjected to exposure to ionizing radiation beyond the prescribed limits and exposures shall be kept As Low As Reasonably Achievable (ALARA) within the restrictions of social and economic factors. This is to be achieved through the operation of the facility and decommissioning activities in compliance with the regulations set out by the CNSC and the AECL Radiation Protection Program.

The current annual dose limit to atomic radiation workers is 20 mSv per year averaged over 5 years (CNSC 2000b).

6.3.7.1 Likely Project/Environment Interactions

The potential for exposure to radiation and hazardous materials from Physical activities/works will be evaluated and documented in Detailed Decommissioning Plans. These will be prepared for each facility.

The following is a list of generic activities expected to result in radiation exposure to workers during decommissioning:

- Decontamination of facilities.
- Dismantling and demolition of facilities.
- Processing, handling and transporting radioactive and hazardous materials on-site.
- Facility maintenance.

6.3.7.2 Likely Environmental Effects

Preliminary radiological dose estimates for Phase 1 of the Whiteshell Laboratories Decommissioning Project have been prepared. The estimates were provided as an initial project hazard assessment to assist with the further development and refinement of facility decommissioning plans.

The estimates do not address Phase 2 and 3 of the project because detailed evaluation, engineering and design of specific project components for these phases has not been completed. Dose estimates for these phases will be done in accordance with AECL's Radiation Protection Protocols and all regulatory requirements and will be documented in the Detailed Decommissioning Plan for each facility.

The Phase 1 radiological dose estimate is for the following facilities:

- Active Liquid Waste Treatment Centre.
- Shielded Facilities.
- Building 300.
- Building 411.
- Site General.
- Waste Management Area.
- Concrete Canister Storage Facilities.

The total estimated dose for Phase 1 is 0.27 person-Sv (27.37 person-rem). Approximately 90% of the dose is expected from the Shielded Facility and Active Liquid Waste Treatment Centre.

The radiation dose to workers will be kept within regulatory limits. This is to be achieved through the operation of the facility and decommissioning activities in compliance with the regulations set out by the CNSC and the AECL Radiation Protection Program.

6.3.7.3 Identified Mitigation Measures

No additional mitigation measures are warranted or recommended.

6.3.7.4 Residual Effects

No residual effects on worker health are expected.

6.3.8 Public Health

For an effect on public health to occur, there must first be a significant effect on one or more of the environmental components linked directly or indirectly to a human receptor. Public health effects were reviewed to determine if it was possible for contaminants to reach offsite human receptors via the air, water, or food chain. If such a process was possible, further analysis, such as estimation of radiation dose and other measures of exposure, was carried out to determine the nature of the effect. Of interest to this assessment are:

- air quality;
- drinking water quality (groundwater and surface water);
- water quality of the Winnipeg River for recreational activities; and
- the dose from exposure to radiation.

As operator of the facility, AECL is responsible for ensuring the health and safety of its employees and the public, and for the protection of the environment. AECL's health objective is that no member of the public or the environment shall be subjected to exposure to ionizing radiation beyond the prescribed limits and exposures shall be kept As Low As Reasonably Achievable (ALARA) within the restrictions of social and economic factors. This is to be achieved through the operation of the facility and decommissioning activities in compliance with the regulations set out by the CNSC and the AECL Radiation Protection Program.

6.3.8.1 Likely Project/Environment Interactions

The physical works/activities with the potential to affect human health are the physical works/activities affecting environmental compartments linked indirectly or directly to a human receptor. These compartments include air, surface water, groundwater and aquatic and terrestrial biota. Physical works/activities affecting these compartments were discussed in the respective sections on environmental effects.

6.3.8.2 Likely Environmental Effects

Potential effects on the public can be assessed by estimating the expected annual dose to members of the critical group in the vicinity of the Project Study Area. A critical group is considered to be the group of individuals who would be expected to receive the highest doses due to their location, age, diet and other characteristics. The current regulatory limit for the public is 1000 µSv/a (CNSC 2000b).

Decommissioning activities are not expected to lead to increased emissions to air and surface water (Section 6.3.1 and 6.3.3). In fact, emissions are expected to decrease. There is the potential for groundwater contamination from the project but any contamination is expected to remain within the Project Study Area. For these reasons, decommissioning activities are not expected to affect public health. No decline in the quality of the air, offsite surface water (Winnipeg River) or offsite groundwater is expected.

Because emissions are expected to decrease, the incremental dose from the project on the public is expected to be less than the incremental dose estimated from current operations reported in Section 5.2.3. Total incremental dose to adults and infants in 1999 were 4.35 E-04 and 2.43 E-04 mSv/a, respectively. These values are significantly less than typical radiation doses to adults from major natural sources and medical diagnostic procedures (3.2 mSv/a). The estimate takes into account water, fish and vegetable ingestion and beach exposure. Immersion in air and ingestion of wildlife (game) are not considered because of the very low radioactivity associated with those two source terms.

A review was also made of the effects of radiation from contaminated river sediments on human health (See Appendix B.1). The hypothesis was that somehow the flow of water in the Winnipeg River was blocked allowing a person to stand on an area of active sediments. This was in itself considered a highly unlikely scenario. This produced a dose from beach exposure of 4.0 E-02 mSv/a for an adult; a value higher than the exposure dose of 2.42 E-05 mSv/a reported by Niemi et al. (2000). Thus the incremental dose remains 2 orders of magnitude lower than the typical dose received by an adult.

6.3.8.3 Identified Mitigation Measures

No further mitigation measures are required to protect the public.

6.3.8.4 Residual Effects

No residual effects on public health are expected.

6.3.9 Socio-Economic Impacts

The *Canadian Environmental Assessment Act* considers socio-economic impacts only when a biophysical effect is identified. In general, few biophysical effects have been indicated and therefore, no socio-economic impacts are anticipated.

6.3.9.1 Impact of Cultural Heritage and Archeological Features

A society's cultural heritage is composed of many elements including history, traditions, arts, architecture, religious beliefs, sciences, education and other distinct traits. Archeological features are particularly important because they are non-renewable. Cultural heritage and archaeological features include:

- Architectural sites.
- Sites or objects formally recognized at the international, national, provincial or municipal level.
- Sites or objects whose cultural value may be greater than the site's physical components.
- Sites or objects of unique cultural value to aboriginal peoples.

Of particular interest are archaeological features that may be present in the study areas.

A review of historical and archaeological information relating to the area was undertaken to determine if there were any particular aspects of the study areas that required attention. The findings are summarized in Section 5.5.6.

Project/Environment Interactions

Any restoration activities undertaken along the Winnipeg River may impact on archaeological features along the shoreline and vicinity.

Likely Environment Effect

The shorelines of the Winnipeg River have been utilized for many centuries. As mentioned in Section 5.5.6, no archaeological studies were carried out on the licensed Property Study Area, however, the abundance of sites in the regional study area would indicate that sites might exist on the property.

Restoration and remediation activities conducted along the Winnipeg River and sewage lagoons have the potential for disturbing or destroying historical or archaeological artifacts.

Identified Mitigation Measures

An archaeologist will be available to assess the significance of any finds during excavation of restoration work conducted along the Winnipeg River area.

Residual Effect/Comment

Other archaeological sites in the region are notable for their rare finds of considerable cultural importance. It is therefore important to have experts on hand to prevent or minimize the loss of artifacts.

6.3.9.2 Impact on Land and Resource Use

The CSR addressed the question of how sustainability of a resource could be potentially affected by the project. For a resource to be affected adversely, a residual environmental effect must decrease the ability of a resource to be used at least at its current level. This could occur, for example, if contamination affected the ability of fish, such as the Winnipeg River sturgeon, to reproduce.

Project/Environment Interaction

Activities that can impact on the land and resource use during and after the decommissioning project include:

- low-level waste in trenches in the Waste Management Area;
- closure of the inactive landfill; and
- closure of the sewage lagoons.

Likely Environment Effect

During decommissioning and the institutional control period, the use of some lands will be restricted.

Identified Mitigation Measures

- Limit areas of restricted use as much as possible.
- Monitor the river sediments, shorelines and river water quality as part of the follow-up program.
- Monitor the inactive landfill and sewage lagoons to provide input for the development of suitable closure plans. The *Manitoba Environment Act* (Regulation 163/88 and Regulation 150/91 for the sewage lagoon and landfill site, respectively) will also be considered in developing the closure plans. This will minimize restrictions for the use of the landfill and sewage lagoons areas.

Residual Effect /Comment

AECL has already taken steps to release a large portion of its property that has remained unaffected by its operations. The unaffected land represents approximately 3,000 hectares of the 4,375 hectares of the licensed site. As the facilities are decommissioned, additional areas will likely be released. Thus, the 'footprint' of AECL property will diminish with time. Towards the end of the decommissioning project, it is expected that the licensed activities will be centred on the Waste Management Area. For the period of institutional control, only a few tens of hectares may be restricted.

6.3.9.3 Economic Impact

As mentioned above, the economic impacts to be assessed in the context of the federal environmental assessment regime are limited to impacts resulting from a change in the bio-physical conditions. Therefore, the socio-economic effects resulting from the closure of Whiteshell Laboratories are not considered here.

Potential Project/Environment Interactions

Project activities that may have an economic impact include:

- Any remediation or restoration activities in or along the Winnipeg River.
- Release of contaminants to surface waters as a result of decommissioning activities.
- Release of contaminants into the groundwater as a result of in-situ management of low-level waste or other sources of contaminants on-site.

Likely Environment Effects

The users of the Winnipeg River and/or the landowners along the river could feel the effects of the aforementioned activities. Those effects, real or perceived, may include:

- Reduction of the Sport Fishery if fish caught are believed to be unsafe for human consumption.
- Reduction in value of cottage properties due to water believed to be of inadequate quality.
- Alternate sources of drinking water if groundwater contamination occurs. This would result in additional costs to property owners.

Identified Mitigation Measures

The mitigation measures that will be implemented are essentially the same as those used to minimize or prevent the deterioration of surface water and groundwater quality (Sections 6.3.3 and 6.3.4). The results of the monitoring activities will be communicated to the public.

AECL also supports the establishment of a Public Advisory Committee that would make recommendations on the monitoring activities. The Committee may also make recommendations on additional mitigation or compensation measures based on the follow-up activities, if and where necessary.

Residual Effects/Comment

Because effects on the bio-physical environment are highly unlikely, any residual economic effects emanating from the project are also unlikely.

6.3.9.4 Impact on Aboriginal Interests

A comprehensive public consultation program was set up which included specific consultation with aboriginal communities. Feedback from these communities was used to determine effects from decommissioning activities as they relate to aboriginal interests. A summary of those interests is presented in Section 5.5.7.

Potential Project/Environment Interactions

The interactions that may impact on Aboriginal interests are as follows:

- Any remediation or restoration activities in or along the Winnipeg River or in the vicinity of the sewage lagoons.
- Release of contaminants to surface waters as a result of decommissioning activities.

Likely Environment Effects

Aboriginal people have acquired an ecological knowledge based on experience and teachings passed from generation to generation. That knowledge brings a holistic view where the environment cannot be separated from the people that live in it. Aboriginal people understand the complexity of ecosystems and can foresee long-term and cumulative impacts resulting from individual activities. The following effects are believed to have some importance:

- Reduction of the Sport Fishery if fish caught are believed to be unsafe for human consumption.
- Land use restrictions particularly along the shores of the Winnipeg River may impact on the traditional use of the land for fishing, hunting, wild rice harvesting and the gathering of medicinal plants.
- Loss of cultural features such as burial sites/mounds, historic campsites, spiritual and ceremonial sites.
- Deterioration of water quality or other environmental features.

Identified Mitigation Measures

Mitigation measures proposed for surface waters (Section 6.3.3.3) will be implemented. Also, the results of the monitoring activities will be communicated to Sagkeeng and other Aboriginal communities potentially affected by the decommissioning.

AECL supports the establishment of a Public Advisory Committee on which representatives from the communities can sit. The Committee would have the ability to make recommendations on the monitoring activities. The Committee may also make recommendations on additional mitigation or compensation measures based on the follow-up activities, if and where necessary.

As mentioned above, an archaeologist will be available to assess the significance of any finds during excavation or restoration work conducted along the Winnipeg River area. Although no cultural features have been identified in the Project Study Area, particular care will be taken during any restoration work performed along the riverbanks to prevent the loss of valuable artifacts if any are identified.

6.3.9.5 Residual Effects/Comment

No land use restrictions are anticipated for the river shoreline; therefore, no effects are anticipated on the traditional use of the shoreline aboriginal people. Potential residual effects include reduction of the sport fishery as a result the contamination of the river water or fish and the possible loss of cultural features during restoration work.

6.4 EFFECTS OF ACCIDENTS AND MALFUNCTIONS

Accidents and Malfunction Events

This section addresses accidents and malfunctions related to on-site events and offsite transportation of radioactive materials which are not part of normal operations, and which may result in potential emergency situations. These events include equipment failure, fire, explosion, spills and leaks loss of services and off-site transportation accidents. These events are briefly described below.

Equipment Failure

Equipment failure may result from equipment malfunction, power loss, fire, explosion, extreme environmental conditions and human intrusion (vandalism) or error. Examples include:

- failure or malfunction of the aqueous waste collection and associated drainage systems;
- failure or malfunction of air emission control equipment associated with decontaminating, repackaging and containment systems;
- failure or malfunction of surface water containment systems;
- failure of product containment systems (storage buildings and tanks);
- failure or malfunction of alarm and monitoring systems; and
- failure of shielding systems.

Fire

Fire may result from equipment malfunction, electrical faults, extreme environmental conditions, and human intrusion (vandalism) or error. Fire hazards include solvents, fuels, and flammable building materials.

Explosion

Explosion may result from equipment malfunction, fire (particularly related to fine particulates, solvents and fuels), building demolition, and human intrusion (vandalism) or error.

Spills and Leaks

Spills and leaks may result from breaks or cracks in piping, storage tanks, holding tanks, drums, transformers and sumps; dripping valves; repackaging operations; loading, transfer and unloading operations; pumping operations; decommissioning and transport equipment; extreme environmental conditions; power loss; fire; explosion; and human intrusion (vandalism) or error (overfilling or improper storage).

Loss of Service to Buildings

Loss of service pertains primarily to power failure which can lead to all of the above accident and malfunction scenarios.

Off-site Transportation Accidents

The movement of hazardous and radioactive materials off-site is governed by the *Packaging and Transport of Nuclear Substances Regulations* (CNSC 2000c). The containers are designed to prevent the release of contaminants in the event of a severe accident and must be approved by the CNSC. In the event of an accident, AECL has procedures for corrective action.

Effects and Mitigation of Accident and Malfunction Events

The effects and mitigation measures of each of the aforementioned events are presented in Table 6.2. As indicated in Section 6.2.1.4., Whiteshell Laboratories already has site wide and facility-specific emergency preparedness plans to address accident and malfunction events. Hazard analyses have been performed on all the major facilities at the Whiteshell Laboratories site and are documented in the Safety Analysis Reports which identify the potential worst-case hazards for each facility. The main focus is on potential radiological hazards but non-radiological hazards are addressed where appropriate. Procedures to respond to the potential hazards are identified in the Safety Analysis Reports or in the facility-specific plan. The decommissioning work will be carried out in accordance with these plans and the plans will remain in effect until the hazards associated with each facility and/or activity are removed or mitigated.

Important aspects of these plans include:

(a) Fire and Explosion:

An incident such as a fire or explosion that could result in a high radiation field or the release of hazardous quantities of radioactive or other toxic substances would initiate a Stay-in or Evacuation. The actions to be taken on discovering such an emergency are:

- ensure no one is in immediate danger;
- pull the nearest fire alarm, if there is a fire;
- call Protective Services and report the location and nature of the emergency;
- request a Stay-in, if warranted; and
- close all doors, windows and fumehoods before vacating the area.

The initiation of a Stay-in will result in the formation of the Emergency Operations Centre (EOC). All information from the scene of the incident will be transmitted to the EOC which will then deploy the required personnel to deal with the incident.

(b) Spills:

For a radiological spill requiring a Stay-in, the same procedures as described for fire and explosion will be followed. If it is a spill of radiological or hazardous material not requiring a Stay-in, the Safety Supervisor will assign a Health Surveyor to the area to determine the extent of the contamination and the remedial measures that are required.

In addition, a number of buildings and infrastructure facilities (e.g. ALWTC; the aqueous waste collection system associated with B300; the Decontamination Centre; WM storage; and processing facilities) will not be shutdown until the latter stages of decommissioning and events associated with equipment failure could occur over the entire period of the decommissioning program.

The movement of hazardous and radioactive materials off-site is governed by the *Packaging and Transport of Nuclear Substances Regulations* (CNSC 2000c). The containers are designed to prevent the release of contaminants in the event of a severe accident and must be approved by the CNSC. In the event of an accident, AECL has procedures for corrective action.

Table 6.2
Summary of Potential Effects of Accidents and Malfunctions on Decommissioning Activities

Accident and Malfunctions	Potential Effects / Mitigation Measures
Equipment Failure	*Effects* • Release of airborne emissions to the atmosphere where they may be subsequently transported and deposited at various distances from the source • Release of liquid contaminants which could contaminate soil, groundwater, surface water and air • Worker health and safety issues *Mitigation* • Where possible equipment will be designed and operated in a fail-safe mode • Secondary containment is already provided for most existing equipment and systems; new equipment and systems will provide for secondary containment where necessary • Contingency plans and emergency preparedness plans already exist for the Whiteshell facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented
Fire	*Effects* • Release of airborne emissions (existing contaminants and those generated from the fire) to the atmosphere where they may be subsequently transported and deposited at various distances from the source • Release of liquid contaminants which could contaminate soil, groundwater, surface water and air • Explosion and propagation to off-site (creation of a large-scale forest fire with wider reaching environmental effects) • Worker health and safety issues *Mitigation* • Whiteshell has fire fighting procedures for dealing with fires • Whiteshell expects to enter into an agreement with local communities with respect to fire protection

Accident and Malfunctions	Potential Effects / Mitigation Measures
	• In the unlikely event of any contaminant release as a result of fire, any migration will be curtailed and immediate clean-up will be implemented
Explosion	*Effects* • Release of airborne emissions to the atmosphere where they may be subsequently transported and deposited at various distances from the source • Release of liquid contaminants which could contaminate soil, groundwater, surface water and air • Fire and associated effects • Worker health and safety issues • Expulsion of projectiles resulting in widespread debris *Mitigation* • Whiteshell has fire fighting procedures for dealing with fires caused by explosions • In the unlikely event of any contaminant release as a result from explosion, any migration will be curtailed and immediate clean-up will be implemented
Spills and Leaks	*Effects* • Release of volatile contaminants to the atmosphere where they may be subsequently transported and deposited at various distances from the origin. • Release of liquid contaminants which could contaminate soil, groundwater, surface water and air • Fire and associated effects • Worker health and safety issues *Mitigation* • Secondary containment is already provided for most existing equipment and systems; new equipment and systems will provide for secondary containment where necessary • Contingency plans and emergency preparedness plans already exist for the Whiteshell facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented
Loss of service (power)	• Failure of lighting, air and water systems (including fans and pumps) which may result in worker health and safety effects • Failure of alarm and monitoring systems which could result in the release of airborne and liquid effluents to the environment and worker health and safety issues *Mitigation* • Where possible equipment and systems will be designed to shutdown in a fail-safe mode in the event of a power loss • Secondary containment is already provided for most existing equipment and systems; new equipment and systems will provide for secondary containment

Accident and Malfunctions	Potential Effects / Mitigation Measures
	where necessary • Contingency plans and emergency preparedness plans already exist for the Whiteshell facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented
Off-Site Transportation Accidents	*Effects* • A transportation accident releasing contaminants to the environment exposing workers and the public to radiation fields and radioactive contamination *Mitigation* • The movement of radioactive materials is governed by the *Packaging and Transport of Nuclear Substances Regulations* (CNSC 2000c) • The containers are designed to prevent the release of contaminants in the event of a severe accident and must be approved by the CNSC. Contingency plans and emergency preparedness plans already exist for Whiteshell Laboratories • In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented

Conclusions

The accidents and malfunctions listed in Table 6.2, have avoidance and contingency plans applicable to each, in order to mitigate the potential environmental effects. Mitigation measures to reduce the potential hazards during decommissioning will be developed in individual decommissioning plans for individual facilities. Accident mitigation is based on prevention, early detection, remediation and accommodation.

6.5 THE EFFECT OF THE ENVIRONMENT ON DECOMMISSIONING ACTIVITIES (NON-ROUTINE EVENTS)

Non-routine environmental events are defined as naturally occurring events that can produce extreme conditions affecting the performance of decommissioning activities. These events include extreme rainfall and flooding, earthquakes, tornadoes, and forest/grass fires. Plans exist for handling such events on-site. They have been submitted and approved by the regulatory authorities and their risks are assessed in the Safety Reports.

These non-routine events are described below and potential effects from them are presented in Table 6.5.

Extreme Rainfall and Flooding

Extreme rainfall statistics are presented in Table 6.3. These statistics integrate return periods and the length of the rainfall event with the amount of rainfall.

Table 6.3
Extreme Rainfall Statistics for Winnipeg, Manitoba

Return Period (Years)	Rainfall in mm								
	5min	**10min**	**15min**	**30min**	**1-hr**	**2-hr**	**6-hr**	**12-hr**	**24-hr**
2	8.34	13.18	15.85	22.36	28.36	32.70	37.38	47.21	52.38
5	11.88	17.60	22.03	31.19	37.19	45.07	51.50	62.22	66.50
10	14.22	20.53	26.14	37.05	43.05	53.27	60.88	72.19	75.88
15	15.54	22.18	28.45	40.35	46.35	57.89	66.16	77.80	81.16
20	16.46	23.33	30.06	42.66	48.66	61.12	69.86	81.72	84.86
25	17.18	24.22	31.31	44.44	50.44	63.62	72.70	84.75	87.70
50	19.37	26.96	35.14	49.92	55.92	71.29	81.47	94.06	96.47
100	21.55	29.69	38.96	55.37	61.37	78.92	90.19	103.33	105.19

Source: W.D. Hogg and D.A. Carr, 1985.

No rainfall event has affected the operation of Whiteshell Laboratories. Therefore, the only potential effect on the decommissioning project will be to curtail activities during a rainfall event.

Overflow of the Winnipeg River

Flooding of the Winnipeg River may result from extreme rainfall conditions and/or as a result of failure of the Seven Sisters Dam which is located southeast of the Whiteshell Laboratories area.

With particular regard to the Seven Sisters Dam, literature indicates that there has never been a failure of any hydroelectric dam in Canada. Further, Manitoba Hydro has contingency plans for comprehensive notification, warning, and response systems in case an emergency condition is detected. It is estimated that it would take 1.5 hours to reach a peak flood level of 7 m above normal conditions 7.8 km downstream of the breach, on AECL property. Table 6.4 provides an estimate of the propagation of flood wave characteristics.

A dam break may affect the shoreline but will not flood the site. The only effects therefore would be on the outfall. Any rupture would not affect the amount of flow into the river. An overflow of the river is deemed highly unlikely and the effects on the decommissioning project would be negligible.

Table 6.4
Propagation of Flood Wave Resulting from Dam Breach at Seven Sisters

Location	Distance Downstream of Breach (km)	Time from Start of Flow Through Breach (hours)		Estimated Duration of Flooding (hours)	Estimated Increase in River Level from Normal Condition	
		First Arrival of Flood Water	Peak Flood Level		(ft)	(m)
AECL Property	7.8	0.7	1.5	6.3	23	7
AECL Property	10.0	0.7	1.6	6.5	23	7

Earthquake

The province of Manitoba is the least earthquake-prone area in Canada. Seismic activity in the prairie region south of 60°N is predominantly confined to southern Saskatchewan in a zone that continues into Montana (Anglin et al. 1990).

The Canadian nuclear fuel waste management program studying seismic stability in Northwest Ontario and Eastern Manitoba has found, based on a detection level of 2.5 on the Richter scale, that the Whiteshell Laboratories area and the southern two-thirds of Manitoba are aseismic (Wetmiller et al. 1996).

Tornado

Between 1868 and 1990 at least 75 tornadoes or tornado groups have occurred in Manitoba with two of these tornadoes passing near Whiteshell Laboratories in 1978. It has been estimated that the probability of a tornado strike in a given 1 km^2 area within the most southerly 190 km of Manitoba is about 4.8×10^{-4}/year; that is, there is a moderate probability of a tornado affecting the Whiteshell Laboratories' site. If a tornado did strike, it would affect many site buildings. It would not, however, affect the reactor or the concrete canisters which are designed to withstand very high winds.

Forest/Grass Fires External to the Facility

Natural grasslands and hardwood forests are located close to the Whiteshell Laboratories site (Guthrie and Scott 1988). Forest/grass fires may result from extremely dry conditions or lightning strikes. Whiteshell Laboratories has procedures for dealing with fires. Fire fighting capability will be supplemented with arrangements with surrounding communities.

Table 6.5

Summary of Effects of Environment (Non-Routine Events) on Decommissioning Activities

Environmental Event	Potential Effects / Mitigation Measures
Extreme Rainfall and Flooding	*Effects* • Increased soil erosion • Significant increase in surface water run-off • Increased worker safety issues (slippery surfaces for both workers and equipment, reduced visibility; increased electrical hazards, etc.) • Delays in the decommissioning schedule *Mitigation* • The suspension of outdoor decommissioning/remediation activities that could lead to contamination of run-off • WR-1 and the concrete canisters, in particular, have been designed to withstand extreme environmental events; new storage facilities constructed during decommissioning will also be designed to withstand extreme environmental events • Maintain adequate storm drainage facilities • In the unlikely event of significant contaminant release, clean-up will be implemented
Overflow of the River	*Effects* • No effect *Mitigation* • No mitigation required *Comments* • A breach of the Seven Sisters Dam is highly unlikely to occur • In the unlikely event of a breach of the dam, flooding would be expected to occur south of Whiteshell Laboratories and further north by Lac Du Bonnet • Notwithstanding, such extreme conditions could affect the AECL Bridge which could result in delays in decommissioning activities involving off-site transportation
Earthquake	*Effects* • Damage to decommissioning containment enclosures • Damage to active drains and stormwater drains • Destabilization of excavation slopes and stockpiles • Worker health and safety effects • Delays in the decommissioning schedule *Mitigation* • WR-1 and the concrete canisters, in particular, have been designed to withstand extreme environmental events; new storage facilities constructed during decommissioning will also be designed to withstand extreme environmental events

Environmental Event	Potential Effects / Mitigation Measures
	• Contingency plans and emergency preparedness plans already exist for the Whiteshell facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented *Comments* • Low probability • Area is aseismic
Tornadoes	*Effects* • Damage to existing above-ground facilities • Damage to decommissioning containment enclosures • Destabilization of excavation slopes and stockpiles • Worker health and safety effects • Delays in the decommissioning schedule *Mitigation* • WR-1 and the concrete canisters, in particular, have been designed to withstand extreme environmental events; new storage facilities constructed during decommissioning will also be designed to withstand extreme environmental events • Contingency plans and emergency preparedness plans already exist for the Whiteshell facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented *Comments* • Effects likely very localized within Whiteshell Laboratories • Moderate probability
Forest/Grass Fires	*Effects* • Temporary cessation of decommissioning activities • Evacuation due to fire and smoke *Mitigation* • The area around the facility will remain cleared to reduce the potential for the spread of fire onto the facility • In the unlikely event of a contaminant release resulting from fire, clean-up will be implemented *Comments* • Fire fighting capability will be supplemented with arrangements with surrounding communities

<u>*Conclusions*</u>

If a non-routine event were to occur, AECL's existing contingency plans and emergency preparedness plans would be implemented. If required, remediation of any new contamination would be undertaken.

6.6 EFFECTS ON SUSTAINABLE USE OF RENEWABLE RESOURCES

The *Canadian Environmental Assessment Act* requires that a Comprehensive Study Report consider the capacity of renewable resources that may be affected by the project. The capacity of sustainable use is based on a range of ecological considerations such as integrity of the ecosystem, productive capacity of the resource, carrying capacity of the ecosystem, and assimilative capacity of the ecosystem.

Renewable resources are those resources that can be naturally regenerated, such as forests or fisheries. The sustainable use of renewable resources refers to the ability to utilize these resources today without adversely affecting prospects for their use by future generations.

The decommissioning of Whiteshell Laboratories will have a positive effect on renewable resources in the biophysical environment both directly or indirectly. For example, the remediation and reestablishment of habitat for wildlife within the area is proposed after decommissioning and demolition. The decommissioning of facilities such as the ALWTC should also result in positive effects to the Winnipeg River. The release of new contaminants will be curtailed and eventually stopped. Subsequently, a review will be made of the contamination in the river sediments to confirm in-situ abandonment as the final end state.

In the case of Whiteshell Laboratories decommissioning, water quality is a renewable resource that will be improved as a result of the project. Other resource improvements would include fisheries, aquatic and terrestrial biota and terrestrial vegetation and wildlife.

Within the Project Study Area, it is expected that the effects of decommissioning on renewable resources should be mostly positive in nature. It is estimated that all but 1,415 ha of the site would be available for new business ventures by 2001. Release of maintained land would result in a larger area for hunting and other recreational activities. Table 6.6 summarizes the effects on renewable resources.

Table 6.6
Renewable Resources

	EFFECT
Forest	Positive – forested area may increase
Winnipeg River	Positive – flow of contaminants is already reduced and will eventually cease
Wildlife	Positive – habitat area will increase
Fisheries	Positive – water quality (which is currently high) will continue improve. This is conducive to the maintenance of fish habitats.

6.7 SUMMARY OF RESIDUAL EFFECTS ON VECS / VSCS

VECs and VSCs were identified in Section 5.6. The Winnipeg River and the aquatic features of the waterway are the area's most important VECs. Additional VECs/VSCs include wildlife in the area, the Sport Fishery and provincial parks and natural forests areas which are valued for their recreational uses.

This section provides an assessment of effects of the project on VECs/VSCs. Examples of possible adverse effects are a reduction in the water quality of a lake or river, a reduction in the population of fish or wildlife, loss of habitat and changes in breeding patterns.

6.7.1 Project/Environment Interactions (VECs/VSCs)

The VECs/VSCs are primarily related to the aquatic and terrestrial environmental components. Physical works/activities affecting air, surface water, soil and groundwater quality have the potential to affect the VECs/VSCs. Those interactions were assessed in Sections 6.3.1, 6.3.3 and 6.3.4.

6.7.1.1 Likely Environmental Effects

Likely effects on VECs/VSCs are as follows:

Winnipeg River and its Shoreline

Environmental effects of the project on the Winnipeg River were discussed in Section 6.3.3 (Hydrology). No adverse effects on the river are expected. Effluent emissions from decommissioning activities are expected to decline from current levels and no effect from contaminated sediments is anticipated (Appendix B.1).

There is the potential for contamination of the shoreline from contaminated surface water runoff and groundwater discharges. The geographical extent of any contamination would be limited to the shoreline on the Whiteshell Laboratories site.

Contaminated river sediments are not expected to affect the shoreline. The contamination levels of the sediments are low and do not represent a risk to public health or aquatic biota (Appendix B.1).

Gullies and Ravines along the Winnipeg River

Gullies and Ravines along the river were chosen as a VEC because they offer a unique habitat to wildlife. There is the potential for contamination from contaminated surface water runoff and contaminated groundwater discharges. The geographical extent of contamination is expected to be limited to the Project Study Area.

Fish Species in the Winnipeg River (Sturgeon, Walleye, Northern Pike and Mooneye) and the Sport Fishery

Effects on aquatic biota including fish species were discussed in Section 6.3.6. No effects on the population of fish species or the Sport Fishery are expected. Sport fishermen have been known to fish in the vicinity of Whiteshell Laboratories and it is expected that they will continue to do so.

Whitetail Deer and Moose

The effect of the project on White Tail Deer and Moose was addressed in the discussion of effects on terrestrial biota (Section 6.3.5). There is the potential for exposure from contaminated soils and surface water, in particular near Waste Management Area. However, no effect on the population of mammals is expected because the:

- contamination is extremely low and vegetation uptake is limited;
- geographical extent of areas affected by residual contamination is expected to be limited to the Project Study Area; and
- deer and moose are mobile and will also feed and graze outside contaminated areas, diluting any uptake.

Habitat Diversity, Coniferous Forest at Whiteshell and the FIG

There is the potential for localized soil, groundwater and surface-water contamination within the Whiteshell Laboratories site, particularly at the WMA (Sections 6.3.3 and 6.3.4). Any effects such as contamination of vegetation are expected to be localized and will not effect habitat diversity, the coniferous forest or other vegetation on the site as a whole.

FIG, the Field Irradiated Gamma research area, is not likely to be affected by decommissioning. It is located approximately 1.5 km from the WMA and 3 km from the laboratory facilities. Surface water and groundwater contamination from the WMA and Laboratories are not expected to reach this area.

Provincial Park, Natural Forest Areas, the Model Forest

These VSCs lie outside of the Whiteshell Laboratories site. No likely environmental effects are expected outside the Whiteshell Laboratories site and therefore no effects on these VSCs are expected.

6.7.1.2 Identified Mitigation Measures

No mitigation measures are warranted or recommended.

6.7.1.3 Residual Effects

There is the potential for contamination of Gullies and Ravines and the Winnipeg River shoreline by contaminated surface runoff and contaminated groundwater discharges.

7.0 EVALUATION OF SIGNIFICANCE

7.1 RESIDUAL EFFECTS

Section 6.0 identified residual effects emanating from the Whiteshell Laboratories Decommissioning Project. Residual effects are defined as any effect, no matter how small, arising from the project after mitigation. *CEAA* requires that an assessment be carried out to determine if any of the residual effects can cause a significant adverse environmental effect. The assessment of significance begins with residual effects. These are summarized in Table 7.1. The column, spatial effect, indicates if it is anticipated that the effect will go beyond the property boundary, that is, offsite.

Table 7.1
Summary of Residual Effects

Category	Description of Residual Effect	Potential Spatial Effect	Facility / Source
Air Quality and Noise	Release of airborne radioactive particulates during disconnecting of services, decontamination retrieval and repackaging of materials and remediation	On-site	ALWTC, WR-1, B300, Decontamination Centre, B402, WMA, Buried Services, Affected Lands, North Ditch, River Sediments
	Release of airborne radioactive particulates during demolition of canisters	On-site	Concrete canisters
	Nuisance dust and fine particulates from building demolition, and site restoration and rehabilitation	On-site	All except Van de Graaff Accelerator and Neutron Generator
	Production of methane gases from landfill	On-site	Inactive landfill
	Noise during demolition and site restoration	On-site	All facilities
Surface water (hydrology)	Surface water contamination associated with migration of decontamination process water, the removal of drains and other buried services and remediation	Off-site Winnipeg River	Buried Services, WMA, Affected Lands, North Ditch
	Discharge of treated water flows into Winnipeg River (active and inactive)	Off-site Winnipeg River	ALWTC, Sewage Lagoons
	Leaks into surface water from in-situ trenches	Off-site Winnipeg River	WMA
Soil and groundwater (geology and hydrology)	Soil and Groundwater contamination during operations	Off-site Winnipeg River	WMA, Sewage Lagoons
	Contamination from leaks around existing facilities or contamination during remediation	Off-site Winnipeg River	Off-site Contaminated Lands, Sewage Lagoons, Buried Services, Affected Lands, North Ditch
	Leachate from in-situ trenches	Off-site Winnipeg River	WMA
	Leachate from remediated facilities	Off-site Winnipeg River	Inactive landfill
Terrestrial Biota	No effects identified		
Aquatic Biota	No effects identified		
Worker Health and Safety	No effects identified		

Category	Description of Residual Effect	Potential Spatial Effect	Facility / Source
Socio-economics	No effects identified		
Public Health	No effects identified		
Physical and Cultural Heritage	Potential to disrupt traditional uses of the Winnipeg River	Off-site Winnipeg River shoreline	Shoreline
Land and Resource Use	Land-use restriction associated with in-situ disposal of radioactive waste	On-site	WMA
	Land-use restrictions associated with in-situ disposal of non-radioactive waste	On-site	Inactive landfill
Archaeology	Artifact loss during excavations near shores of the Winnipeg River	On-site Shoreline	Sewage lagoon, shoreline
Aboriginal Interests	General interest in the project especially as it affects the Winnipeg River. Artifact loss during excavations near shores of the Winnipeg River	On-site Shoreline	Sewage lagoon, shoreline

There are four overall comments that should be made with respect to all releases:

- Releases during decommissioning will not be continuous. The decommissioning process is spread over many years and activities will occur sporadically.
- Radioactive releases are controlled. For example, discharges from the ALWTC are regulated and releases above prescribed limits are not permitted.
- A Detailed Decommissioning Plan (DDP) will be prepared for every nuclear facility to be decommissioned. The DDPs will address environmental control issues, describe control procedures and form the basis for regulatory approval of individual decommissioning projects.
- Monitoring will be continuous. It will not be possible for an emission which exceed regulatory limits to go undetected. In most cases, the detection is less than a day.

The following is a brief description of the residual environmental effects for each of the categories in Table 7.1.

Air Quality and Noise

Air quality issues were related to most decommissioning activities including decontamination, building demolition and site remediation. Air quality effects ranged from the release of very small amounts of radioactive air borne particulates to nuisance dust and noise. Several observations may be made:

- airborne radioactive emissions are controlled to be below the DRL and kept as low as reasonably achievable (ALARA). The target for total emissions is a small fraction of the DRL. HEPA filters effectively control radioactive particulates. Where greater control is required, additional HEPA filters can be added. The result is that the release of radioactive particulates is negligible;

- radioactive materials will be removed from all structures through a decontamination process. HEPA filters used during decontamination will remove a high level of radioactively contaminated dust (99.97%). As a result virtually no radioactivity will be released during the demolition process;
- experience at other sites suggests that from time to time nuisance dust will be generated. Recent work (Watson and Chow 1999) suggests that the fine fraction (PM_{10}) of fugitive dust, generated by construction-type activities, will tend to remain in the lowest 2 m of the atmosphere and that the local deposition losses and impaction losses (vegetation and especially trees) will reduce the amount transported beyond 50 metres by over 90%;
- under extremely windy conditions, when there is a possibility that emissions may leave the site, activities will be curtailed; and
- the nature of the decommissioning activities will limit the generation of noise. The preservation of the dense tree coverage across the site will provide a natural noise barrier between site activities and potential noise receptors within the Project Study Area. Vibration effects would likely only be of concern within the Project Study Area to adjacent buildings and structures.

Soil and Groundwater

Small amounts of active contamination may remain in the soils where leaks have occurred around buried services and where active buildings or facilities, such as Shielded Facilities, have been removed. A small amount of leachate from these contaminated soils and from the inactive landfill may migrate into the groundwater. The evaluation of contaminant migration from the WMA trenches (Appendix C) concluded that there is no contaminant migration beyond the WMA boundaries. These amounts will be extremely small and below release limits. The approaches to their treatment will be addressed in the DDPs.

Surface Water

Residual effects on surface water, particularly the Winnipeg River, were identified from ALWTC discharges and the sewage lagoon. These discharges are currently lower than accepted release levels and will gradually diminish to virtually zero by the time the decommissioning is complete. Contaminated river sediments will not affect surface water quality (Section 6.3.3).

Terrestrial Biota

No effects were identified on terrestrial biota. The only potential effect of the project on terrestrial wildlife might be intermittent noise. However deer and moose have ranges much larger than the property and, if disturbed by noise, can go to other areas.

Aquatic Biota

The only effect on aquatic biota is related to the Winnipeg River. The river will only be affected if there is a substantial leak. Contaminated river sediments will not affect aquatic biota (Section 6.3.6).

Socio-Economic

Socio-economic effects were related to contamination of the Winnipeg River in amounts sufficient to affect aquatic life, drinking water quality and in general the economic activities associated with the river. No such contamination levels were identified and no effects are anticipated.

Worker Health and Safety

Workers will be exposed to radiation in many of the decommissioning activities. Adherence to AECL's radiation protection and occupational health and safety programs will ensure that doses are controlled and incorporate ALARA principals. Decommissioning activities will build upon past experience with nuclear facility decommissioning. Other worker health and safety risks are limited to the kinds of risk associated with normal building demolition.

Physical and Cultural Heritage

Physical and cultural heritage refers to the use of the land by First Nations and others over time. In particular, First Nations groups have used the area and especially the Winnipeg River for hunting, fishing and many other traditional activities. Other archaeological sites in the region are notable for their rare finds of considerable cultural importance.

Land and Resource Use

A potential residual effect identified is long-term restriction on land use. The use of certain areas (the WMA) will be restricted during the institutional control period. There may also be some restrictions on use of the area around the inactive landfill site. The amount of land associated with all of these areas is very small relative to the 4375 ha area of the Whiteshell Laboratories site.

Public Health

Currently there are no public health threats from the Whiteshell Laboratories Decommissioning Project. Releases are well within limits. Regular monitoring ensures that any aberrations are detected immediately. There is the possibility of an accident associated with the transport of radioactive wastes offsite. Approaches to ensuring the safety of radioactive materials transport have been developed and include contingency plans for accidental spills.

Archaeology

Residual effects in this area may be associated with the decommissioning of the sewage lagoon and any remediation activities along the Winnipeg River. Small areas adjacent to the Winnipeg River have been previously excavated to create the existing facilities. An archaeologist will be available during excavations to ensure that no artifacts are lost. The end state of the project will return the area to a "natural" state.

<u>*Aboriginal Interests*</u>

Activities of specific interest to aboriginal communities are associated with historical and current uses of the Winnipeg River, the disturbance of sacred lands and artifacts as well as other aspects of interest to other groups. No particular valuable historical site has been identified and First Nations will kept apprised of any findings during excavations as well as being kept abreast of the progress of the project in general. The quality of the Winnipeg River will be maintained as described in previous sections.

7.2 APPROACH TO ASSESSING SIGNIFICANCE

A two-step procedure was used to determine the significance of these effects. The first step was to identify effects that were considered significant based on existing legal and social standards that would be applied to any project or activity. A residual environmental effect was automatically determined to be significant if it:

- contravenes an applicable federal, provincial or municipal standard such as water quality or CNSC regulations;
- displaces or endangers a designated or protected environmental feature or population;
- adversely affects established treaty and/or aboriginal rights;
- displaces a human community; or
- causes a proven chronic effect on human health.

The second step, which was applied to those effects that did not contravene the Step 1 criteria, involved evaluating significance within a framework developed specifically for this project. The object was to determine the degree to which VECs or VSCs were affected. The framework was developed following a review of procedures described in Natural Resources Canada (1996), Canadian Environmental Assessment Agency (1997) and Canadian Standards Association (in preparation).

Significance was determined by the degree of change from existing conditions and the value of the environmental components being affected. The measures of significance used include:

- the anticipated magnitude of disturbance in relation to existing conditions;
- the duration of the effect, is the time period over which the event will last;
- the occurrence of the effect, percent of entire decommissioning period when effects occur;
- the geographical area covered, specifically whether it went beyond the Project Study Area; and
- the reversibility of the environment affected, specifically whether the environment affected can be reversed within a reasonable time period.

The specific evaluation criteria used are presented in Table 7.2. Definitions of the terms are also provided in the glossary.

Table 7.2
Evaluation Criteria Used to Assess Significance of Residual Environmental Effects

Criteria	Rating*	Definition
Magnitude: extent of predicted disturbance compared to existing conditions	L M H	No measurable disturbance Measurable disturbance but no loss of function Measurable disturbance but with some loss of function
Duration: the time period over which the event will last	L M H	Short-term (less than a week) Moderate (less than a month) Long-term (continuous over at least a one year period)
Occurrence: percent of entire decommissioning period when effects occur	L M H	Less than 1% of the time Less than 30% of the time Greater than 30% of the time
Geographic extent: area over which the effect will occur	L M H	Project Study Area Local Study Area Regional Study Area
Reversibility: the ability of the environment affected to return to the state before the effect occurred	L M H	Effect naturally reversible within one year Effect reversible within one year but only with human intervention Effect not reversible within one year

* L = Low; M = Medium; H = High.

Note: These are generally qualitative judgements. In some cases, especially for duration and occurrence, different definitions related to human health and ecological risks would apply.

In carrying out the assessment, it became apparent that the most important criteria affecting the significance of the effect was magnitude. The nature of the project calls for sporadic activities carried out over a long period of time, with more intense level of activities at the beginning and at the end of the decommissioning project. Thus, the temporal aspect would not appear to be a dominant factor. Likewise, it was shown that, for most of the effects identified, the area affected would be relatively small in the regional context. Finally, the ability of an environmental component to recover from a stress – the reversibility of an effect – is largely linked to the severity or magnitude of an effect. Accordingly, the following rules were set:

Magnitude Rating	Requirements for Effect to be Significant
"H"	One additional criterion rated "H" and two other criteria that rated e
"M"	Two additional criteria rated "H" and two other criteria that rated either "H" or "M"
"L"	Four additional criteria rated "H"

Note: These rankings when applied individually do not imply that there is a significant effect.

7.3 SIGNIFICANCE ANALYSIS

Step 1

All activities met the criteria outlined in Step 1 and no violations were found.

Step 2

Application of the criteria outlined in Table 7.2 led to the results shown in Table 7.3.

Table 7.3
Significance Analysis

Component	Description of Residual Effect	*M*	*D*	*O*	*G*	*R*	Comment / Conclusion
Air Quality and Noise	Release of airborne radioactive particulates during operating and maintenance of the facility	**L**	**M**	**L**	**L**	**L**	***Not significant:*** *Radioactive emissions are regulated and controlled in accordance with derived release limits. The target for total emissions is a small percentage of the DRL. HEPA filters effectively control radioactive dust and where greater filtration is required, more filters can be added. The result is that the release of radioactive emissions is negligible.*
	Release of airborne radioactive particulates during disconnecting of services, decontamination retrieval and repackaging of materials and remediation	**L**	**L**	**M**	**L**	**L**	
	Release of airborne radioactive particulates during break-up of concrete canisters	**L**	**L**	**L**	**L**	**L**	
	Nuisance Dust and fine particulates from building demolition, and site restoration and rehabilitation	**L**	**M**	**L**	**L**	**L**	***Not significant:*** *A number of factors will limit the transport of nuisance dust to the licensed property area.*
	Production of methane gases from Landfill	**L**	**H**	**H**	**L**	**L**	***Not significant:*** *Effect is easily mitigated as venting is widely used technology for controlling methane gas build-up.*
	Noise during demolition and site restoration	**L**	**L**	**L**	**L**	**L**	***Not significant:*** *The preservation of the dense tree cover across the site will provide a natural noise barrier between site activities and potential noise receptors within the Project Study Area. Vibration effects would likely only be of concern within the Project Study Area to adjacent buildings and structures.*

Table 7.3 (continued)
Significance Analysis

Component	Description of Residual Effect	*M*	*D*	*O*	*G*	*R*	Comment / Conclusion
Surface Water Quality (hydrology)	Surface water contamination associated with migration of decontamination process water, the remediation of affected lands and buried services	**L**	**M**	**M**	**L**	**M**	***Not significant:*** *Decontamination process water will be sent to the ALWTC for treatment. Decontamination is normally done indoors and there is no opportunity for water to go anywhere except to the ALWTC drains.*
	Discharge of treated water flows into Winnipeg River (active and inactive)	**L**	**L**	**L**	**M**	**L**	***Not significant:*** *Releases controlled so that effluents remain below acceptable standards.*
	Leaks into surface water from in-situ trenches	**L**	**M**	**L**	**M**	**L**	***Not significant:*** *No migration of radioactive contaminants to surface water.*
Soil and Groundwater Contamination (geology and hydrogeology)	Contamination from leaks around existing facilities	**L**	**M**	**L**	**L**	**M**	***Not significant:*** *Contamination will be removed and only small amounts at levels to allow unrestricted use will remain. Amounts too small affect groundwater.*
	Soil and Groundwater contamination during operations	**L**	**M**	**L**	**L**	**M**	***Not significant:*** *Routine monitoring to ensure integ rity of facility.*
	Soil and Groundwater contamination during remediation	**L**	**L**	**L**	**L**	**M**	***Not significant:*** *Use of rain barriers, berms, to keep water from flowing away from site being remediated containment barriers to direct water to drains.*
	Leachate from WMA trenches	**L**	**M**	**M**	**L**	**M**	***Not significant:*** *The hydrogeological conditions at the WMA are favourable for in-situ management of the waste. There is no evidence of upward or lateral migration to date and scooping calculations suggest no significant migration from the WMA will occur (Appendix C). Monitoring performed as part of the follow-up will ensure no undetected migration from the WMA.*
	Leachate from remediated facilities	**L**	**M**	**M**	**L**	**M**	***Not significant:*** *Remediation plan measures will limit leachate to below acceptable standards.*
Terrestrial Biota	No effects identified						
Aquatic Biota	No effects identified						
Worker Health and Safety	No effects identified						
Public Health	No effects identified						
Socio-Economic	No effects identified						

Table 7.3 (continued)
Significance Analysis

Component	Description of Residual Effect	*M*	*D*	*O*	*G*	*R*	Comment / Conclusion
Physical and Cultural Heritage	Loss of resource use of Winnipeg River associated with sediment removal option	**L**	**L**	**L**	**M**	**L**	***Not significant:*** *Remediation will only be undertaken if there are no significant environmental effects.*
Land and Resource Use	Land-use restriction associated with in-situ disposal of radioactive waste	**L**	**H**	**L**	**L**	**H**	***Not significant:*** *Areas involved very small; especially relative to the total amount of land being released on site.*
	Land-use restrictions associated with in-situ disposal of non-radioactive waste	**L**	**H**	**L**	**L**	**H**	***Not significant:*** *Areas involved very small; land still useable for many purposes.*
Archaeology	Artifact loss during excavations near shores of Winnipeg River	**L**	**L**	**L**	**M**	**H**	***Not significant:*** *The Presence of an Archaeologist during excavations will ensure that artifacts are not destroyed or lost.*
Aboriginal Interests	General interest in the project especially as it affects the Winnipeg River. Special interest in artifact loss during excavations near shores of Winnipeg River	**L**	**L**	**L**	**M**	**H**	***Not Significant*** *Concerns about specific artifacts have been addressed under physical heritage and archaeological aspects. There will no significant effects on the wider concerns of First Nations' people with respect to the protection of the Winnipeg River.*

* L = Low; M = Medium; H = High.

7.4 CONCLUSION

It is concluded that the Whiteshell Laboratories Decommissioning Project, taking into account the appropriate mitigation measures, is not likely to cause significant adverse environmental effects.

8.0 CUMULATIVE EFFECTS

Section 16(1) of the *Canadian Environmental Assessment Act* requires that the environmental assessment include a consideration of cumulative environmental effects. Cumulative environmental effects are defined in the Agency's Practitioner's Guide (1999) as "changes in the environment that are caused by an action in combination with other past, present and future human actions". The following steps are used in determining the cumulative effects of the Whiteshell Laboratories Decommissioning Project:

- the identification of actions or works that in some way might interact with the project;
- the characterization of those actions or works in terms of the effects that might interact with those effects from the decommissioning project;
- the assessment of the interactions;
- the identification of any additional mitigation measures;
- the assessing of the significances; and
- follow-up measures.

8.1 IDENTIFICATION OF ACTIONS / PHYSICAL WORKS

A total of 30 actions/physical works were identified through consultation with people knowledgeable of the Local and Regional Study Areas and potential development. These actions/physical works are located either within the Local or Regional Study Areas defined for this assessment. The status of these actions/physical works have been determined according to three categories:

- past or ongoing;
- certain or reasonably foreseeable (i.e. are identified in an approved development plan); and
- hypothetical (i.e. no definitive information on proceeding is available).

A listing of the actions/physical works, their location with respect to the study areas and their current status is given in Table 8.1.

Table 8.1
Proposed Actions/Physical Works

Actions/Physical Works	Relevant Study Area	Current Status
Awanipark Residential Development	Local	Ongoing
Manitoba Hydro-Pointe du Bois Expansion	Regional	Ongoing
Pinawa, existing Sewage Treatment facility	Local	Ongoing
Pinawa Landfill	Local	Ongoing
Pine Falls Paper Company mill	Regional	Ongoing
Powerland Centre	Local	Ongoing
Rural Municipality of Lac du Bonnet (includes towns)	Local	Ongoing
Rural Municipality Whitemouth (includes towns)	Local	Ongoing
Technology Firms - ACSION (Whiteshell Irradiator), Channel, ECOMatters	Local	Ongoing
Underground Research Laboratory	Local	Ongoing
AECL's WM Privatization	Local	Hypothetical
Agricultural Expansion	Local	Hypothetical
Alternative Forest Products	Local	Hypothetical
Aqueduct Project	Local	Hypothetical
Call Centre	Local	Hypothetical
Education/Training Centre	Local	Hypothetical
Fish Farming, Hatcheries, etc	Local	Hypothetical
High Tech Centre	Local	Hypothetical
Market Gardening	Local	Hypothetical
National Wildlife Area	Local	Hypothetical
Natural Gas Co-operative	Local	Hypothetical
NEON project	Local	Hypothetical
Pinawa Industrial Park	Local	Hypothetical
Pinawa Residential/Commercial Expansion	Local	Hypothetical
Seven Sisters Falls Development	Local	Hypothetical
SunGro Peat Expansion	Local	Hypothetical
Tanco Expansion	Local	Hypothetical
Technology Firms - ASD opportunities B402	Local	Hypothetical
Tourism Expansion - TCT, adventure trips, river cruises	Local	Hypothetical
Wild Rice Production Increase	Local	Hypothetical

As recommended in the Agency's Practitioner's Guide, the scope of the cumulative effects assessment includes those past, ongoing and likely future actions/physical works that are certain and reasonably foreseeable. Ten actions in Table 8.1 were listed as “Ongoing”. None were deemed certain.

The effect of relevant *past* projects and activities, such as the past construction and operation of the Whiteshell Laboratories, nuclear bomb testing in the 1950s and 1960s, etc. are documented in the description of the existing environment in Section 5.0 (e.g. existing residual ^{137}Cs concentrations in sediments and soils). The cumulative effects of those past activities with the effects of the decommissioning project are therefore implicitly taken into account in the assessment of the project effects in Section 6.0. To complete the assessment of cumulative effects, therefore, the cumulative effects of the project with *ongoing* and foreseeable *future* projects are considered in this section.

8.2 CHARACTERIZATION OF RELEVANT ACTIONS / PHYSICAL WORKS

On the basis of the interviews conducted and a review of the actions and physical works, ten actions/physical works selected for further review were characterized in terms of their likely environmental effects on the VECs/VSCs considered in the environmental assessment. The VECs and VSCs were summarized in Section 5.6. Table 8.2 summarizes the potential environmental effects of each action/physical work and the respective VECs/VSCs that would be affected.

Table 8.2
Review of Potential Effects of Ongoing Actions/Physical Works on VECs

Name	Location	Possible *VEC* Effect	Comment
Awanipark Residential Development	2.5 km Upstream of Whiteshell Laboratories	Seepage from Septic Tanks to the *Winnipeg River*	Septic tank systems are designed so that the flow from the tanks will be adequately diluted by the tile beds and that no contaminants can reach the river. This and the distance from the outfall and consequent dilution of any contaminant that may leak into the river mitigate against any combination of effects from drainage from the Whiteshell Laboratories sewage lagoon.
Manitoba Hydro Point du Bois Power Station recent Expansion	25 km Upstream of Whiteshell Laboratories	Potential for higher flows resulting from increased power production to cause greater erosion of river bottom and re-suspend sediments and contaminate the *Winnipeg River*	The sediment review (see Appendix B) has indicated that the sediment contamination in the river adjacent to the outfall is at level which, under the most conservative assumptions, presents no threat to human health or the environment. In addition the amounts of contamination are small (1.3 GBq). It would appear that even if the sediments were re-suspended, there would be no effect on water quality. The greater flows associated with any possible and unlikely displacement would augment the already substantial dilution effect.
Pinawa, Existing Sewage Treatment Facility	10 km upstream	Flows from lagoon into the *Winnipeg River*	Discharges from sewage lagoons are designed to minimize effects on the receiving water body. The result is that contamination from the lagoon is likely to be minimal and have little effect on water quality. By the time the contaminant reaches Whiteshell Laboratories, 10 km downstream, dilution is likely to render this already small amount of contamination not only negligible but essentially undetectable.
Pinawa Landfill	East of Whiteshell Laboratories	Leachate into the *Winnipeg River*	The landfill ultimately drains into the Winnipeg River via the Pinawa Channel and Lac Du Bonnet, a distance of 30 kilometres. The landfill which is subject to Provincial jurisdiction is designed to have minimal effects on surface and groundwater and, by the time it reaches the Winnipeg River, dilution is likely to render this already small amount of contamination not only negligible but essentially undetectable. Given that small amounts of contaminants are released from Whiteshell, the likelihood of any significant for interaction between those two sources is very small.
Pine Falls Paper Company Mill – waste treatment facility	At mouth of Lake Winnipeg 50 km downstream	Flow from Treatment facility into the *Winnipeg River*	Whiteshell discharges are extremely small and the dilution effect over the distance involved is such that the small amount of contamination released at Whiteshell is likely to be not only negligible but essentially undetectable by the time it reaches the paper mill outfall.
Powerland Centre - Commercial Development	Downtown Pinawa	No effect identified	Interactions with environmental components are unlikely
Rural Municipality of Lac du Bonnet (including. town of Lac du Bonnet) Sewage Treatment Facility	10 km downstream	Flows from lagoon into the *Winnipeg River*	Discharges from sewage lagoons are designed to minimize effects on the receiving water body. The result is that contamination from the lagoon is likely to be minimal and have little effect on water quality. Very little contamination is expected from Whiteshell, and by the time the contaminants reach Lac du Bonnet, 10 km downstream, dilution is likely to render this already small amount of contamination not only negligible but essentially undetectable.
Rural Municipality of Whitemouth (including town of Whitemouth)	Below Seven Sisters, 4 kms upstream	Flows from lagoon into the *Winnipeg River*	Discharges from sewage lagoons are designed to minimize effects on the receiving water body. The result is that contamination from the lagoon is likely to be minimal and have little effect on water quality. By the time any contaminants reach Whiteshell Laboratories, 4 km downstream, dilution is likely to render this already small amount of contamination not only negligible but also essentially undetectable.

Name	Location	Possible *VEC* Effect	Comment
Technology Firms	At Whiteshell Laboratories site	No effect identified	Interactions with environmental components are unlikely
Underground Research Laboratory		Flows from tailing ponds into the *Winnipeg River*	Liquid emissions from the mine water settling pond and mined rock storage area reach the Winnipeg River through a convoluted path (first a small surface stream, then the Lee River, Lac du Bonnet and finally, the Winnipeg River.) The surface stream is dry most of the year and no discharges from URL reach the Lee River unless the conditions are quite wet -spring and fall). Very small amounts of contaminants will be discharged from Whiteshell Laboratories. Therefore, there is little chance of any additive effects.

8.3 INTERACTIONS WITH THE DECOMMISSIONING PROJECT

This cumulative effects assessment must build upon the results of the analysis presented in previous sections of this report. Table 7.1 provides a summary of the residual effects from the project. The cumulative effect assessment focuses on the VECs and VSCs. The only VEC that the proposed actions/physical works outlined in Table 8.2 can affect is the Winnipeg River and by extension, the Sport Fishery.

The assessment also shows that the likelihood of interaction with between residual effects from the Whiteshell Laboratories Decommissioning Project and effects from the ten proposed actions/physical works is very small owing to the limited amount of contaminants released into the Winnipeg River from those actions and physical works. This is because:

- The design of the effluent control systems (septic systems are designed to produce acceptable effluents that will not adversely affect ground or surface water).
- The points of discharge or influence are so far away from the River that no significant levels of contaminants are likely to reach the river (e.g. the leachate from the Pinawa Landfill).
- Some actions/physical works affect a stretch of the Winnipeg River well downstream of the decommissioning project (e.g. URL). Others simply do not have any significant environmental effects (e.g. Powerland and Technology Firms).

8.4 CONCLUSIONS

A review of proposed and existing actions and physical works in areas surrounding the Whiteshell Laboratories site reveals that there is no measurable interactions between the effects of the ten projects and those of the Whiteshell Laboratories Decommissioning Project. It follows that there is no need for mitigation beyond the proposed decommissioning project and no significant cumulative effects are expected. As such, the only follow-up programs necessary are those related to the project as a whole. These are outlined in Section 9.0. The extent of the proposed follow-up actions including monitoring activities will allow for the identification of any unlikely cumulative effects.

9.0 FOLLOW-UP PROGRAM

In this section, the goals and description of the proposed follow-up program are provided for the operational shutdown of the facilities and the three phases of the decommissioning program. The monitoring program in effect during operations of the Whiteshell Laboratories will be used as a basis for the proposed program. However, the existing monitoring program will be subject to change as a result of discussions with regulatory agencies, information obtained, periodic review of the data, response to public concerns and actual performance of the decommissioned facilities.

9.1 GOALS AND OBJECTIVES

The purpose of follow-up is to:

- optimize the monitoring and surveillance program;
- confirm that appropriate mitigation measures are implemented;
- develop appropriate responses to unforeseen effects; and
- identify effects of the project that may not have been predicted.

Follow-up activities include monitoring, surveillance and inspection, all of which may require data collection, analysis, evaluation and reporting. Additional mitigation measures may be implemented as a result of follow-up.

9.2 DETAILED DECOMMISSIONING PLANS

Detailed Decommissioning Plans (DDP) document health, safety and environmental considerations for implementation of decommissioning work. DDPs will be prepared for each nuclear facility, outlining the proposed mitigation measures that will be in place to reduce or eliminate hazards associated with decommissioning. Individual DDPs form the basis for approval of decommissioning by the CNSC.

DDPs for activities in Phase 2 and Phase 3 will be modified as required, based on the monitoring and surveillance activities in the earlier phase(s). As such, it is not possible to present specific changes to the existing monitoring program for activities in later phases until the surveying and monitoring activities proposed for the majority of facilities have been undertaken.

9.3 ENVIRONMENTAL MONITORING PROGRAM

AECL maintains a comprehensive Site Environmental Monitoring Program for Whiteshell Laboratories to ensure that radiation doses as a result of releases of radioactive material remain well below the annual dose limits for members of the public. These annual doses are specified in the *Nuclear Safety and Control Act* and are as low as reasonably achievable (ALARA), taking into account economic and social factors. The primary objectives of the Environmental Monitoring Program are:

- to provide a quantitative record of radioactive contaminants in the environment resulting from operation of the site, which will permit assessment of actual or potential radiation doses to critical groups and populations;
- to provide data to confirm compliance with regulatory limits and other guidelines and to provide public assurance of compliance;
- to provide verification of the effectiveness of facility operation and control of emissions and the adequacy of effluent monitoring; and
- to provide data to verify or refine the assumptions and models used in DRL calculations for the site, where applicable.

The following secondary objectives are also considered in the design of the site Environmental Monitoring Program:

- to provide data for trend analysis;
- to provide baseline data and capability for monitoring and assessment in the event of emergency conditions; and
- to provide information and assurance to the public about radiological and non-radiological hazards involved in site operations.

AECL maintains a comprehensive Site Verification Monitoring Program for Whiteshell Laboratories. Monitoring locations on airborne and liquid effluent streams are representative of the final discharge to the off-site environment and may include the combined discharge from a number of facilities. Where necessary, additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at that location. An overview of environmental monitoring activities at Whiteshell Laboratories is shown in Table 9.1.

Table 9.1
Summary of Environmental Monitoring Activities at the Whiteshell Laboratories

Environmental Component	Sampling Location	Parameters	Sampling Frequency
Air	Whiteshell Laboratories perimeter, WMA, off-site	ã (TLDs)	A
Surface Water	Winnipeg River	-spec., ^{90}Sr, non-radiological	D-W
	WMA Ditch	Gross á/â, ã-spec., ^{90}Sr	M
Groundwater	WMA	Gross á/â	S/A
	FIG,	“	A/R
	Misc. (Cs ponds, landfill, B200)	“	A/R
Sediments	Winnipeg River	Gross á/â, ^{137}Cs	A
Fish	Winnipeg River	Gross á/â, ^{137}Cs, ^{40}K	A
Vegetation	Whiteshell Laboratories perimeter	Gross á/â, ^{137}Cs, ^{90}Sr	A
Land Surveys	On-site, off-site	ã-spec	A

D: Daily   M: Monthly   S/A: Semi-annually
W: Weekly   A: Annually   A/R: As required

Effluent streams are monitored for all radionuclides or groups of radionuclides that are known to be, or are likely to be, present in the effluent, and that are likely to be a significant component of emissions via the monitored effluent stream. Monitoring is conducted by direct measurement or by sampling and analysis.

An outline of the existing monitoring programs and schedules at Whiteshell Laboratories is provided below. Details of these programs may be found in specific documents issued under AECL's Environmental Protection Program.

- Radiological Environmental Program – this program provides details concerning radiological environmental monitoring of the following parameters:

- air;
- surface water;
- fish from Winnipeg River;
- sediments in the Winnipeg River;
- groundwater;
- perimeter vegetation;
- land gamma surveys of roads; and
- off-site deposition.

Details of monitoring location, frequency of sample collection and analytical methods and parameters are provided in Tables 9.2 to 9.9.

Table 9.2
Whiteshell Laboratories Environmental Monitoring - Air

Monitoring Location	Location Code	Collect/Analysis Frequency
ON-SITE STATIONS		
(a) Controlled (Active) Area Fence (4 chips/location)		
AAF South Fence (3 locations)	AAF	A
AAF East Fence (3 locations)	AAF	A
AAF North Fence (3 locations)	AAF	A
AAF West Fence (3 locations)	AAF	A
(b) Waste Management Area Perimeter Fence (4 chips/location)		
WMA West Fence (3 locations)	WMP	A
WMA North Fence (3 locations)	WMP	A
WMA East Fence (3 locations)	WMP	A
WMA South Fence (locations)	WMP	A
(c) Canister Area Perimeter Fence (4 chips/location)		
CAP North Fence (2 locations)	CAP	A
CAP East Fence (2 locations)	CAP	A
CAP South Fence (2 locations)	CAP	A
CAP West Fence (2 locations)	CAP	A
SITE BOUNDARY STATIONS		
Ambient Radiation Monitoring Stations (4 chips/location)		
Whiteshell Laboratories Perimeter, 3.2 km North, ARMS1	001	A
Whiteshell Laboratories Perimeter, 4.3 km ESE, ARMS2	002	A
Whiteshell Laboratories Perimeter, 3.4 km SSE, ARMS3	003	A
Whiteshell Laboratories Perimeter, 2.2 km W, ARMS4	004	A
Whiteshell Laboratories Perimeter, 2.4 km NW, ARMS5	005	A
OFF-SITE STATIONS		
Pinawa (8 chips/location)		
Pinawa Town Yard, ARMS6	006	A
Pinawa Hospital	007	A
Pinawa, Kelsey House	008	A

Legend: A - Annual

Table 9.3
Whiteshell Laboratories Environmental Monitoring - Surface Water

Sample Location			Sample Collection		Analytical Methods And Parameters				
Location Name	**Location Code**	**Comment**	**Freq.**	**Sample Type**	**Gross Beta**	**Gross Alpha**	**Tritium**	**Gamma Spec.**	**^{90}Sr**
WINNIPEG RIVER WATER									
Pinawa	SFD	Water Treatment Plant	D	Grab	Mcd	Mcd		Mcd	Mcd
Lac du Bonnet	LDB	Water Treatment Plant	D	Grab	Mcd	Mcd		Mcd	Mcd
Whiteshell Laboratories Downstream boundary	K11		W	Grab	Mcw	Mcw		Mcw	Mcw
Great Falls	GFD	Water Treatment Plant	D	Grab	Mcd	Mcd		Mcd	Mcd
WASTE MANAGEMENT AREA DITCH WATER									
East of WMA	WMA-1	Furthest east of WMA	Me	Grab	Me	Me		Me	A/R
East of WMA	WMA-2	Closer to WMA	Me	Grab	Me	Me		Me	A/R
SE of WMA	WMA-3	SE corner of WMA fence	Me	Grab	Me	Me		Me	A/R
SW of WMA	WMA-4	Between WMA & Canisters	Me	Grab	Me	Me		Me	A/R
SW of Canisters	WMA-5		Me	Grab	Me	Me		Me	A/R
West of Canisters	WMA-6		Me	Grab	Me	Me		Me	A/R
Road West of Canisters	WMA-7		Me	Grab	Me	Me		Me	A/R
North ditch	WMA-8	Ditch to RM of Lac Du Bonnet	Me	Grab	Me	Me		Me	A/R
West ditch	WMA-9	Ditch to Winnipeg River	Me	Grab	Me	Me		Me	A/R
Drill site road	WMA-10		Me	Grab	Me	Me		Me	A/R

Legend:

D - Daily sample.
Mcd - Monthly composite of daily samples.
Me - Monthly event, when the ditch contains water.
W - Weekly sample.
Mcw - Monthly composite of weekly samples.
A/R - As Required.

Table 9.4

Whiteshell Laboratories Environmental Monitoring – Fish

Sample Location			Analysis Method/Parameter			
Location Name	**Location Code**	**Comments**	**Gross Beta**	**Gross Alpha**	**^{137}Cs**	**^{40}K**
FISH FROM WINNIPEG RIVER **- Walleye (pickerel) and White Sucker**						
Pinawa	Jxx	Background – Upstream of Seven Sisters Dam	A		A	A
0.5 km downstream of Whiteshell Laboratories Outfall	K03		A		A	A
5 km downstream of Whiteshell Laboratories outfall	K23		A		A	A

Legend: A – Annual.

Notes: Minimum of 6 Walleye and 6 White Sucker at each location.
Mass (kg), length (cm) and radioactivity (Bq/kg) of each species to be recorded.

Table 9.5

Whiteshell Laboratories Environmental Monitoring - Sediments

Sample Location		Analysis Method/Parameter		
Location Code	**Distance from the Site Outfall (km)**	**Gross Beta**	**Gross Alpha**	**^{137}Cs**
UPSTREAM OF THE WHITESHELL LABORATORIES OUTFALL				
J04	-0.76	A	A	A
J02	-0.37	A	A	A
DOWNSTREAM OF THE WHITESHELL LABORATORIES OUTFALL				
OFL	0.0	A	A	A
K01	0.15	A	A	A
K03	0.52	A	A	A
K05	0.79	A	A	A
K14	2.56	A	A	A
K19	3.48	A	A	A
K23	4.78	A	A	A
K30	13.06	A	A	A

Legend:
A - once per annum.

Notes:
3 samples of the top 1 cm to be taken at each location.
Results to be reported as Bq/m^2 and Bq/g.

Table 9.6
Whiteshell Laboratories Environmental Monitoring - Groundwater

Sample Location			**Sample Collection**		**Analytical Methods and Parameters**	
Location Name	**Location Code**	**Comment**	**frequency**	**Sample Type**	**Gross Beta**	**Gross Alpha**
WASTE MANAGEMENT AREA PIEZOMETERS						
WMA Centre North	P61-1	3 m deep	S	Grab	S	S
WMA Centre North	P61-2	6 m deep	S	Grab	S	S
WMA Centre North	P61-3	9 m deep	S	Grab	S	S
WMA West	P62-1	8.8 deep	S	Grab	S	S
WMA West	P62-2	3	S	Grab	S	S
WMA West	P62-3	6.4	S	Grab	S	S
WMA North	P63-1	6.1	S	Grab	S	S
WMA North	P63-2	8.5	S	Grab	S	S
WMA North	P63-3	3	S	Grab	S	S
WMA East	P64-1	3	S	Grab	S	S
WMA East	P64-2	6.1	S	Grab	S	S
WMA East	P64-3	9.1	S	Grab	S	S
Outside WMA	P23..	Background	S	Grab	S	S
WASTE MANAGEMENT AREA WELLS						
WMA Deep	S01		S	Grab	S	S
WMA Deep	S03		S	Grab	S	S
WMA Deep	S04		S	Grab	S	S
WMA Deep	S05		S	Grab	S	S
WMA Deep	S10		S	Grab	S	S
WMA Deep	S12		S	Grab	S	S
WMA Water Table	T01		S	Grab	S	S
WMA Water Table	T03		S	Grab	S	S
WMA Water Table	T04		S	Grab	S	S
WMA Water Table	T05		S	Grab	S	S
OTHER WATER TABLE WELLS						
FIG Area	FIG 1		S	Grab	S	S
FIG Area	FIG 2		S	Grab	S	S
FIG Area	FIG 200	Near Bog	S	Grab	S	S
FIG Area	FIG 300	Near Bog	S	Grab	S	S
SUPPLY WELLS						
Building 503	Bldg 503	Water supply to bldg 503	S	Grab	S	S
Building 423	Bldg 423	Water supply to bldg 423	S	Grab	S	S
MISCELLANEOUS						
WMA HLW tank tray	WMT	Checks for leak from high level liquid storage	M	Grab	M	M
Building 200	P	Piezometers	A/R	Grab	A/R	A/R
Cesium Pond	CSP	Experimental pond near WMA	A/R	Grab	A/R	A/R
Inactive Landfill	ILS		A/R	Grab	A/R	A/R

Legend:
S - Every 6 months.
M - Monthly.
A/R - As required.

Table 9.7

Whiteshell Laboratories Environmental Monitoring - Perimeter Vegetation

Sample Location			Analysis Method/Parameter			
Location Name	**Location Code**	**Comments**	**Gross Beta**	**Gross Alpha**	**^{90}Sr**	**^{137}Cs**
ARMS1	001		A	A	A	A
ARMS3	003		A	A	A	A
ARMS4	004		A	A	A	A

Legend:
A – Annual.

Notes:
Results to be reported in Bq/m^2, Bq/g (dry weight) and Bq/g (wet weight).

Table 9.8

Whiteshell Laboratories Environmental Monitoring
Land Gamma Surveys of Roads

Monitoring Route	Location Code	Survey Freq.
ON-SITE CONTROLLED (ACTIVE) AREA ROADS		
Building 401 into active area	A05	A
South side building 300	A06-A07	A
Approach to Hot Cells	A08-A09	A
West side of building 300	A10	A
Building 519 to building 200	A11	A
Sides of building 200 and building 411	A12 - A14	A
Building 200 to building 409	A18 - A19	A
Building 409 to East gate	A19 - A20	A
East gate to building 401	A17	A
ON-SITE SUPERVISED (FENCED) AREA ROADS:		
Building 401 to West gate	A04	A
West gate to building 408	A02	A
Building 408 to building 504	A01	A
South side of building 504	A01	A
ON-SITE UNCONTROLLED (OUTER AREA) ROADS:		
East gate to sewage lagoon road	A21- A22	A
Lagoon road	A23	A
Lagoon to site North boundary	A24	A
Drill site road		A
WMA road and landfill	A25-A35	A
OFF-SITE ROADS:		
Plant road (site to hwy. 211)		A
Highway 211		A
Pinawa		A
Highway 520 (hwy 211 to tower road)		A
Tower road		A
Riverland Road (Site to Lac du Bonnet Bridge)		A
Lac du Bonnet		A
Hwy 11 (Lac du Bonnet to Brookfield)		A
Hwy 11/Hwy307 (Brookfield to Seven Sisters)		A
Seven Sisters		A

Legend: A – Annual.

Table 9.9
Whiteshell Laboratories Environmental Monitoring - Deposition

Sample Location		**Collect / Analysis Freq.**				
Location Name	**Location Code**	**Gross Beta**	**Gross Alpha**	**Gamma Spec**	**^{90}Sr**	**^{137}Cs**
OFF-SITE:						
Pinawa Town Yard	006	M	M	A / R	M	A / R

Legend:
M - Monthly .
A / R - As Required.

Note:
Precipitation / deposition (total wet and dry). collected continuously in a plastic-lined open container.

- Non-Radiological Environmental Program – this program provides details concerning non-radiological monitoring for the following parameters:

  - BOD
  - fecal coliform
  - pH
  - total phosphorus
  - conductivity
  - total suspended solids
  - phenolics
  - oil / grease
  - chromium
  - copper
  - iron
  - lead
  - nickel
  - zinc
  - mercury

These parameters are monitored in the ALWTC tanks, sewage lagoon discharges and outfall effluent. The current sampling schedule for non-radiological liquid effluent sampling is provided in Table 9.10.

Table 9.10
Whiteshell Laboratories Non-Radiological Liquid Effluent Sampling Schedule

Parameter	Building 200 Laundry	(ALWTC) Decontam	Tanks R&D	WR-1	Site Outfall	Lagoon
BOD (5 day)*						Dis
Fecal Coliform*						Dis
pH	Dis	Dis	Dis	Dis	W	Dis
Phosphorus, Total	W	M	M	M	W	Dis
Conductivity	Dis	Dis	Dis	Dis	W	Dis
Tot. Susp. Solids	W	Dis	Dis	Dis	W	Dis
Phenolics (4AAP)	M	M	M	M		Dis
Oil/grease	W	Dis	Dis	Dis	W	Dis
Chromium	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Copper	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Iron	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Lead	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Nickel	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Zinc	Mcw	Mcw	Mcw	Mcw	Mcw	Dis
Mercury	Mcw	Mcw	Mcw	Mcw	Mcw	Dis

Legend:

Dis	Per discharge:	Approximately 15 times a month for laundry tanks. Approximately 2 times a month for decontam tanks. Approximately 2 times a month for R&D tanks. Approximately 2 times a month for WR-1 tanks. 2 times a year for sewage lagoon (average of 3 samples each discharge).
M	Monthly grab sample:	Normally taken 1st week of the month, or 1st discharge of the month in case of batch discharges.
Mcw	Monthly composite of weekly grab samples.	
W	Weekly grab sample:	Normally taken 1st discharge of week in case of batch discharges.
Wcd	Weekly composite of daily samples or samples taken at each discharge.	
*	Analysis of BOD and Fecal Cloakroom is by the Provincial Laboratory.	

9.4 SITE EFFLUENT VERIFICATION MONITORING PROGRAMS

AECL maintains comprehensive Site Effluent Verification Monitoring Programs for the Whiteshell Laboratories site to ensure that radiation exposures as a result of any releases of radioactive material remain well below the annual dose limits. These doses are specified in the *Nuclear Safety and Control Act*, and as low as reasonably achievable (ALARA), taking into account economic and social factors. The primary objectives of the Site Effluent Verification Monitoring Program are:

- to verify compliance with regulatory emission limits and conformance with AECL's internal emission levels and guidelines;
- to provide a quantitative record of radioactive emissions to the environment that will permit assessment of potential radiological effects on people and the environment as a result of site operations;
- to provide independent verification of site and facility operational performance with respect to radioactive emissions; and
- to provide warning of abnormal emissions that may require investigation or corrective action.

- Radiological Air Effluent Verification Monitoring – details of this program are provided in Table 9.11. For each monitored stream, routine reports provide information on:

    - the period monitored;
    - total weekly effluent volume (m^3) discharged;
    - total release (loading) in Bq of each monitored parameter for the week; and
    - a summary of any failures or unavailability of measurements or equipment.

Table 9.11
Whiteshell Laboratories Air Effluent Sampling and Analysis Schedule – Effluent Verification Monitoring

Sample Location		Sample Collection		Analytical Method & / or Parameter			
Location Name	**Location Code**	**Freq.**	**Method**	**Gross Beta**	**Gross Alpha**	**Tritium**	**Gamma Spec**
Bldg. 100 Stack	WR1	Cont	GFA Filter	W	W		W
		Cont	Charcoal Filter				W
		Cont	Bubbler			W	
Bldg. 100, SDR Exhaust Duct		Cont	GFA Filter	W	W		W
		Cont	Charcoal Filter				W
Bldg 200 V1F	AW	Cont	GFA Filter	D5	D5		D5
			Charcoal Filter				W
Bldg 200 V2F		Cont	GFA Filter	D5	D5		D5
			Charcoal Filter				W
Bldg 300 HCF	DA-1	Cont	GFA Filter	D5			D5
	DA-2	Cont	Charcoal Filter				W
	DA-3	Cont	Millipore Filter		D5		
Bldg 300 IFTF	DA-5	Cont	GFA Filter	D5			D5
		Cont	Charcoal Filter				W
	DA-4	Cont	Millipore Filter		D5		
Bldg 300 Lab 2-136	DA-7	Cont	GFA Filter	D5	D5		
WMA Compactor	WMA	A/R	GFA Filter	A/R	A/R		A/R
WMA Incinerator		A/R	GFA Filter	A/R	A/R		A/R

Legend:
Cont - The air effluent is measured by passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, and charcoal or silver zeolite for radioiodine, and a water bubbler for tritium.
D5 - Daily during normal workdays.
W - Weekly.
A/R - As required, continuous sample when facility is operating.

- Radiological Liquid Effluent Verification Monitoring – details of this program are provided in Tables 9.12 and 9.13. For each monitored stream, the following information is given in routine reports:

    - the period monitored;
    - total monthly (if applicable) weekly effluent volume (litres) discharged;
    - total release (loading) in Bq of each monitored parameter for the period;
    - the average concentration (Bq/L) of each monitored parameter; and
    - a summary of any failures or unavailability of measurements or equipment.

Table 9.12
Whiteshell Laboratories Liquid Effluent Monitoring Locations

Sample Location			Source Monitored	Flow Measurement		
Location Name	**Location Code**	**Location**		**Method**	**Devices**	**Frequency**
Whiteshell Laboratories Site						
Site Outfall	OFS	Bldg 422	Sewer that discharges to Winnipeg River	Continuous integrated	Weir & ultrasonic level	Continuous
Sewage Lagoon	SL2	Sewage lagoon outlet	Semi-annual discharge of domestic sewage lagoon	Depth of lagoon water	Manual depth measurement	Each discharge
Ditch north of WMA	8	Ditch north of WMA	Surface water from the Waste Management Area	not measured		
Ditch west of WMA	9	Ditch west of WMA	Surface water from the Waste Management Area	not measured	.	
Building 200						
Laundry Tank 801	TK801	Bldg 200	Laundry	Tank Volume	Level gauge	Each discharge
Laundry Tank 802	TK802	Bldg 200	Laundry	Tank Volume	Level gauge	Each discharge
Decontamination Tank 803	TK803	Bldg 200	Decontamination facility	Tank Volume	Level gauge	Each discharge
Decontamination Tank 804	TK 804	Bldg 200	Decontamination Facility	Tank Volume	Level gauge	Each discharge
R&D Tank 805	TK805	Bldg 200	Building 300 LLW	Tank Volume	Level gauge	Each discharge
R&D Tank 806	TK806	Bldg 200	Building 300 LLW	Tank Volume	Level gauge	Each discharge
WR1 Tank 808	TK808	Bldg 200	WR1 Reactor LLW drains	Tank Volume	Level gauge	Each discharge
WR1 Tank 809	TK809	Bldg 200	WR1 Reactor LLW drains	Tank Volume	Level gauge	Each discharge

Table 9.13
Whiteshell Laboratories Liquid Effluent Sampling and Analysis Schedule
Effluent Verification Monitoring

Sample Location		Sample Collection		Analytical Method & / or Parameter									
Location Name	**location Code**	**Freq.**	**Method**	**Beta Screen**	**Gross Beta**	**Gross Alpha**	**Tritium**	**Gamma Spec Liquid**	**Gamma Spec Dry**	**Sr-89**	**Sr-90**	**Pu**	**Uranium**
Whiteshell Laboratories Site													
Site Outfall	OFS	Cont	Auto	D5	Wc	Wc	Mc	Wc	Mc	Mc	Mc	Mc	Mc
Sewage Lagoon	SL2	Disch	Auto		Disch	Disch		Disch			Disch		
Ditch north of WMA	8	Me	Grab		Me	Me		A/R					
Ditch west of WMA	9	Me	Grab		Me	Me		A/R					
Building 200													
Laundry Tank 801	TK801	Disch	Grab		Disch	Mc		Mc			Mc		
Laundry Tank 802	TK802	Disch	Grab		Disch	Mc		Mc			Mc		
Decontamination Tank 803	TK803	Disch	Grab		Disch	Disch		Disch			Disch		
Decontamination Tank 804	TK804	Disch	Grab		Disch	Disch		Disch			Disch		
R&D Tank 805	TK805	Disch	Grab		Disch	Disch		Disch			Disch		
R&D Tank 806	TK806	Disch	Grab		Disch	Disch		Disch			Disch		
WR1 Tank 808	TK808	Disch	Grab		Disch	Disch		Disch			Disch		
WR1 Tank 809	TK809	Disch	Grab		Disch	Disch		Disch			Disch		

Legend:
D5 - Daily on normal weekdays.
Disch - Per discharge, twice a year for the sewage lagoon, as required for building 200.
Wc - Weekly composite, composite of samples collected during the week.
Mc - Monthly composite, composite of samples collected during the month.
Me - Monthly, when ditches have water, usually after a rain or snow melt.

- Personnel Radiation Dosimetry – this program provides data on occupational radiation doses and is part of AECL's Radiation Protection Policy #40301. The health and safety of AECL employees and the public, as a result of AECL operations, are governed by federal legislation under the *Nuclear Safety and Control Act* and Regulations. Administration of the *Act* and Regulations is performed by the CNSC.

9.5 MONITORING AND SURVEILLANCE FOR DECOMMISSIONING

Drivers

- For the decommissioning period, the monitoring program will be modified to reflect any new potential release pathways (both radioactive and non-radioactive).
- Fiscal responsibility (develop the best monitoring program possible for the resources invested).
- Environmental responsibility (monitor all parameters that are currently thought to be important).
- Temporal responsibility (the program will continue for about 60 years and knowledge will change over that period).

Environmental monitoring during the decommissioning period will be conducted in accordance with AECL's Environmental Protection Program, part of which has been outlined in Section 9.3. Monitoring and/or resurveying is built into each of the three phases of decommissioning. For monitoring requirements arising from decommissioning but not covered in the Environmental Protection Program, appropriate procedures will be developed that will meet or exceed federal and provincial regulatory requirements. Whiteshell Laboratories procedures and protocols for Emergency Preparedness will be updated to include decommissioning activities.

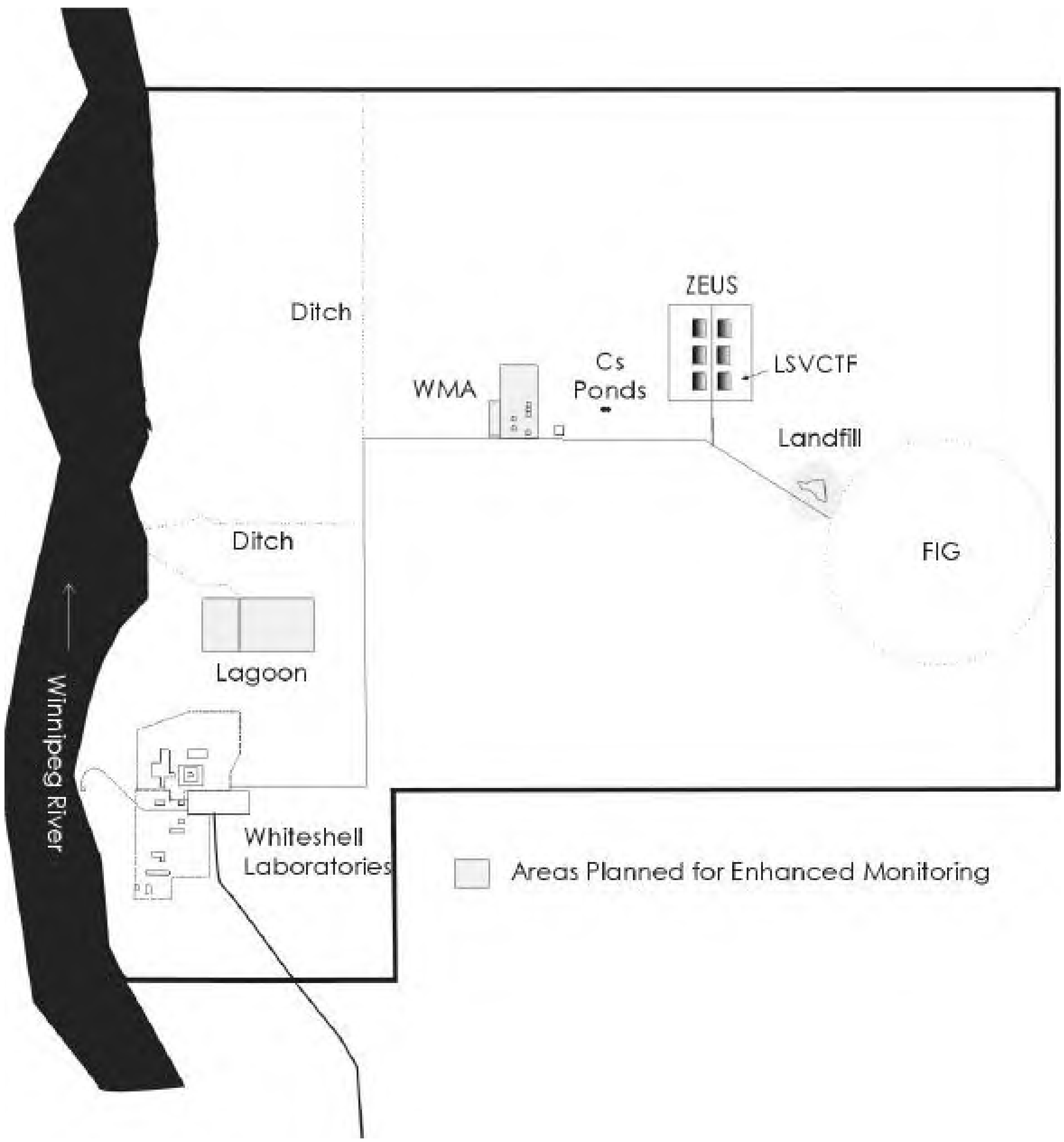
A post-decommissioning monitoring program will be established for those areas where a potential need is identified, such as in remediated sites, or in areas such as the Waste Management Area where low-level radioactive materials remain in-situ. The degree of monitoring and surveillance established for each area will be commensurate with radiological hazards or other hazards.

While baseline information is available with respect to most of the decommissioning activities to be undertaken, in some circumstances, baseline information may need to be gathered in order to define and carry out follow-up activities. One such example is the Winnipeg River, where an investigation of the river around and downstream of the outfall has been carried out as part of the CSR (See Appendix B.1).

A further area where some baseline work will be necessary during decommissioning is for air quality parameters affected by decommissioning activities. Airborne dust is the principal issue here; however, in order to properly interpret the data, meteorological data will also be needed. This aspect is discussed in the next section.

In addition, there are three further areas where additional follow-up monitoring can be envisaged at this time. The first is the waste management area where a special investigation to characterize the potential pathways for movement to the surface or laterally was carried out in the fall of 2000. (See Section 4.3.1 for a brief description of the program and the results to date) Although they are not considered to represent a hazard, for precautionary reasons, some follow-up monitoring is also proposed for the inactive landfill and the sewage lagoon. Each of these three areas is shown on Figure 9.1.

Figure 9.1
Affected Lands – Follow-Up Monitoring Program Map



The key disciplines required to carryout the Monitoring and Surveillance activities at the site are security, radiation protection, environmental monitoring and building/infrastructure maintenance staff. Fire fighting is also required but will likely be provided on a local community sharing basis. AECL will maintain adequately trained resources in each of these areas consistent with carrying out the elements of the Monitoring and Surveillance plans defined for the facility interim end states and the remaining operational support facilities.

9.5.1 Follow-Up Monitoring for Air and Meteorology

The strategy for air quality monitoring is premised on the concept that there are two monitoring states namely:

"Dormant", "Stand-by" or "Waiting" State

- This state occurs during a monitoring and surveillance period when decommissioning activities are limited.

"Active" State

- This state occurs during a period of decontamination or decommissioning. Activities likely to occur during this state include digging of soil, sandblasting buildings and demolishing buildings.

During the "dormant" state, the following is proposed:

- monitor once per season for air quality parameters of concern (dust, PM_{10}, radionuclides);
- monitor continuously for meteorological parameters (wind speed, wind direction, temperature, rainfall); and
- monitor at current locations (i.e. where there are existing state monitoring stations only).

During the "active" state, it is proposed to monitor:

- air quality parameters of concern (program to suit the activity involved);
  - dust, PM_{10}, radioactivity – 24 hour averages;
  - odour – trained nose on-site during the process;
- monitor continuously for meteorological parameters (wind speed, wind direction, temperature, rainfall); and
- monitor around the active area at upwind (one monitor) and downwind (3 monitors at various distances) locations.

It is also suggested that there be a review or audit after the first demolition projects. This audit would:

- review and analyze all monitoring data from the previous year;
- review all monitoring activity and add/subtract monitoring tasks for future monitoring as appropriate;
- review the methodology being used and adjust for future monitoring if necessary; and
- review parameters being monitored against the issues-of-the-day and adjust future monitoring requirement as necessary to address any new issues.

The reports would be prepared annually and/or after each "active" cycle, whichever comes first.

9.5.2 Follow-Up Monitoring Waste Management Area

In the fall of 2000, a program of trench cover sampling and coring adjacent to the trenches was carried out to confirm the hypothesis that there is no (significant) upward or lateral migration from the trenches. As noted earlier, a detailed description of this program and its results can be found in Appendix C.

A part of this investigation was the evaluation of hydrographs from the WMA area to confirm that the area is, for the majority of the time, a water discharge zone as originally concluded by investigators from the University of Waterloo. Part of the follow-up program will be the annual evaluation of the key hydrographs and evaluation of any potential changes to the flow pattern.

A further element of the follow-up program will be the installation of a few groundwater quality wells which will be established in key locations close to the waste trenches. The bcations and monitoring details for these wells will be established following a data quality objectives protocol and discussions with the CNSC. Information from the ongoing environmental monitoring programs noted in Section 9.3 and the results of the recent investigations (Appendix C) in the trench area will be considered in developing the details of this program.

As discussed elsewhere in this document (Section 4.3.1), selective removal of certain trenches or elements of certain trenches is contemplated. In anticipation of at least some partial relocation, a plan will be developed to characterize the wastes at the time of relocation in order to strengthen the understanding of the basis for the waste inventory which has been developed from historic records. This sampling/characterization plan will be developed as part of the planning for selective trench relocation through a data quality objectives protocol and reviewed with the CNSC prior to implementation.

Confirmation of in-situ disposal of LLW as the final end state will be subject to regulatory review and approval. The safety case will be prepared to address all the basic requirements applicable to the long-term aspects of radioactive waste disposal. Those aspects are currently documented in CNSC Regulatory Policy R-104. The basic requirement is to minimize the burden on future generations and to protect the environment and human health. The maximum acceptable risk is 10^{-6} fatal cancers and serious genetic effects in a year. For the WMA trench environment a control period of up to 200 years (the period required for ^{90}Sr and ^{137}Cs to decay to background) is required. The data required to support the safety case for the final end state will be collected through the updated follow-up monitoring program. The safety case will be supported by an environmental assessment.

9.5.3 Follow-Up Monitoring for Inactive (Non-Radioactive) Landfill

The inactive (non-radioactive) landfill was placed into operation to manage non-radioactive and non-hazardous wastes, excluding food wastes. The landfill is less than 10 m in height and covers an area of less than 1 ha.

The landfill is located at a high point in the local terrain approximately 2 km east of the main site immediately north-west of the FIG (Figure 9.1). The surficial geology in this area is mainly sand and gravel which is underlain by the following units: lacustrine clay; clayey-silty-sand till; bouldery gravel; and bedrock. The surficial geology is illustrated in Figure 5.13 and in cross-section in Figure 5.14.

The landfill is located in a recharge zone and water from the landfill moves either toward the Winnipeg River (located 2.3 km to the west) or northeast towards a large black spruce and sphagnum bog.

Typical materials managed in the landfill include plastic, paper, wood, cardboard, glass and building materials. There is some possibility, however, that the landfill site may still have some radioactivity associated with instances of inadvertent placement of radioactive materials associated with industrial waste deposited in the area, although radioactive materials have been removed from the landfill and any resultant contamination has been remediated. Gross alpha and beta activity has been monitored at the periphery of the landfill for several years to ensure these actions are effective and will continue as required.

The landfill will remain fully operational for Phases 1 and 2. A plan for remediation of the landfill will be developed during Phase 2 and an environmental evaluation will be carried out to provide input to the remediation plan.

During Phase 1, monitoring of gross alpha and beta activity will continue. Monitoring will be conducted both at the periphery of the landfill and on the materials to be placed in the landfill, to ensure no further inadvertent contamination of the landfill with radioactive or hazardous materials occurs.

Due to the relatively permeable nature of the surficial sediments on which the landfill is located, and the fact that the landfill is located in a groundwater recharge area, there may be a need to monitor groundwater up and downgradient of the landfill to ensure the groundwater is not impaired such that loadings to the receiving environment are unacceptable. The details of such a plan will be developed as part of the Phase 2 remediation plan. Determination of monitoring well locations to ensure adequate monitoring and characterization of potential contamination from the site will likely involve a phased hydrogeological investigation. Any groundwater that is sampled should be analyzed for selected key radiological and non-radiological parameters similar to those being monitored in the groundwater around the WMA, in addition to standard parameters of interest with respect to a non-hazardous landfill.

9.5.4 Follow-up Monitoring for Sewage Lagoon

The sewage lagoon system consists of a primary and a secondary lagoon located 150 metres east of the Winnipeg River. The lagoons are constructed from low permeability clay embankments, which have been placed on a prepared clay surface. Underlying natural glacial deposits in the area consist of relatively low permeability silt, lacustrine clay, and clay-till deposits overlying a thin sandy layer which is itself underlain by bedrock, as illustrated in Figure 5.13 (Section 5.4.3).

Currently water is released from the facility every spring and fall to the Winnipeg River through a drainage channel from the secondary lagoon. Discharged water is monitored for the following non-radiological parameters: BOD_5, fecal coliform, pH, total phosphorus, conductivity, total suspended solids, phenolics, oil/grease, chromium, copper, iron, lead, nickel, zinc and mercury. Discharged water is also monitored for the following radiological parameters: gross beta, gross alpha, gamma spec liquid, gamma spec dry and ^{90}Sr. The monitoring is conducted to confirm compliance with regulatory limits guidelines, to provide verification of the facility operation and to provide public assurance of compliance.

During Phase 1 and early Phase 2, the sewage lagoon will remain fully operational and the existing effluent discharge monitoring program will continue unchanged. In preparation for remediation of the lagoon system, an environmental evaluation will be conducted to determine the effects of the system, if any, on local groundwater and the Winnipeg River. This evaluation will initially require the installation of several (3 to 4) groundwater monitoring well nests, one of which will be located upgradient (to the east) of the lagoon system in order to determine groundwater quality prior to any effects from the lagoon system. The remaining monitoring well nests will likely be installed immediately downgradient of the site (to the west) between the lagoons and the Winnipeg River. Further monitoring programs for the decommissioning and post-decommissioning periods will be developed as required based on the proposed investigations and the remediation plan to be developed for the site.

9.6 FACTORS AFFECTING SCOPE OF MONITORING

Monitoring requirements will change in terms of frequency, duration and type over the course of decommissioning and following the completion of decommissioning. These changes will reflect not only changes in regulatory requirements and technological advancements but also the characteristics of the effects being monitored. Air quality monitoring, for example, will have only relatively short-term monitoring requirements because air quality generally is only affected during construction/ demolition related activities. In addition, the type of air quality monitoring will depend on the specific activity being undertaken; remediating contaminated interior spaces requires a different type and scale of air quality monitoring than that required during demolition.

The frequency and type of monitoring will continue to be evaluated over time. Monitoring will be adjusted to reflect findings from the monitoring activities. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory or other standards such as community concerns. Any modifications to the monitoring program will be communicated to the CNSC.

In the event that an unanticipated effect develops from the decommissioning activities, special surveys would be developed to assess and monitor the effect. Appropriate mitigation measures would evolve from the monitoring and surveying activities.

9.7 REPORTING

The Whiteshell Laboratories' licence requires that AECL submit to the CNSC an annual report for each calendar year summarizing the results of monitoring of radiation exposures to personnel at the site, the results of monitoring of radioactive materials in airborne and liquid effluents from the site and the results of environmental monitoring at and around the sites.

Reporting measures during decommissioning activities will follow the requirements of the regulatory bodies in addition to AECL's policy on reporting. Regular record keeping will be undertaken and include maintenance of hard copies of all monitoring reports, manuals and procedures for care and maintenance and contingency plans. A complete set of historical documents will also be maintained by AECL or other agency, as appropriate. Records may include all or some of the following:

- annual reports;
- transition monitoring-transition assessments; and/or
- background and reference studies.

9.8 AUDITING

Auditing is an independent verification of AECL's environmental monitoring programs. Auditing at Whiteshell Laboratories takes place at AECL's Safety Review Committee's discretion and/or at the CNSC's discretion. Options for auditing include:

- self auditing;
- public environmental review committee to oversee the long-term follow-up activities for the site; and
- reporting of an independent auditor to the CNSC.

Actual responsibility for ensuring that appropriate follow-up activities are undertaken will lie with the CNSC or other designated agencies.

9.9 PUBLIC ADVISORY COMMITTEE

AECL supports the idea of a Public Advisory Committee which could include members of the public, First Nations, appropriate government agencies and other stakeholders. This committee could make recommendations on the type, extent and frequency of monitoring activities on an on-going basis. It could also review monitoring results, and make recommendations on modifications to the decommissioning program and to mitigation measures, where necessary. Terms of reference for formation of the Public Advisory Committee require consultation with the local community and will be undertaken early in Phase 1.

9.10 MONITORING RESPONSIBILITY

AECL is responsible for the decommissioning activities and on-going monitoring of the project. AECL is committed to ensuring that the funding to meet the Whiteshell Laboratories decommissioning requirements is identified as a component of the segregated appropriation for decommissioning treasury board.

10.0 PUBLIC CONSULTATION

10.1 OVERVIEW

A public consultation plan was designed to fully satisfy the *Canadian Environmental Assessment Act's (CEAA)* requirements by providing opportunities for people interested in the proposed decommissioning program to learn about it and comment on it. It was also designed to establish long-term relationships with stakeholders, First Nations and interested members of the public that would endure beyond this environmental assessment phase and extend throughout the entire decommissioning program. A number of the initial communication and consultation activities were designed to communicate information about the proposed decommissioning program and environmental assessment process and to seek input into the proposed program. The consultation program was designed to meet the different informational needs of the public, stakeholders and First Nations.

The public consultation plan and program are described in detail in Sections 10.2 and 10.3. Issues raised throughout the process are presented in Section 10.4. The First Nation consultation program and issues raised in the program are described in Section 10.5. Background material is contained in Appendix E. Appendix E.1 contains a record of AECL's ongoing communications program with stakeholders. Appendix E.2 contains a record of public consultation on the Comprehensive Study Report (CSR) including a summary table of all contacts and Appendix E.3 contains copies of all public information material. Appendix E.8 contains a record of the First Nation consultation program including a table of all contacts. All issues and questions have been responded to in one of three ways: addressed in the CSR, addressed with a response from AECL or to be addressed through a follow-up program.

10.2 PUBLIC CONSULTATION PLAN

10.2.1 *CEAA* Requirements

The specific requirements of *CEAA* regarding public participation in a CSR include consideration of public comments by the Responsible Authority, public notification and consideration of public comments by the Canadian Environmental Assessment Agency and public notification concerning follow-up programs. There is no specific requirement of *CEAA* to consult with the public during an environmental assessment at the self-assessment stage; however, *CEAA* clearly supports the principle of an early and meaningful public consultation. The intent of the following public consultation plan is to comply with and where possible exceed the requirements of *CEAA*.

10.2.2 Objectives

The objectives of the public consultation plan relating to the *CEAA* component were to:

- inform stakeholders, potentially interested parties, First Nations and the public about the proposed decommissioning program and the environmental assessment process;
- introduce the decommissioning team and the environmental assessment team to stakeholders, interested parties, First Nations and the public;

- develop on-going relationships that would be important throughout the environmental assessment process, closure and decommissioning phases;
- identify issues and concerns early in the environmental assessment process and address them;
- provide input to the environmental assessment team on VECs and VSCs;
- gauge interest and level of concern; and
- assist in defining mitigation measures and follow-up programs.

10.2.3 General Strategy and Approach

The Whiteshell Laboratories operation has developed an ongoing broad communication strategy to ensure that the general public has access to information on the proposed decommissioning program. More focused consultation efforts were directed at stakeholders, First Nations and potentially interested parties. AECL recognized that relationship building was an important aspect of the consultation program and that different groups and interests would require different consultation approaches. AECL also refined its ongoing communication program.

AECL recognized that many issues surrounding the closure of Whiteshell Laboratories were of a socio-economic nature and were being addressed through other processes, whereas the CSR dealt with the decommissioning activities which result from the permanent shutdown of nuclear facilities and other associated facilities and lands. For clarity, AECL sought the Canadian Environmental Assessment Agency's comment on the exclusion of socio-economic aspects of the closure of Whiteshell Laboratories from the scope of the CSR. The Agency confirmed that these aspects could be excluded from the CSR. Communication materials were developed accordingly. Nevertheless, issues that were raised throughout the consultation process and fell outside the scope of the CSR were duly recorded.

The following discussions are related primarily to the *CEAA*-related environmental assessment public consultation plan which is an add-on and complementary to the on-going Whiteshell Laboratories' broad communication program.

10.2.4 Identification of Interests

One of the first tasks in designing the *CEAA*-related public consultation program was to identify the potential interests in the proposed project. The following interests were identified as potentially affected or interested parties:

- municipal governments
- elected federal and provincial officials
- First Nations/First Nation organizations
- aboriginal associations
- cottage associations
- tourism organizations
- area businesses
- community organizations
- environmental organizations
- nature/wilderness organizations
- conservation associations
- birders
- current AECL employees
- tenants at Whiteshell Laboratories
- land development group
- industry associations

- community associations
- economic development organizations
- area residents
- cottagers
- regional resource industries
- provincial government officials
- federal government officials
- health/education associations
- fishers, hunters, trappers, wild rice harvesters

Based on this list of interests, organizations were identified to be targeted in the communication and consultation program. The general public was recognized as a broad group with no specific interest in the proposed program but who may wish to become involved.

10.3 *CEAA*-RELATED PUBLIC CONSULTATION PROGRAM

10.3.1 Overview of Activities and Timing

Techniques that were selected for communicating information and obtaining feedback and input included newsletters, open houses, presentations, key-person interviews, meetings and information sessions. Throughout the public consultation process, identification and comments on valued ecosystem (VECs) and social components (VSCs) were also sought. An interview process was also established to identify public opinions on VECs and VSCs for input to the project team. AECL recognized that public involvement is a dynamic process and undertook an evaluation of interest and activities as the consultation program progressed.

An overview of activities carried out during the *CEAA*-related public consultation and the timing of these activities is presented in Table 10.1.

Table 10.1
Public Consultation Activities

Activities	1999	2000
Key-person Interviews	July-September	
Interviews (VECs/VSCs)	July-August	
Newsletter	October	June
Letters to Contact List	October	June
Open House	October	
Information Sessions	October	June
Follow-up Presentations	November	April

10.3.2 Presentations to Municipal Councils

AECL conducted a series of briefings for local municipal officials in winter of 1998/1999 to inform them of closure and decommissioning activities. These briefings were undertaken to advise area municipalities of AECL's notification to the Canadian Nuclear Safety Commission (CNSC) of AECL's intention to decommission the Whiteshell Laboratories site and to outline the proposed strategy and regulatory framework. An update was provided in June 1999 to the same municipalities except the L.G.D. of Pinawa which indicated that it did not require a briefing at that time. These briefings are part of AECL's routine communications and will continue throughout the decommissioning program.

10.3.3 Presentations to Interested Organizations and Individuals

Briefings for elected federal and provincial officials, Manitoba Conservation (formerly Manitoba Environment) and the media were undertaken in the winter of 1998/1999. These briefings were undertaken to advise interested parties of AECL's notification to the CNSC of AECL's intention to decommission the Whiteshell Laboratories site and to outline the proposed strategy and regulatory framework. An update was provided to Manitoba Conservation and other provincial departments in July 1999. There was also a briefing by AECL at Whiteshell Laboratories to the provincial Minister of Industry, Trade and Mines in November 1999 as part of AECL's on-going briefings. AECL will provide additional briefings at appropriate junctures in the environmental assessment process and throughout the decommissioning program.

10.3.4 Key-Person Interviews

Key-person interviews are a useful consultation tool for soliciting background information from key people about their communities and their concerns respecting a proposed undertaking. Interviews were conducted with the following people: Administrator, L.G.D. Pinawa; Mayor, L.G.D. Pinawa; President, Pinawa Community Development Corporation; Co-ordinator, Pinawa Implementation Committee; and Reeve, R.M. Lac du Bonnet.

10.3.5 Newsletter

A newsletter (No. 1 October 1999) was prepared to facilitate understanding of the proposed decommissioning program and environmental assessment process and to invite people to participate in the environmental assessment process. This newsletter was distributed on October 5 and October 6, 1999 to 7,627 post boxes in the Regional Study Area. The newsletter announced the date for an open house at Whiteshell Laboratories and provided contact information. Copies of the newsletter were also placed in Manitoba Conservation's Resource Centre in Winnipeg. A copy of the newsletter is provided in Appendix E.3.

A follow-up newsletter (No. 2 June 2000) was prepared to provide a status update on the planning of the Whiteshell Laboratories Decommissioning Project. This newsletter was distributed June 5 and June 6, 2000 to 7,627 post boxes in the region. The newsletter provided responses to issues and questions raised during the consultation process. It also invited people to discuss the project at information sessions in area communities. Copies of the newsletter were also placed in Manitoba Conservation's Resource Centre in Winnipeg. A copy of the newsletter is provided in Appendix E.3.

10.3.6 Letters to Potentially Interested Organizations/Persons

A contact list was developed based on the initial identification of potentially interested organizations and persons. The list was used to notify organizations by letter of the consultation process that was underway in 1999 and to invite them to an open house. Further, organizations that were not involved in regular briefings were asked if they would like to have a presentation made to them on the proposed decommissioning program and environmental assessment process. Copies of the newsletter were also distributed to this contact list. One organization responded with a request for a presentation. The contact list is presented in Table 10.2. A copy of the letters is provided in Appendix E.4.

Organizations were contacted in June 2000 to advise them of the status of the decommissioning project and to invite them to attend drop-in information sessions in area communities. A copy of the second newsletter was also provided. A copy of the letters is presented in Appendix E.4.

Table 10.2
Contact List

Nature and Wildlife Associations and Environmental Organizations
- Manitoba Wildlife Federation
- Manitoba Trappers Association
- Manitoba Recreational Canoeing Association
- Manitoba Naturalists Society
- Manitoba Model Forest Inc.
- Manitoba Eco-Network
- Canadian Parks and Wilderness Society
- World Wildlife Fund
- Heather Game & Fish

Whiteshell Laboratories Tenants
- ACSION Industries Incorporated

Regional Resource Industries
- Pine Falls Paper Company Inc.
- Tanco

Cottage Associations
- Lorell Cottage Owners Association
- Black Bear
- Leisureland
- Cape Coppermine
- Bonnet Oaks
- Fishers Grove
- Grosdin Point
- Lee Side Recreation Co-op
- Wendigo Association
- Arnold's Campers Co-op
- Lee River Falls Holdings

Municipal Governments
RM of Alexander
RM of Whitemouth
RM of Brokenhead
Town of Beausejour
RM of Lac du Bonnet
Town of Lac du Bonnet
LGD of Pinawa

Community and Economic Development Organizations
- Pinawa Chamber of Commerce
- Lac du Bonnet Chamber of Commerce
- Economic Development Authority of Whiteshell
- Winnipeg River Brokenhead Community Futures Development Corp.
- Pinawa Community Development Corporation
- Eastman Regional Development Corporation Inc.
- Pinawa Land Development Group
- Pinawa Implementation Committee
- Workforce Adjustment Centre

First Nations and Aboriginal Associations
- Sagkeeng First Nation
- Brokenhead Ojibway First Nation
- Treaty 3 First Nations
- Manitoba Metis Federation

Health/Education Associations
- North Eastman Health Association
- School District of Whiteshell

Community Associations
- Pinawa 50 Plus Club
- Pinawa Recycling Inc.
- Pinawa Lion's Club

Elected Federal and Provincial Officials
- MLA - La Verendrye
- MLA - Lac du Bonnet
- Senior federal Minister (Hon.Lloyd Axworthy)
- Secretary of State for Western Economic Diversification
- Member of Parliament – Provencher

Government Officials
- Chairperson –TAC, Manitoba Environment (now Conservation)
- Assistant Deputy Minister, Manitoba Environment (now Conservation)
- Director, *CEAA* Regional Office

Industry Associations
- Canadian Nuclear Association

10.3.7 Open House

The major consultation event related to *CEAA* was an open house that was hosted by AECL at Whiteshell Laboratories on Saturday, October 16 1999 from 10 a.m. to 4 p.m. This session provided an opportunity for interested persons to engage in discussions with the decommissioning team and the environmental assessment team. Tours of some of the facilities to be decommissioned including the Waste Management Area and Concrete Canister Storage Area were organized for those who wished to take them. Notification of the open house occurred via newsletters and ads in the regional newspapers.

AECL EACL

We invite you to attend the
Whiteshell Laboratories Open House
October 16, 1999
10 a.m to 4 p.m

Location: Whiteshell Laboratories off Highway 211
(accessed via Highway 11)

Atomic Energy of Canada's Whiteshell Laboratories is being shut down and will be decommissioned. The decommissioning plan is undergoing an environmental assessment. Public input is important for the environmental assessment.

Discuss the plan with the decommissioning and environmental assessment team. View displays, take tours and provide us with your feedback.

For more information, please call (204) 753-2311 ext. 2294

Storyboards were displayed on multi-screen displays in the Whiteshell Laboratories' cafeteria. The storyboards discussed the following topics:

- Purpose of the Open House.
- Whiteshell Laboratories-Historical Highlights.
- Regulatory Framework.
- Future Availability of Land.
- What is Decommissioning?
- Decommissioning Alternatives.
- Decommissioning Strategy.
- Decommissioning Scope.
- Decommissioning Activities.
- Waste Management.
- Environmental Protection.
- Health and Safety Programs.
- Regional and Local Setting.
- Valued Ecosystem and Social Components.
- Study Areas.
- Environmental Assessment Process.
- Next Steps in the Environmental Assessment Process.
- AECL's Commitments.

Members of AECL's decommissioning team and the environmental assessment consulting team were stationed at the various displays to respond to questions and assist with understanding the decommissioning program. Comment sheets were available to be completed at the open house or mailed or faxed back. A total of 10 comment sheets were returned. Questions raised at the displays or on tours were recorded.

Attendance at the open house was 121. Ten tours were conducted and 80 people took the tour. Table 10.3 shows the distribution of people who attended the open house and communities they live in.

Table 10.3
Breakdown of Attendance at Open House Whiteshell Laboratories
16 October 1999

Location	No.	Location	No.
Pinawa	57	Beausejour	6
Seven Sisters	9	Pine Falls	1
Lac du Bonnet	23	Whitemouth	2
Winnipeg	15	Elma	3
Garson	4	Sagkeeng First Nation	1

10.3.8 Information Sessions

Information sessions were held in October 1999 following the open house as an opportunity for individuals who may not have been able to attend the open house. Some of the display panels were selected for display at these information sessions. They were staffed by three AECL decommissioning team members and one or two environmental assessment team members. Communities were notified with an ad in regional newspapers, posters in communities and a phone call to the municipal administrators. The information sessions were held from 4 p.m. to 6 p.m. in Beausejour, Pinawa, Whitemouth and Lac du Bonnet. In total, 19 people attended these information sessions. No comment sheets were completed.

AECL EACL

A display on the Whiteshell Laboratories decommissioning program will be set up in the following communities.

You are invited to drop in between 4p.m. and 6p.m.

Oct 21	**Beausejour**	**Town Office , 639 Park**
Oct 25	**Pinawa**	**Whiteshell Centre**
Oct 26	**Whitemouth**	**Community Hall**
Oct 28	**Lac du Bonnet**	**Community Center**

Members of the Whiteshell Decommissioning and Environmental Assessment teams will be on hand to answer your questions and obtain feedback.

For more information,
please call (204) 753-2311 ext 2294 or 1-800-665-0436

A second round of information sessions was held in June 2000 in the same communities. These information sessions were held to provide an opportunity for people to discuss responses to issues and questions raised during the first round of consultations. New display material was developed to update the public and respond to issues raised. Communities were notified with ads placed in regional newspapers, posters sent with letters and information in the newsletter. In total, 24 people attended the information sessions. No comment sheets were completed.

10.3.9 Scoping of Valued Ecosystem and Social Components

An interview process was one of the tools used to develop a list of what members of the public considered to be valued ecosystem components. Four experts and three lay people were interviewed. In addition to the interview process, the open house, key-person interviews, information sessions and First Nation consultation process were used to obtain opinions of what individuals considered to be valued ecosystem and social components.

10.3.10 Information Availability

A handout of the display panels was made available at the open house and the October 1999 information sessions and placed on the public registry. A copy of the handout is provided in Appendix E.3. The report Whiteshell Laboratories Detailed Decommissioning Plan, Volume 1-Program Overview (Helbrecht 1999) was made available to interested persons at the open house and information sessions. A draft of the scope of assessment document written by the CNSC was made available to the public for comment in early November 1999. The reports were also made available by request through AECL. The draft CSR Revision 1 was distributed by the CNSC for technical review to federal and provincial departments and agencies in April 2000. At that time, AECL provided a copy as a courtesy to 7 municipal councils, the Whiteshell Laboratories/Provincial Leaders Committee and the Sagkeeng and Brokenhead First Nations. A copy of the transmittal letters is provided in Appendix E.4. The draft CSR will be made available to the public by the CNSC. When completed, the CSR will be released as a final report and placed on the Public Registry by the Responsible Authority for public review.

10.3.11 Web Site and Toll-Free Number

AECL's web site, e-mail address, local telephone number and toll-free number were advertised in both newsletters. A public affairs staff person at Whiteshell Laboratories managed the local information requests. As of December 2000, AECL had received nine telephone calls, four e-mails, one information pick-up and one letter. Seven of these were requests for a copy of the Decommissioning Plan.

10.3.12 Public Registry

The Canadian Environmental Assessment Agency operates a public registry and the *CEAA* requires that the Responsible Authority, in this case, the CNSC, set up a file and maintain it on the registry for all federal comprehensive study projects. The CNSC registered the Whiteshell Laboratories Decommissioning Project on the *CEAA* public registry and also made available information on its own web site. Manitoba Conservation established a public registry at the Pinawa Library, the Winnipeg Centennial Library and at its Winnipeg Regional Offices at 123 Main Street.

10.3.13 Government Contacts

A provincial Technical Advisory Committee (TAC) for the Whiteshell Laboratories Decommissioning Project was formed to undertake a technical review of the decommissioning program. The TAC is an advisory body to the Director and the Minister of Conservation and includes experts from within government as well as external agencies. The TAC is chaired by

Manitoba Conservation. The regional Canadian Environmental Assessment Agency office is represented on the TAC. TAC meetings were held in June and October 1999. The CNSC made a presentation at the June and October meetings and AECL made a presentation at the October meeting. Other briefings of provincial officials occurred in July with the Chair of the TAC and the Assistant Deputy Minister of Manitoba Conservation. The TAC reviewed the draft CSR Revision 1 and forwarded comments to the CNSC.

10.3.14 Community/Provincial Leaders Committee

Another forum for addressing issues related to dosure and decommissioning is the Whiteshell Laboratories Community/Provincial Leaders Committee that was established in December 1998. The purpose of the Committee is to develop a strategy for addressing the regional effects of the closure of Whiteshell Laboratories. The Committee is co-chaired by the MLA for Lac du Bonnet and the Mayor of the L.G.D. of Pinawa. The Committee membership consists of the School District of Whiteshell; the Rural Municipalities of Lac du Bonnet, Whitemouth, Brokenhead; the Towns of Lac du Bonnet and Beausejour; the Economic Development Authority of Whiteshell; the Departments of Industry Trade and Tourism, Rural Development and Conservation; and the MLA for La Verendrye.

The Committee's April 30, 1999 report identified four main issues with respect to the regional and provincial impacts of the closure of the Whiteshell Laboratories. Three of these issues fall outside AECL's mandate or the scope of the CSR and the fourth issue relates to decommissioning. The Committee also developed a set of 20 recommendations for the decommissioning program. AECL has responded to these recommendations as outlined in Table 1 in Appendix E.5. AECL contacted the Committee by letter in November 1999 to determine if it would like a briefing with the decommissioning team and environmental assessment team. A letter was sent on January 31, 2000 advising the Committee that responses to its 20 recommendations had been prepared and included in Appendix E.5. AECL offered the Committee an opportunity to discuss these responses at a meeting. A meeting was held on April 8, 2000.

10.4 RESULTS OF PUBLIC CONSULTATION

A number of issues were raised in the public consultation process. These issues were recorded from interviews, open house comments, briefings and responses to the CNSC scoping document. As well, comments were provided on the draft CSR Revision 1 by the Community/Provincial Leaders Committee. For organizational and analytic purposes, the issues have been categorized and organized into tables.

Issues that were raised that are within the scope of the CSR are discussed below and presented in Table 10.4. Other issues that fall outside the scope of the CSR have been noted and responded to in Table 1 in Appendix E.6. AECL understands these to be important community issues and notes instances where other processes are responding to them. Questions and comments that were raised at the Open House that are not otherwise recorded as issues are noted in Table 1 of Appendix E.7. Responses to these were given by AECL and environmental assessment consultants at the Open House.

Issues that were raised that are within the scope of the CSR have been categorized in the following manner:

1. Scope of decommissioning program.
2. Time frame.
3. Environmental effects.
4. Terrestrial biota / wildlife effects.
5. Aquatic biota / fish effects.
6. Land / resource use.
7. Health and safety.
8. Environmental monitoring.
9. External events.
10. Security.
11. Future staffing requirements.
12. Site characterization.
13. Storage.
14. Long-term communications.
15. Financial assurances.
16. Planning considerations.
17. Acceptability of plan.

Table 10.4

Issues / Comments Raised in the Public Consultation within the Scope of the CSR

ISSUES / COMMENTS	STATUS
Scope of Decommissioning Program	
Why not mothball the Hot Cells and the IFTF complex and not decommission them, both as a national asset and until the question of the Canadian Neutron Facility can be debated?	**Addressed in CSR:** The business decision to discontinue research at Whiteshell Laboratories creates the requirement to decommission the nuclear facilities and the site to: Produce a safe monitoring and surveillance state until all wastes can be removed to disposal facilities; Reduce the cost of maintaining the site; and Meet all regulatory requirements for shutdown of nuclear facilities. Furthermore, mothballing of facilities to the above requirements generally precludes any further use. **Outstanding Issues:** None.
Why not consider keeping the WR-1 building and Building 300 for future use?	Same as above.
It is not acceptable to the community to not demolish the Hot Cell Facility and Building 300 until a disposal facility is available.	**Addressed in CSR:** AECL notes that conflicting community views have been expressed on the timing for demolition of these buildings. AECL plans to achieve and maintain a safe monitoring and surveillance state until disposal becomes available. The safest way to manage non-mobile hazards in these facilities is with the current facility and building structures until disposal options become available. All potentially mobile hazards will be addressed prior to placing the facilities in a safe monitoring and surveillance condition. **Outstanding Issues:** None.
We insist that the hot cells should remain serviceable until after all of the repackaging and storage of high and intermediate-level decommissioning wastes is complete.	**Addressed in CSR:** Hot cells will be in service until no longer needed. Packaging / handling of high level wastes may require local shielded equipment in the WMA. AECL's analysis of the decommissioning requirements indicate that the SF is required only to process active liquid wastes currently stored in the WMA and the SF. The facility will be decommissioned after that need has been met and local shielded structures will be used for repackaging WMA wastes where required. Transfer of wastes to the Shielded Facility is not economic nor an efficient processing option. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
There is a concern about future uses of the site being outside the scope of the environmental assessment.	**Addressed in CSR:** Any new site business uses or activities are expected to be subject to the environmental assessment requirements for the proposed activity. Section 8.0 of the CSR which deals with cumulative effects, addresses this issue. **Outstanding Issues:** None.
Time Frame	
The Whiteshell site must be fully decommissioned in less than 20 years and not defer costs to future generations.	**Addressed in CSR:** AECL believes the preferred alternative of a final end-state by 2060 is advantageous for a variety of reasons. Although there is a national policy for disposal of nuclear waste, permanent disposal space for Whiteshell Laboratories waste is not expected to be available until 2025 for LLW and 2050 for HLW. The proposed plan optimizes the use of existing engineered structures and building envelopes to control nuclear liabilities. The plan takes advantage of the reduction in activity of key radionuclides. This minimizes the exposure to workers/the environment, and the cost for protection of workers/the environment. The issue of double handling is avoided. For example, if a waste storage facility were currently available for HLW, it would have to be handled twice. First, it needs to be handled at Whiteshell Laboratories when being sent to the storage location. Then, it would need to be handled for a second time, when a permanent disposal location becomes available. The cost efficiency of this approach will be assessed and compared to other alternatives. **Outstanding Issues:** None.
The 60-year timeframe for decommissioning is unacceptable to communities.	**Addressed in CSR:** AECL understands the concern of communities and acknowledges different points of view. The proposed phased approach optimizes the timeframe relative to the existing life of buildings and storage structures, radioactivity decay and the availability of disposal facilities. **Outstanding Issues:** None.
The average person doesn't understand why a long time frame is contemplated and the argument needs to be made in terms that they understand.	**Addressed in CSR:** AECL acknowledges that the rationale for the long time frame may not be understandable to the average person and it will endeavour to communicate this in lay terms. **Outstanding Issues:** None.
There are a number of outstanding public issues, the principal one being AECL's intention to close up the site and not do any real decommissioning and decontamination until decades in the future.	**Addressed in CSR:** The amount of decommissioning that will occur during the first 10 years is substantial. While it is true that WR-1 will not be decommissioned for 50 years to allow for radioactive decay and to enhance safety, the decommissioning of other facilities will begin as soon as approval is given. Figure 4.4 summarizes plans for the management of liquid and solid waste and indicates that decommissioning including decontamination will begin as early as 2002. **Outstanding Issues:** None.
Long-term storage is unacceptable to communities.	**Addressed in CSR:** Groundwater monitoring around the WMA indicates no movement of radionuclides during the 35 years of operation. A safety assessment has been conducted to determine the long-term environmental acceptability of in-situ management of low-level waste. (Appendix C) **Outstanding Issues:** None.
Very little needs to be postponed for safety reasons.	**Addressed in CSR:** It is true that only WR-1 and some intermediate-level waste in the WMA benefit from radioactive decay over a deferment period. However, other safety considerations include minimizing overall radiation doses to decontamination staff by avoiding double handling of material. Whiteshell Laboratories' waste is currently in safe storage and will only be moved when national disposal facilities are available. **Outstanding Issues:** None.
AECL has also ignored the additional risks of leaving the radioactive materials in their present location for long periods.	**Addressed in CSR:** Additional information on the waste inventory, the trenches and the river sediments etc. and the associated risks has been provided in Section 5 and 6. In the case of WR-1, early decommissioning such as a 20-year time frame increases safety risks and is extremely costly especially given the unavailability of a national waste disposal facility. The risks of early decommissioning of WR-1 are outlined in Section 3.0. Regardless of how long the project takes, the site will remain under CNSC licence control and will be subject to appropriate monitoring to ensure people and the environment are adequately protected. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
We expect AECL to fully decommission the site in a continuous process in less than twenty years. A project with a sixty-year completion date can never be guaranteed.	**Addressed in CSR:** The CNSC will maintain full licensed control of the decommissioning project for as long as is necessary to ensure there are no unreasonable risks to people and the environment. The assessment has determined that a phased decommissioning approach over several decades will pose the least risk to people and the environment. **Outstanding Issues:** None.
AECL's strategy of deferring decommissioning is out of step with practices and safety considerations applied in other OECD countries.	**Addressed in CSR:** The policies for national waste disposal are set at the national level in all countries. Canadian policies and laws are being followed. Deferred decommissioning is practiced in virtually every OECD country. Even where waste disposal is already available, health, safety and environment priorities and funding priorities determine the immediate or early decommissioning requirements. When public and environmental safety is not a critical issue, deferment is routinely applied as an interim decommissioning step. **Outstanding Issues:** None.
The morality of deferring the immense costs of decommissioning the Whiteshell site to our grandchildren who had no benefit of AECL's existence is reprehensible.	**Addressed in CSR:** Many of the costs are being borne by this generation. Note also, that the benefits of the Whiteshell Laboratories research projects apply to more than one generation. **Outstanding Issues:** None.
The integrity of concrete canisters over the long term is questioned as is potential for radioactivity leaking out of the canisters.	**Addressed in CSR:** The life of the concrete canisters is expected to be at least 50 to 100 years. Twenty-five years of experience indicates no deterioration and AECL expects the actual life to be adequate until final disposal is available. The integrity of the canisters will be routinely assessed during the decommissioning program. Deterioration prior to fuel transfer would require construction of replacement canisters. **Outstanding Issues:** None.
Environmental Effects	
There is concern about potential contamination of the environment in general during decommissioning and over the longer term.	**Addressed in CSR:** The purpose of decommissioning is to mitigate, remove or reduce hazards. All work is conducted according to this principle. The general approach to assessing potential environmental effects is to investigate them through the site characterization activities, which are a component of the decommissioning program. Decommissioning activities related to all project tasks are evaluated in the CSR and where necessary, mitigation plans are developed or proposed. AECL will maintain environmental monitoring for the site for as long as wastes requiring management remain at the site. **Outstanding Issues:** None.
There is concern about downstream water quality.	**Addressed in CSR:** Residual contamination in river sediments was found to be small. In the most contaminated area, near the outfall, the inventory is a small fraction of the annual releases prior to 1985. Even if the entire inventory was released into the river, the incremental Cs-137 concentration would be negligible. **Outstanding Issues:** None.
There is concern about surface water contamination.	**Addressed in CSR:** AECL will maintain a comprehensive environmental monitoring program during the decommissioning program that will include surface water. Any indication of releases will be followed up immediately and corrective action undertaken. **Outstanding Issues:** None.
Terrestrial Biota/Wildlife Effects	
What are the potential impacts of decommissioning activities on wildlife?	**Addressed in CSR:** The environmental monitoring program includes analysis of road kill. Results indicate that the effect to wildlife from past operations has been negligible and no additional effects are expected from decommissioning activities. Remediation of contaminated land may disturb wildlife habitat but it would be very localized and of short duration. These areas are previously disturbed areas. Potential effects would be no different than if new development occurred on previously used site lands. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
There is potential for increased contamination during removal of waste from bunkers and tile holes in Phases 1 and 3.	**Addressed in CSR:** All work that includes the remediation of radioactive or industrial materials and hazards has the potential to spread contamination to the environment. AECL operates established and approved Radiation Protection, Occupational Safety & Health, and Environmental Protection programs that are designed to ensure the safety of workers, the public and the environment. These programs are in compliance with federal and provincial regulations, incorporate international standards and practices and are approved by the CNSC. Careful work planning is carried out using these program requirements and implemented using AECL's work permit system and pre-job briefings. During decommissioning, these programs will continue to be implemented and will be enhanced where uncommon or unique situations are addressed. This includes the use of engineering controls such as specially built enclosures to contain hazards during remediation and the use of specialized equipment designed to address these types of hazards (e.g. HEPA ventilated vacuum systems). **Outstanding Issues:** None.
There is the potential for disturbance of wildlife, increased contamination and destruction of habitat during Phases 2 and 3 remediation of contaminated lands.	Same as above.
Land/Resource Use	
There is the potential for increased contamination and sediment load during Phase 3 removal of active drain lines.	Same as above.
Aquatic Biota/Fish Effects	
There is the potential for increased contamination and sediment load during Phase 3 removal of active drain lines.	**Addressed in CSR:** All work that includes the remediation of radioactive or industrial materials and hazards has the potential to spread contamination to the environment. AECL operates established and approved Radiation Protection, Occupational Safety & Health, and Environmental Protection programs that are designed to ensure the safety of workers, the public and the environment. These programs are in compliance with federal and provincial regulations, incorporate international standards and practices and are approved by the CNSC. Careful work planning is carried out using these program requirements and implemented using AECL's work permit system and pre-job briefings. During decommissioning, these programs will continue to be implemented and will be enhanced where uncommon or unique situations are addressed. This includes the use of engineering controls such as specially built enclosures to contain hazards during remediation and the use of specialized equipment designed to address these types of hazards (e.g. HEPA ventilated vacuum systems). **Outstanding Issues:** None.
There is the potential for increased contamination, sediment load and habitat destruction during Phases 1 and 3 removal of river sediment.	**Addressed in CSR:** Residual contamination in river sediments was found to be small. In the most contaminated area, near the outfall, the inventory is a small fraction of the annual releases prior to 1985. Even if the entire inventory was released into the river, the incremental Cs-137 concentration would be negligible. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
Land/Resource Use	
There is the potential for increased contamination and sediment load during Phase 3 removal of active drain lines.	**Addressed in CSR:** All work that includes the remediation of radioactive or industrial materials and hazards has the potential to spread contamination to the environment. AECL operates established and approved Radiation Protection, Occupational Safety & Health, and Environmental Protection programs that are designed to ensure the safety of workers, the public and the environment. These programs are in compliance with federal and provincial regulations, incorporate international standards and practices and are approved by the CNSC. Careful work planning is carried out using these program requirements and implemented using AECL's work permit system and pre-job briefings. During decommissioning, these programs will continue to be implemented and will be enhanced where uncommon or unique situations are addressed. This includes the use of engineering controls such as specially built enclosures to contain hazards during remediation and the use of specialized equipment designed to address these types of hazards (e.g. HEPA ventilated vacuum systems). **Outstanding Issues:** None.
Health and Safety	
Some members of community lack confidence in future safety measures.	**Addressed in CSR:** AECL's health and safety programs are reviewed by the CNSC and will continue to be implemented during the decommissioning project. AECL will retain the responsibility for maintenance of the licence. AECL is committed to an ongoing communication program with area communities and stakeholders and will report on its health and safety program. **Outstanding Issues:** None.
There is a concern that a loss of hands-on knowledge is a risk to future worker and community safety.	**Addressed in CSR:** AECL has retained key individuals to develop and initiate its decommissioning program. AECL is committed to maintaining key people in its decommissioning team. Currently, AECL is recalling some former staff on a contract basis. There are standards and procedures that will be followed and future staff will be required to adhere to these standards and procedures. **Outstanding Issues:** None.
Will there be adequate fire fighting services?	**Addressed in CSR:** Yes. AECL's fire fighting capability is reviewed annually by the AECB and is subject to the Federal Fire Regulations and the National Fire and Building Code. Fire fighting capability at Whiteshell Laboratories will be maintained consistent with these regulations. **Outstanding Issues:** None.
What are the potential health effects from decommissioning?	**Addressed in CSR:** Decommissioning involves less activity than the operations phase of Whiteshell Laboratories. During operations, the estimated annual doses to the public have been, and continue to be, well within regulatory limits established by the CNSC. All releases and doses to the public will continue to be reported annually. **Outstanding Issues:** None.
How can people be assured that health and safety are protected?	**Addressed in CSR:** AECL is committed to an ongoing communication program with area residents to ensure they are informed of site activities and to respond to concerns that residents may have. **Outstanding Issues:** None.
Plan is clearly at odds with basic safety principles applied in other countries.	**Addressed in CSR:** The CNSC will not authorize the project to proceed until it is satisfied that it meets all of the relevant regulatory requirements. **Outstanding Issues:** None.
Environmental Monitoring	
There should be local input to the design of monitoring program.	**Addressed in CSR:** AECL supports the idea of a Public Advisory Committee. Local input into the design of the monitoring program could be accommodated through this mechanism. **Outstanding Issues:** A Public Advisory Committee will be considered in parallel with implementation of the decommissioning program.
Regular reporting of information to neighbouring communities would help alleviate concerns.	**Addressed in CSR:** AECL is committed to an ongoing communication program with neighbouring communities. **Outstanding Issues:** None.
The fact that there is off-site monitoring would imply that there are releases of concern to the environment.	**Addressed in CSR:** Off-site monitoring is undertaken to confirm that there are no releases above regulatory limits and to measure any effect of site operations. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
Independent monitoring would give people more confidence.	**Addressed in CSR:** Independent monitoring has been done in the past (e.g. Fisheries and Oceans Canada and Health Canada). Health Canada continues to monitor at stations downstream of Whiteshell Laboratories. **Outstanding Issues:** None.
External Events	
Significant external events like forest fires could impact on security.	**Addressed in CSR:** External events have been considered in the Safety Analysis Reports for the various nuclear facilities at Whiteshell Laboratories. **Outstanding Issues:** None.
There is a need to undertake a probabilistic risk assessment of external events.	**Addressed in CSR:** Safety Analysis Reports have considered external events. Future safety analysis to support interim end-state and monitoring and surveillance plans will also consider external events. **Outstanding Issues:** None.
Has the effect of flooding of the Winnipeg River on stored waste materials been considered?	**Addressed in CSR:** Flooding was assessed by Manitoba Hydro on the basis of a dam failure at Seven Sisters. The assessment determined the Whiteshell Laboratories site including the WMA would be unaffected. **Outstanding Issues:** None.
Security	
24-hour monitoring of Waste Management Area should be considered.	**Addressed in CSR:** There will be 24-hour camera surveillance of the WMA during decommissioning. Any incidents can be responded to within a reasonable timeframe (approximately one-half hour). This represents an enhancement in routine monitoring and surveillance from the level in place throughout the site operating period. **Outstanding Issues:** None.
There is the perception that AECL is abandoning the site and leaving it to a security company with low-paid employees.	**Addressed in CSR:** AECL is committed to maintaining fully trained and qualified staff on site to carry out the site monitoring and surveillance activities As well, AECL's management system clearly identifies responsibilities for radiation protection, environmental protection and monitoring, and health and safety. **Outstanding Issues:** None.
Future Staffing Requirements	
The loss of technical resources in region will impact on future availability of qualified staff.	**Addressed in CSR:** Key people have been retained and will be retained to maintain all site management requirements. **Outstanding Issues:** None.
Loss of corporate memory is reducing peoples' confidence in ability of future staff to manage problems.	**Addressed in CSR:** There are a variety of methods AECL uses to protect against the loss of corporate memory. These include: A management system that defines responsibilities, sets goals and uses standards for operating the Company and its staff; Internal and external training programs (e.g. radiation protection training); Maintaining a complement of key staff; Contracting back former staff to help address operational or decommissioning issues; Operating procedures for the various buildings and systems; Centralized records and reports systems; On-line information available through the Intranet; Retention of internal and external consultants to assist in the identification and assessment of historical information and data. **Outstanding Issues:** None.
There is a concern about whether training will be adequate for staff and what their qualification requirements will be.	**Addressed in CSR:** A training program will be maintained as required by the CNSC to meet all site monitoring and surveillance requirements. AECL can also call on its resources at Chalk River to provide support for training if it is not available at Whiteshell Laboratories. The program is audited by the CNSC. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
When decommissioning, using personnel familiar with the operations of a facility and the location and nature of the contamination poses less risk to the employees.	**Addressed in CSR: It** is desirable to take advantage of the knowledge of people who are on the site. The DDP's will be developed using information from all available sources. Generally, these plans will be completed during the next five years. However it should be pointed out that virtually all of the people who have worked on Whiteshell will have reached retirement age within the next ten years. They simply won't be available to participate in the actual decommissioning process regardless of the alternative selected. That said, the DDP's will provide a detailed disciplined step-by-step description of the decommissioning process in accordance with CNSC Regulatory Document G-219. This will ensure that the process is not dependent on human memory alone. It should also be noted that "corporate memory" is most important in the achievement of facility shutdown. Once shutdown is complete, there is a transition to a team expert in monitoring, dismantling, demolishing, and remediating. **Outstanding Issues:** None.
To leave a site virtually unattended without the necessary staff to provide full protection is unprecedented. The CSR does not even give an indication of the structure and competence of the caretaker operation.	**Addressed in CSR:** AECL has clearly committed to maintaining the resources required to carry out the monitoring and surveillance activities to the end of the decommissioning program including security, fire fighting, environmental monitoring, radiation protection and buildings maintenance. A new Section (9.5.1) describing the disciplines required has been added. The site will remain under CNSC licence as appropriate to ensure there will be no unreasonable risk to people or the environment. **Outstanding Issues:** None.
AECL has been putting pressure on the L.G.D. of Pinawa to agree to provide fire protection to the active area of the site. AECL must maintain their own fully trained fire protection staff as long as there are contaminated facilities on the site.	**Addressed in CSR:** As noted in the above response, AECL commits to meeting fire protection requirements for the licensed site and facilities. The provision of such services can include the use of shared community resources. The CNSC will also ensure, through its licensing and compliance process, that adequate emergency response is in place. **Outstanding Issues:** None.
Start immediately to fully decommission the Whiteshell site in a continuous way according to the twenty-year time frame. This would allow full advantage to be taken of local knowledge and provide continuous employment for a decommissioning team and a level of economic activity that would go some way to alleviating the impact of the withdrawal of AECL's R&D activities.	**Addressed in CSR:** See response to 4th comment above. Note also that, with respect to economic effects, the scope of the assessment includes only those effects that are directly the result of changes that the project is likely to cause to the biophysical environment. **Outstanding Issues:** None.
An intermittent decommissioning process will have huge problems in assembling the human resources each time there is an incremental activity.	**Addressed in CSR:** With the exception of the WMA and WR-1, a large portion of the decommissioning will occur during the first 20 years. The safety and environmental rationales for the proposed phasing of the decommissioning program are set out in the draft CSR. A summary table and figures outlining the scheduling of key decommissioning activities is included in Section 4.0. Given the lead times available for the detailed planning and preparation of the various decommissioning phases, and the anticipated requirements for the provision of financial guarantees, the assembly of the necessary resources to carry out the decommissioning stages is not anticipated to be a problem. **Outstanding Issues:** None.
Site Characterization	
Does AECL know everything about the site?	**Addressed in CSR:** AECL has adequate knowledge about the site to ensure maintenance of health and safety and environmental protection. Decommissioning involves activities to characterize the hazards and minimize potential effects on workers, the public and environment. **Outstanding Issues:** None.
There is the perception that records on where materials are stored at the WMA are not good.	**Addressed in CSR:** This is a false perception. Records are good and the locations of where waste is stored at the WMA are well documented. As well, records will be maintained in a secure, centralized location. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
There is a lack of detail as to the nature of the contamination in the facilities and the quantities and location of the various waste forms.	**Addressed in CSR:** Full information on the waste streams involved for each site awaits the completion of the DDP's. Additional information on the characterization of the river sediments and the Waste Management Area is provided in the appropriate sections of Section 4.0. AECL believes that the amount of information necessary to demonstrate that the decommissioning can be carried out without significant effects on the environment, as required under *CEAA*, has been provided. **Outstanding Issues:** None.
Much more detail on the condition of the facilities (nature, location and amounts of contamination) is required before AECL can be allowed to proceed with decommissioning.	**Addressed in CSR:** The responsible authority(ies) will consider in the CSR the information necessary to decide if the project is likely to cause significant adverse environmental effects, taking into account the appropriate mitigation measures. This will require a certain amount of detail on the conditions and characteristics of the facilities and the ranges of contamination present. It is normally not necessary to have all of the detailed information to make an EA decision on the overall likelihood and significance of effects. The revised CSR now contains the information appropriate for arriving at environmental assessment-level decisions with a reasonable level of certainty. Further detailed information will be required for licensing purposes, such as prior to the authorization of specific decommissioning tasks to be specified in Detailed Decommissioning Plans for each facility. Furthermore, the proposed follow-up and monitoring program will be designed to gather more specific information during the actual decommissioning process. That information will be used to verify the predicted effects and ensure effectiveness of the mitigation measures. **Outstanding Issues:** None.
There is no analysis in the report to support the conclusions. AECL is controlling the access to information about the condition of the facilities and the quantities, types and disposition of the radionuclides, making it impossible to undertake independent safety assessments.	**Addressed in CSR:** All of the information necessary to support the conclusions of the environmental assessment has now been added to the CSR. If the project proceeds from the environmental assessment stage, further detailed information will be included at the time that the Detailed Decommissioning Plans for each component of the facility will be prepared under the CNSC licensing process. All information used in the environmental assessment is available to the public in either the CSR itself, or from the related documents listed in the Public Registry. Information related to the licensing will also be available to the public from the CNSC. **Outstanding Issues:** None.
Storage	
Waste currently stored in trenches or below ground should be moved to above ground storage bunkers or series of bunkers.	**Addressed in CSR:** Current environmental monitoring demonstrates that waste is safely stored. Except for one trench with fuel channels and some standpipe waste, waste will continue to be stored in this manner. Current safety assessments show there is no risk to human health. **Outstanding Issues:** None.
The decommissioning plan should not anticipate the availability of a repository but should focus on getting all of the high-level waste into safe storage now.	**Addressed in CSR:** All waste will be stored in CNSC-approved storage facilities throughout the decommissioning process. As buildings approach the limits of their useable and safe life they will be decommissioned. WR-1 currently meets all safety requirements and it is safer to manage components of WR-1 in the facilities until a national waste disposal site becomes available than to move it. The alternative would require the construction of an interim storage facility with shielding equal to that currently provided by WR-1. **Outstanding Issues:** None.
They must not use the lack of a repository as an excuse for not building engineered storage facilities now.	**Addressed in CSR:** Any storage of existing wastes, or those that may arise from the decommissioning project, will remain in waste management facilities, licensed by the CNSC until such time as other alternative, licensed facilities are made available. **Outstanding Issues:** None.
Long-Term Communications	
There is a need for ongoing communications to provide information on decommissioning program.	**Addressed in CSR:** AECL is committed to an ongoing communication program with area communities and stakeholders. **Outstanding Issues:** None.
There is a need to inform and involve the community in a communications plan during the decommissioning years (i.e. role in monitoring, notification protocol for work in progress, accidental releases into the environment, etc.)	**Addressed in CSR:** AECL supports the idea of a Public Advisory Committee. These are the kinds of activities that the local community could be involved with through a Public Advisory Committee. **Outstanding Issues:** A Public Advisory Committee will be considered in parallel with implementation of the decommissioning program.

ISSUES/COMMENTS	STATUS
Financial Assurances	
Will AECL be able to acquire the necessary resources for decommissioning particularly when it is looking for new money for Chalk River?	**Addressed in CSR:** AECL's decommissioning budget is a separate appropriation from Treasury Board. This money is separate from any operations/refurbishment budget needed for Chalk River. **Outstanding Issues:** None.
What guarantees are there that resources will be available for long-term monitoring?	**Addressed in CSR:** Decommissioning is covered under a direct appropriation from the Treasury Board to ensure that adequate funding is available to meet commitments. AECL has a responsibility to maintain compliance for a licensed site which includes long-term monitoring. **Outstanding Issues:** None.
What assurances does the public have that AECL won't take shortcuts?	**Addressed in CSR:** AECL has a historical track record of responsibly managing nuclear sites and operations. AECL prides itself on that reputation and intends to maintain it. The CNSC also provides a routine check on the ongoing performance of AECL and the administration of nuclear sites. As well, AECL will be required to operate within guidelines laid down by other federal and provincial agencies. **Outstanding Issues:** None.
Whatever decommissioning plan is finally accepted, there must be guaranteed funding in place to carry it out.	**Addressed in CSR:** The CNSC will require that financial guarantees are in place to ensure successful completion of the decommissioning project. **Outstanding Issues:** None.
AECL and the federal government must stop passing the buck on the financial liability and all future commitments for decommissioning should be presented and guaranteed jointly. We understand that the new CNSC regulations require that financial provisions be made before decommissioning plans can be implemented.	**Addressed in CSR:** The CNSC will require that financial guarantees are in place to ensure successful completion of the decommissioning project. **Outstanding Issues:** None.
Once a decommissioning plan is accepted and approved, firm financial guarantees from the federal government must be put in place, with penalties for missing major targets.	**Addressed in CSR:** The CNSC will require that financial guarantees are in place to ensure successful completion of the decommissioning project. **Outstanding Issues:** None.
Planning Considerations	
Table 3.2, in which the rationale for choosing the 60-year plan is presented, contains many unsupported conclusions.	**Addressed in CSR:** In general, conservative estimates have been used for costs and radioactivity. These estimates are entirely suitable for planning purposes. **Outstanding Issues:** None.
This decommissioning plan is clearly driven by fiscal considerations and not by considerations of safety, economics or public morality. Some references in the report to economic choices are not supported by analysis.	**Addressed in CSR:** The major factors controlling the timing of the decommissioning are the availability of an off-site disposal facility and the safety of the workers. That said, a costly solution such as early decommissioning of WR-1 that achieves no safety goals is not prudent. Maintaining facilities over the proposed long decommissioning time frame is also costly. **Outstanding Issues:** None.
We expect AECL to contract immediately for the necessary decommissioning facilities so that the project can move forward.	**Addressed in CSR:** The decommissioning project may not proceed until the environmental assessment requirements are complete and a decommissioning licence has been issued by the CNSC. **Outstanding Issues:** None.
Remediation of the tile hole situation should proceed with the highest priority and not wait 10 years to proceed.	**Addressed in CSR:** Addressing fuel waste stored in standpipes at Whiteshell Laboratories will capitalize on remediation planning for similar materials at Chalk River Laboratories. Engineering specifications are currently being developed for retrieval, processing and re-packaging facilities at Chalk River to safely handle the wastes. This project is aggressively in progress at Chalk River Laboratories and the realistic timeframe for implementation is 10 years. **Outstanding Issues:** None.

ISSUES/COMMENTS	STATUS
There is concern that attention will soon become focussed on decommissioning liabilities at Chalk River and that the Whiteshell liabilities will drop in priority.	**Addressed in CSR:** The priority of the Whiteshell Laboratories Decommissioning Project is adequately recognized to proceed with activities outlined in the reference document. Initiation of the decommissioning planning process with the regulator has begun and AECL is committed to this process.
Acceptability of Plan	
The CSR ignores the concerns of the Community Leaders and falsely concludes that there are no concerns in the community about the decommissioning plan.	**Addressed in CSR:** All relevant concerns expressed by the public will be carefully documented and considered in the completion of the environmental assessment. The CSR addresses recommendations made by the Community Leaders Committee in Appendix E.5. Also, a meeting was held with the Committee April 8, 2000 to respond to its recommendations. Other concerns that the Committee has that are of an economic nature are outside the scope of the CSR and are being addressed through other processes. **Outstanding Issues:** None.
Urge that the CNSC reject this decommissioning plan and instruct AECL to seek the necessary resources to properly decommission the Whiteshell Laboratories in accordance with the expectations of the communities in Eastern Manitoba and the Government of Manitoba.	**Addressed in CSR:** The CNSC will not authorise the decommissioning project until it is satisfied that it will meet all of the applicable regulatory requirements, including those for the protection of people and the environment, and for ensuring that the exposure of workers and the public to radiation is as low as reasonably achievable, social and economic factors taken into account. **Outstanding Issues:** None.
The decommissioning plan as outlined is totally unacceptable to the L.G.D. of Pinawa, also to the Mayors and Reeves of the surrounding communities, an important fact that the report neglects to mention.	**Addressed in CSR:** A draft CSR, including a description of the proposed decommissioning project, will be circulated for public review and comment before it is finalized and submitted to the Canadian Environmental Assessment Agency for a further public review. That future draft and final CSR will contain the views expressed by the public on the project and how they were considered in the environmental assessment. **Outstanding Issues:** None.
AECL's concept of community consultation is to ignore them and move on with their plan as originally conceived.	**Addressed in CSR: The** scope of the assessment offers several opportunities for public input. All relevant comments received from stakeholders will be carefully considered in the completion of the assessment. **Outstanding Issues:** None.

In general terms, the time frame to decommission is not viewed favourably by the public. However, the associated issue of availability of national disposal facilities is recognized as a constraint to the Whiteshell Laboratories decommissioning program. The CNSC has indicated that these matters fall outside the scope of the Whiteshell Laboratories decommissioning program and environmental assessment process. The long-term in-situ waste management of low-level radioactive wastes is also a concern. The environmental monitoring program confirms that these wastes are being safely managed. A risk assessment has been conducted to evaluate the feasibility of in-situ waste disposal. Results are documented in Appendix C.

The main concerns revolve around the time frame to decommission and the associated issues related to overall site management, staffing and security requirements; health and safety; environmental protection; containment of waste; long-term involvement of local communities; and financial assurances.

The public is seeking assurances from AECL that appropriate levels of financial and human resources are committed to the Whiteshell Laboratories decommissioning program. The public is seeking assurances that AECL will put in place appropriate procedures and staffing requirements to ensure that public safety and security are protected. There is concern that a loss of corporate technical knowledge through staff reductions at Whiteshell Laboratories could have an impact on the ability of AECL to adequately characterize hazards and minimize effects.

Potential environmental effects are also a concern. Much of the public has not been aware of the routine releases to the environment during Whiteshell Laboratories operations and of the comprehensive environmental monitoring program in place. A heightened awareness has occurred through the public consultation program and the public is seeking opportunities to become informed about the environmental monitoring program and to provide their input. The public is also concerned about the integrity of the concrete canisters over the long term and wants assurances that radioactivity will not leak out.

The public has consistently noted the need for a long-term communications and consultation program. AECL also notes that conflicting points of view on the proposed decommissioning plan have been raised during the consultation process. AECL acknowledges these points of view and encourages ongoing participation during the decommissioning program.

10.5 FIRST NATION CONSULTATION

10.5.1 Overview

As part of the *CEAA*-related consultation program, a process was designed to consider the informational needs and consultation preferences of First Nations whose communities and/or traditional territories are within the Regional Study Area. Areas considered in the CSR include lands covered by the terms of Treaty 1 and Treaty 3. The Treaty 1 Ojibway communities of Sagkeeng First Nation (also known as Fort Alexander, Manitoba) and Brokenhead Ojibway Nation (also known as Scanterbury, Manitoba) are located within the Regional Study Area. Lands within the Regional Study Area and Local Study Area are part of the traditional territories of Sagkeeng First Nation and Treaty 3 First Nations located in Ontario. Finally, Brokenhead Ojibway Nation has recently identified lands approximately 25 km east and south of Pinawa as part of its Treaty Land Entitlement.

Given the different contexts of each First Nation community and its potential interest in the Whiteshell Laboratories' decommissioning program, AECL developed a different initial consultation strategy with the two First Nations located in the Regional Study Area and the Treaty 3 communities located outside the study area. A description of the approach follows in Sections 10.5.2 to 10.5.4. Copies of correspondence, project description, communication protocol with Sagkeeng First Nation and a summary of contacts is provided in Appendix E.8.

10.5.2 Sagkeeng First Nation

AECL has had some previous interaction with the Sagkeeng First Nation through its participation on the Winnipeg River Roundtable on Environment and Economy. The Round Table has taken an interest in the Winnipeg River and has a number of objectives including providing recommendations on environmental sustainability with respect to specific issues and encouraging a bioregional perspective.

The initial consultation with Sagkeeng First Nation on the proposed Whiteshell Laboratories' decommissioning program involved a meeting with staff of Sagkeeng's Environment Department and AECL's consultant in August 1999. This provided an initial understanding of potential interest in the Whiteshell Laboratories' decommissioning program. A follow-up letter was sent to Chief and Council outlining the proposed decommissioning program and environmental assessment process and providing a project description with maps of the Local and Regional Study Areas. AECL also suggested that a meeting be held at Whiteshell Laboratories. A meeting was held at Whiteshell Laboratories in October 1999, that also included a tour of the facilities. Newsletters were forwarded to the Band office and staff and Chief and Council were notified of the Open House. A meeting was held in November 1999 with the Elders Council at Sagkeeng.

Sagkeeng First Nation secured external resources to retain a consultant to assist with the development and implementation of a communication protocol. A meeting was held with Sagkeeng and its consultants in November 1999 to discuss a joint communication process. The *Consultation and Communication Process for the Participation of the Sagkeeng First Nation* was jointly developed by AECL and Sagkeeng First Nation in November 1999 and set out the process for AECL and Sagkeeng First Nation to follow in reviewing and discussing issues of concern to Sagkeeng First Nation (Appendix E.8). A Core Group has been established to undertake this process.

At the request of Sagkeeng First Nation, AECL provided copies of reports for review for its assessment of potential issues of concern. Two copies of the environmental monitoring display panels indicating environmental monitoring locations were also provided.

10.5.3 Brokenhead Ojibway Nation

Initial contact was made with Brokenhead Ojibway Nation in September 1999 by AECL's consultant to notify it of the proposed decommissioning program and to determine if Brokenhead was interested in participating in the process. A follow-up letter with the attached project description and Regional and Local Study Area maps was forwarded with a suggestion that a meeting be held. A meeting was held at the Brokenhead Ojibway Nation's offices in November 1999, with Chief and Council and AECL. Copies of the newsletter were provided at an earlier date. As a follow-up to the meeting, copies of 15 years of environmental monitoring reports were forwarded for their review.

10.5.4 Treaty 3 First Nations

Initial contact was made with seven First Nations in the Treaty 3 region of Ontario in September 1999, by AECL's consultant to advise them of the proposed decommissioning program and to determine if they had an interest in the project. A follow-up letter in September 1999 provided a project description and Regional and Local Study Area maps. AECL indicated that it was interested in knowing if the First Nations currently use the local area as identified in the local area map for traditional activities. The First Nations that were contacted included: Shoal Lake 40 First Nation, Iskatewizaagegan #39 Independent Nation, Anishinabe of Wauzhushk Onigum, Ochiichagwe'babigo'ining First Nation, Lac Seul First Nation, Wabaseemoong Independent Nations and Grassy Narrows First Nation. A letter was sent in November 1999 to the Grand Chief of Treaty 3 to advise him of the contacts that had been made with the individual First Nations.

10.6 RESULTS OF CONSULTATION

10.6.1 Sagkeeng First Nation

The Sagkeeng First Nation forwarded its issues of concern in February 2000 in a document entitled "*Identified Issues for Atomic Energy of Canada for the Preparation of a Comprehensive Study Report for the Whiteshell Laboratories Decommissioning Program.*" This document is provided in Appendix E. A summary of the issues raised along with responses is presented in Table 10.5. A meeting to discuss issues and responses with representatives of the Sagkeeng First Nation was held on April 11, 2000. Further to that meeting, AECL forwarded a copy of "Whiteshell Laboratories Emergency Plan" and a copy of the draft CSR Revision 1 in April 2000. Sagkeeng was advised of the information sessions in area municipalities and were forwarded copies of the June 2000 newsletter. Copies of transmittal letters are provided in Appendix E.8. Further communication with Sagkeeng occurred at a meeting held on August 28, 2000 to provide a status update of the CSR technical review and to discuss Sagkeeng's potential involvement in the environmental monitoring program and its training requirements. As a result of discussions in November 2000, it was agreed that further meetings would be held on completion of the technical review of the draft CSR.

Table 10.5
Issues Raised by Sagkeeng First Nation

ISSUES/COMMENTS	STATUS
Impacts to Flora and Fauna	
CSR should address possible impacts on flora and fauna from historical activities as well as proposed decommissioning activities. Study should also address impacts to migratory species.	**Addressed in CSR:** Results of the environmental monitoring program indicate that the effects on flora and fauna, including migratory species, from past operations have been negligible. Proposed remediation of contaminated land may disturb wildlife habitat but it would be very localized and of short duration.
Specific concern about impacts to wildlife as they move in and out of Waste Management Area.	Since the WMA is fenced, large animals cannot enter the area. Although smaller species and birds enter and leave the site, monitoring data which includes animal carcasses identified no previous impacts. **Outstanding issues:** None.
Risks Associated with the Waste Management Area	
Concern about how accidental releases will be mitigated and monitored and what sort of institutional controls will be provided.	**Addressed in CSR:** The fact that the WMA is situated in clay soils and in a ground water discharge zone has positive benefits. Contaminants stored within the WMA will not move downward to the sandy zone, and this zone will not act as a transmission zone for contaminants from the WMA into the Winnipeg River. Contaminants will be rendered relatively immobile due to sorption on clay soils. Mitigation measures that will be put in place include construction of containment barriers where necessary to ensure collection and control of decontamination process water and routine site inspections to ensure the integrity of the facility. Table 6.12.2 describes the proposed mitigation measures for the continued operation and decommissioning of the WMA. Monitoring locations in the vicinity of the WMA will be maintained for as long as wastes requiring management remain at the WMA. Monitoring results will be reported annually to the regulator and will be publicly available.
Clarification sought on how intentional intrusion into the WMA will be mitigated.	Site security will be maintained as a component of monitoring and surveillance.

ISSUES/COMMENTS	STATUS
Request that a risk assessment report be prepared for the WMA that quantifies risks to the environment and human health from material stored in the WMA and material ultimately slated for disposal in the WMA that currently lies in the trench facility.	A risk assessment for the in-situ disposal of low-level wastes at the WMA has been prepared. (see Appendix C). **Outstanding Issues:** None.
Impacts to Sediment and Water Quality	
AECL asked to describe background conditions prior to Whiteshell Laboratories operations and nature and extent of impacts from releases.	**Addressed in CSR:** Background conditions for the site are documented in Guthrie and Scott 1988 "Pre-operational Environmental Survey Report of the Whiteshell Nuclear Research establishment Area" WNRE-756. AECL has an extensive program for monitoring the environment the site including the Winnipeg River. Results are documented in annual environmental monitoring reports. The 1995 Winnipeg River Task Force report concluded that it is unlikely that Whiteshell Laboratories has ever posed a significant threat to the health of downstream residents. With respect to fishery impacts, radioactivity levels in fish in the Winnipeg River are typical of values obtained across Canada, including regions very remote from nuclear facilities. These levels are well below Health Canada's guidelines.
Concern about contaminated sediment and water downstream of Whiteshell Laboratories and impacts on fish species from AECL activities and potential for impacts from decommissioning.	The Winnipeg River and associated fishery will only be affected if there is a substantial leak. AECL records show that routine discharges are currently maintained within acceptable standards and discharges will gradually diminish to virtually zero by the time decommissioning is complete. The likelihood of a major leak is low because all site and facilities protection systems and work controls are maintained during the decommissioning project. The decision on the in-situ abandonment of river sediments was dependent on completion of the assessment outlined in Appendix B. The study carried out in the fall of 2000 revealed a small inventory of contaminants immediately downstream of the outfall. It was determined that if the entire inventory was resuspended in the river, the increase in Cs-137 concentration in the river would be negligible. An assessment indicated that the dose to human or non-human biota would be well below applicable limits. No remediation is contemplated in light of those results. **Outstanding Issues:** None.
Accidents	
Concern about potential accidents during the decommissioning process and potential impacts to human health and land and water resources. AECL asked to describe safeguards that will be implemented and contingency plan in case of an accident.	**Addressed in CSR:** Potential accidents and malfunctions have avoidance and contingency plans applicable to each in order to mitigate potential environmental effects. Table 6.26 describes safeguards that will be put in place. Contingency plans and emergency preparedness plans already exist for the Whiteshell Laboratories facility. In the unlikely event of significant contaminant release, any migration will be curtailed and immediate clean-up will be implemented.
Sagkeeng request a communication program to notify Sagkeeng in the event of an incident.	Consistent with the November 1999 communications protocol between AECL and the Sagkeeng First Nation, AECL will ensure that the Sagkeeng First Nation is notified of any accident that has the potential to impact the resources within its Traditional Land Use Area. **Outstanding Issues**: None.
Reporting	
Sagkeeng request that decommissioning status reports be prepared for each phase and that reports be placed in a public registry.	**AECL Response:** AECL will prepare publicly available decommissioning status reports for submission to the CNSC. Such reports are available to any interested party. Status reporting will also be maintained as part of the ongoing communications program with the Sagkeeng. **Outstanding Issues:** A formal mechanism for public registries during decommissioning project implementation has not been established**.**

ISSUES/COMMENTS	STATUS
Involvement in Monitoring	
Sagkeeng request that they be involved in the development of a long-term monitoring program and that the people of Sagkeeng be trained and employed in the collection of monitoring data. Sagkeeng would like to partner with AECL in the monitoring of resources within the regional study area.	**AECL Response:** AECL is committed to the involvement of the Sagkeeng First Nation in the development of the long-term monitoring program. AECL is prepared to provide training and some employment in the collection of monitoring data. Discussions on Sagkeeng's involvement were initiated in August 2000 with representatives of AECL and Sagkeeng First Nation. Involvement could begin when the project commences. **Outstanding Issues:** None.

10.6.2 Brokenhead Ojibway Nation

At the initial consultation meeting with Chief and Council of the Brokenhead Ojibway Nation, AECL provided an overview of the decommissioning program and made the offer to host a tour at Whiteshell Laboratories. A number of questions were raised. In summary, concerns were expressed on the following issues:

- impacts to surface water, ground water and any effects on the Brokenhead River;
- airborne effects;
- assessment of potential contamination of lands that may be turned into a wildlife management area;
- potential impacts to wildlife; and
- potential impacts to bison herd at Brokenhead.

AECL explained that the environmental monitoring program has demonstrated that there have been no adverse environmental effects off-site. Also, the Brokenhead River is not within the same watershed.

The Brokenhead Ojibway Nation advised AECL in a letter in January 2000 that the Chief and Council wished to remain informed about the decommissioning project and further reiterated its concerns. AECL advised Brokenhead in a follow-up letter that its concerns were being addressed in the CSR and that AECL would continue to keep Chief and Council informed. Further communications included a copy of the draft CSR Revision 1 in April 2000 and copies of the June 2000 newsletter. Copies of correspondence are presented in Appendix E.8.

10.6.3 Treaty 3 First Nations

Based on information reviewed by Chief and Council, the Iskatewizaagenean Independent Nation and Shoal Lake #40 First Nation have both confirmed that they have no immediate concerns regarding the proposed decommissioning program. However, if anything new were to come up, both First Nations requested that they be contacted again. The Anishinabe of Wauzhushk Onigum confirmed receipt of AECL's letter and information. However, they have indicated that other matters were more pressing in their community and they have not yet had the opportunity to respond.

The Wabaseemoong Independent Nations indicated that they have extensive interest in the Regional Study Area, but have not responded with an identification of interests or concerns. No response was received from the Grassy Narrows First Nation, the Ochchagwe'babigo'ining First Nation or the Lac Seul First Nation.

The Treaty 3 First Nations and the Grand Chief of the Grand Council Treaty #3 were advised by letter in January 2000 that under the *CEAA* guidelines there were further opportunities for them to submit their interests during the review process. They were forwarded copies of the June 2000 newsletter to update them on the status of the CSR. Copies of correspondence is in Appendix E.8.

10.7 ONGOING CONSULTATION

AECL is committed to an ongoing communication and consultation program after the environmental assessment process is complete. Ongoing communications with area municipalities and elected officials will be undertaken. AECL supports the idea of a Public Advisory Committee and will give this consideration in parallel with implementation of the decommissioning program.
A process for a long-term relationship between AECL and Sagkeeng First Nation that ensures Sagkeeng's ongoing involvement in its areas of interest in the decommissioning program (e.g. environmental monitoring) will be established. In the spirit of partnership and capacity-building, AECL will endeavour to provide opportunities for the Sagkeeng First Nation to build on skills at the community level.

10.8 SUMMARY OF PUBLIC AND FIRST NATION CONSULTATION

The consultation program that has been undertaken by AECL has included a number of different mechanisms for providing information and receiving input on the proposed decommissioning program. These mechanisms included:

- Presentations
- Open Houses
- Information sessions
- Interviews
- Newsletters
- Reports and documents
- Meetings with stakeholders
- Public tours
- Public notices
- On-going communication via telephone, e-mail, letters.

The questions and concerns raised through the consultation process were responded to in a number of different ways:

- Verbal response at a meeting, presentation, or open house;
- Written response by letter;
- Development of a communications protocol;
- Incorporation of input into appropriate sections of the Comprehensive Study Report;
- Responses in issues tables in the Comprehensive Study Report and its appendices; and
- Follow-up programs.

AECL's commitments to an ongoing communication and consultation program will ensure that information on the decommissioning program will be made available during the implementation phases and opportunities will be available for further input. Further, AECL supports the establishment of a Public Liaison Committee in parallel with the implementation of the decommissioning program.

10.9 CONCLUSIONS

Through its consultation program, AECL is confident that it has provided appropriate opportunities for interested parties, First Nations and members of the public to become informed about the proposed decommissioning program and to raise issues of concern. These issues have been addressed in the Comprehensive Study Report. AECL is committed to an ongoing communication and consultation program to provide opportunities for public involvement during the implementation phases. It appears that the public has had and will continue to have adequate information to assess the effects of the project. No outstanding concerns associated with the decommissioning activities have been indicated.

11.0 CONCLUSIONS OF THE ASSESSMENT

This report describes the Whiteshell Laboratories Decommissioning Project and provides the results of an assessment of the likely effects of the project including an assessment of the cumulative effects of the project with other existing and proposed projects. Where appropriate, it describes mitigation measures and identifies any adverse environmental effects. The report provides the results of an assessment, which used standard and accepted methodologies, of the significance of all residual effects. Finally, the report describes the extensive and ongoing public consultation program associated with this assessment. This program includes a process developed in consultation with First Nations to keep them informed of the progress of the decommissioning program and to allow them to participate in the project in a meaningful way.

The Decommissioning Project covers a very long time frame – estimated at 60 years for the reference alternative, Alternative 3. To address the inevitable uncertainties associated with a time frame of this length, the report proposes an ongoing follow-up and monitoring program designed to keep track of environmental indicators and to allow for any necessary changes to be made. Two parts of that program are of particular interest. One is the preparation of DDPs for each nuclear facility; the other is support for a Public Advisory Committee that could assist AECL in issues related to the decommissioning.

The following conclusions may be drawn from the Comprehensive Study Report:

- the Whiteshell Laboratories Decommissioning Project is not likely to cause significant adverse environmental effects taking into account the mitigation measures recommended in the report;
- the cumulative effects analysis indicates that there are not likely to be any cumulative effects associated with the Project; and
- the public has had appropriate opportunities to become informed and to raise issues of concern. Responses have been provided for all concerns related to the proposed Decommissioning Project.

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Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 20-M22

Date signed/Signé le : 5 OCTOBER 2020

Annual Program Report

Rapport annuel sur les programmes

Canadian Nuclear Laboratories

Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2019

Laboratoires Nucléaires Canadiens

Rapport de surveillance réglementaire pour les sites des Laboratoires Nucléaires Canadiens: 2019

Public Meeting

Réunion publique

Scheduled for:
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Le 10 décembre 2020

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Le personnel de la CCSN

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Canada

Summary

This Commission member document (CMD) concerns the Regulatory Oversight Report for sites operated by Canadian Nuclear Laboratories (CNL) for the 2019 calendar year. CNL is the licensee for each of these sites.

No actions are required of the Commission. This CMD is for information only.

Résumé

Le présent document à l’intention des commissaires (CMD) porte sur le Rapport de surveillance réglementaire pour les sites exploités par les Laboratoires Nucléaires Canadiens (LNC) durant l’année civile 2019. Les LNC sont le titulaire de permis pour chacun de ces sites.

Aucune mesure n’est requise de la part de la Commission. Ce CMD est fourni à titre d’information seulement.

Signed/signé le

October 5, 2020

Kavita Murthy

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice générale

Direction de la réglementation du cycle et des installations nucléaires

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EXECUTIVE SUMMARY

The *Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2019* is a Commission member document (CMD) which presents the Canadian Nuclear Safety Commission (CNSC) staff's assessment of licensee performance at sites that are licensed to Canadian Nuclear Laboratories (CNL) for the 2019 calendar year. This report also provides an update on CNSC staff's activities related to public information, community engagement and relevant aspects of the CNSC's Independent Environmental Monitoring Program.

CNSC staff use the safety and control area framework to evaluate the performance of each licensee. This report provides performance ratings for all 14 safety and control areas (SCAs). It focuses on radiation protection, environmental protection and conventional health and safety, in particular. Taken together, these SCAs provide a meaningful overview of the safety performance of the facilities addressed in this report.

The report also includes information on the licensee's public information programs, its engagement with Indigenous groups and communities, reportable events, and areas of increased regulatory focus, where applicable to the sites. It also provides updates to matters discussed at the Whiteshell Laboratories' licence renewal Commission Hearing held in October 2019; namely an update on the security SCA and preliminary information on the potential effects on the collective occupational dose from the proposed accelerated decommissioning.

In order to assess the safety performance of licensees, the CNSC conducts regulatory oversight activities consisting of onsite inspections, technical assessments, reviews of reports submitted by licensees, reviews of events and incidents, general communication with licensees, and exchanges of information with them. While licensee performance across all SCAs is not explicitly documented in this report, CNSC staff's regulatory oversight activities extend to all SCAs.

CNSC staff have rated CNL's performance at its sites[1] in 2019 in each SCA as either "satisfactory" (SA) or "below expectations" (BE), as shown in the following table:

[1] CRL: Chalk River Laboratories; WL: Whiteshell Laboratories; PHP: Port Hope Project; PGP: Port Granby Project; DP: Douglas Point; G-1: Gentilly-1; NPD: Nuclear Power Demonstration.

SCA	CRL	WL	PHP	PGP	DP	G-1	NPD
Management system	SA	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA	SA	SA
Security	SA	BE	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA	SA	SA

CNSC staff confirm that in 2019, CNL sites continued to perform licensed activities safely. For this reporting year, CNSC staff rated all SCAs as “satisfactory” with the exception of the security SCA at Whiteshell Laboratories which was rated as “below expectations”, the same rating as 2018.

Overall, CNSC staff’s compliance activities determined that:

- radiation protection programs at all sites adequately controlled radiation exposures, keeping doses as low as reasonably achievable (ALARA)
- environmental protection programs at all sites were effective at protecting people and the environment
- conventional health and safety programs at all sites continued to protect workers

Therefore, CNSC staff conclude that in 2019, the CNL sites covered by this regulatory oversight report made adequate provisions for the health and safety of workers, the protection of the public and the environment, and Canada’s international obligations.

1 INTRODUCTION

For the purposes of the *Nuclear Safety and Control Act* (NSCA), and its associated Regulations, the Canadian Nuclear Safety Commission (CNSC) regulates Canada's nuclear industry to protect the health, safety, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely, and are required to implement programs that make adequate provision for meeting legislative and regulatory requirements.

The Commission has directed CNSC staff to report to the Commission annually on the safety performance of sites operated by Canadian Nuclear Laboratories (CNL) in the form of a regulatory oversight report (ROR). This ROR provides an overview of CNSC regulatory efforts and staff's assessment of licensee performance at sites operated by CNL for the 2019 calendar year.

The CNL sites covered by this report are:

- Chalk River Laboratories (CRL)
- Whiteshell Laboratories (WL)
- Port Hope Area Initiative (PHAI)
    - Port Hope Project (PHP)
    - Port Granby Project (PGP)
    - Port Hope Pine Street Extension Temporary Storage Site
    - Port Hope Radioactive Waste Management Facility
- Douglas Point (DP) Waste Facility
- Gentilly-1 (G-1) Waste Facility
- Nuclear Power Demonstration (NPD) Waste Facility

This report focuses on radiation protection, environmental protection, and conventional health and safety, as they provide a good overview of safety performance at CNL sites. The report also provides an overview of licensee operations, licence changes, major developments at licensed facilities and sites, and reportable events. In addition, the report includes information on CNL's public information programs, engagement with Indigenous groups and communities, Waste and Decommissioning and the CNSC's Independent Environmental Monitoring Program (IEMP). It also provides updates to matters discussed at the WL licence renewal Commission Hearing held in October 2019, namely an update on the Security SCA and information on the potential effects on the collective occupational dose from the proposed accelerated decommissioning. The information in this document is complementary to the information provided in the PowerPoint presentation titled *Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2019* CMD 20-M22.A.

2 CANADIAN NUCLEAR LABORATORIES

CNL is responsible for the operation and management of nuclear sites owned by Atomic Energy of Canada Limited (AECL) under a Government-Owned, Contractor-Operated model.

A brief overview of each CNL site is provided below, with a link to the CNSC web page that contains more details such as facility information, announcements, regulatory reporting and other key topics.

2.1 Chalk River Laboratories

Chalk River Laboratories (CRL) is located in the province of Ontario, 160 kilometers (km) northwest of Ottawa. CRL operates under a single licence that includes Class I and Class II nuclear facilities, waste management areas, radioisotope laboratories, support facilities and offices. The CRL site continues to undergo a period of change. Where permitted by the current licensing basis, CNL is shutting down and decommissioning legacy facilities, and constructing and commissioning replacement facilities throughout the site. Further information on CRL is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/nuclear-facilities/chalk-river/index.cfm

CNL continues work on the proposal to construct and operate a Near-Surface Disposal Facility (NSDF) at the CRL site. This project is currently under review by CNSC staff, is subject to an environmental assessment pursuant to the *Canadian Environmental Assessment Act, 2012*, and will require authorizations from the Commission. Additionally, Global First Power is proposing a small modular reactor at the CRL site. This project is also undergoing an environmental assessment with Global First Power as the proponent. Because there will be separate Commission decisions on these projects, they are not specifically discussed in further detail in this ROR.

2.2 Whiteshell Laboratories

Whiteshell Laboratories (WL) is a former nuclear research and test facility located near Pinawa, Manitoba that was established in the early 1960s. The site hosts the 60 megawatt thermal (MWth) Whiteshell Reactor No. 1 (WR-1), a SLOWPOKE demonstration reactor, other research and support facilities, and a waste management area that contains low-level waste (LLW), intermediate-level waste and high-level radioactive waste. The WR-1 and SLOWPOKE reactors were permanently shut down in 1985 and 1990 respectively. Decommissioning activities at WL commenced in 2003. Further information on WL is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/whiteshell-laboratories.cfm.

In 2016, the CNSC received an application by CNL to change the decommissioning approach for WR-1 from full dismantlement to in situ decommissioning. This proposed approach is currently under review by CNSC staff, is subject to an environmental assessment pursuant to the *Canadian Environmental Assessment Act, 2012*, and will require authorization from the Commission. As there will be separate Commission decisions on this project, it is not specifically discussed further in this ROR.

2.3 Port Hope Area Initiative

The Port Hope Area Initiative (PHAI) consists of the Port Hope Project (PHP) and the Port Granby Project (PGP). The scope of the PHAI is defined by a legal agreement between the Municipalities of Port Hope and Clarington and the Government of Canada, originally signed in 2001. These projects involve the clean-up of historic low-level radioactive waste contamination found in Port Hope and Port Granby, and its emplacement in new long-term waste management facilities (LTWMFs) located in each community.

The Port Hope Pine Street Extension Temporary Storage Site and the Port Hope Radioactive Waste Management Facility are small temporary storage sites for low level waste that are being remediated as part of the PHP. As such, they are included under the PHP in this report.

Further information on the PHAI is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/waste/historic-nuclear-waste/port-hope-area-initiative/index.cfm.

2.4 Prototype Power Reactors

The Douglas Point (DP), Gentilly-1 (G-1), and Nuclear Power Demonstration (NPD) waste facilities are three prototype power reactors that are currently safely shut down and undergoing decommissioning activities of hazard reduction and waste characterization, in line with plans reviewed and accepted by CNSC staff. These prototype reactors are required to implement and maintain programs such as radiation protection, occupational health and safety, security and fire protection.

2.4.1 Douglas Point Waste Facility

DP, located in Tiverton, Ontario on the Bruce nuclear site is a partially decommissioned prototype power reactor. The 200-megawatt electric (MWe) prototype Canada deuterium uranium (CANDU) power reactor was put into service in 1968 and permanently shut down in 1984. CNL safely manages low- and intermediate-level radioactive wastes, as well as used nuclear fuel stored in concrete dry storage canisters at the site. CNL is also undertaking decommissioning planning activities. Further information on DP is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/douglas-point-waste-facility.cfm.

In July of 2019, CNL submitted to the CNSC an application for a licence amendment to allow CNL to begin dismantlement work at DP. This work includes a discrete set of proposed decommissioning activities that form part of a proposed multi-stage, 50-year decommissioning project. The scope of this amendment request does not include decommissioning of the Spent Fuel Canister Area or the Reactor Building. CNSC staff's assessment of the DP application can be found in CMD 20-H4. This request is subject to a separate Commission Hearing scheduled for November 2020.[2]

2.4.2 Gentilly-1 Waste Facility

G-1, located in Bécancour, Québec within Hydro-Québec's Gentilly-2 site, is a partially decommissioned prototype power reactor. The 250 MWe boiling water reactor was put into service in 1972 and shut down in 1984. At G-1, CNL safely manages low- and intermediate-level radioactive wastes, as well as used nuclear fuel in concrete dry storage canisters. Additionally, CNL is undertaking decommissioning planning activities. Further information on G-1 is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/gentilly-1-facility.cfm.

2.4.3 Nuclear Power Demonstration Waste Facility

NPD, located in Rolphton, Ontario, is a partially decommissioned prototype power reactor. The 20 MWe prototype CANDU power reactor was placed into service in 1962 and operated until 1987. At NPD, CNL safely manages low- and intermediate-level radioactive wastes. Additionally, CNL is undertaking decommissioning planning activities. Further information on NPD is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/nuclear-power-demonstration.cfm.

In 2016, CNL submitted an application to the CNSC to modify the decommissioning approach for NPD from full dismantling to in situ decommissioning, which could accelerate the decommissioning process. This application is under review by CNSC staff, is subject to an environmental assessment pursuant to the *Canadian Environmental Assessment Act 2012*, and will require authorization from the Commission. Because there will be a separate Commission decision on this project, it is not specifically discussed further in this ROR.

[2] Further information on the DP licence amendment hearing can be found on the CNSC's Website at: https://www.nuclearsafety.gc.ca/eng/the-commission/hearings/documents_browse/results.cfm?dt=26-Nov-2020&yr=2020

3 THE CNSC'S REGULATORY OVERSIGHT OF CNL

The CNSC performs regulatory oversight of licensed facilities to verify compliance with the requirements of the NSCA and associated Regulations made under the NSCA, each site's licence and licence conditions handbook (LCH), and any other applicable standards and regulatory documents.

CNSC staff use the Safety and Control Area (SCA) framework to assess, evaluate, review, verify and report on licensee performance. The SCA framework includes 14 SCAs, which are subdivided into specific areas that define its key components. Further information on the CNSC's SCA framework can be found on the CNSC's Website at: http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm.

3.1 Regulatory Activities

CNSC staff spent over 33,500 hours in 2019 working on licensing and compliance activities for CNL sites. This included effort from CNSC staff in 36 different divisions spread over 9 directorates.

Compliance

The CNSC ensures licensee compliance through verification, enforcement and reporting activities. CNSC staff implement compliance plans for each site by conducting regulatory activities including on-site inspections, desktop reviews and technical assessments of licensee programs, processes and reports.

In 2019, CNSC staff spent over 17,400 hours on compliance activities, including 14,500 hours performing desktop reviews and technical assessments of licensee documents and 2,900 hours conducting inspections. Appendix A contains a list of CNSC inspections carried out at each CNL site in 2019. All findings in these inspections were considered low-risk and did not have an impact on safety at CNL sites.

Licensing

In 2019, CNSC staff spent over 16,100 hours on licensing activities, which includes drafting new licences, preparing Commission member documents, and drafting or revising LCHs. A summary of licensing activities is below:

Site, Facility or Project	Licence Changes	LCH Changes
Chalk River Laboratories	None	Revised LCH issued February 2019
Whiteshell Laboratories	5-year licence issued December 2019 • CMD 19-H4 • Record of Decision	New LCH issued January 2020
Port Granby Project	Licence amendment with new release limits, April 2019 • CMD 19-H101 • Record of Decision	New LCH issued April 2019
Douglas Point, Gentilly-1 & Nuclear Power Demonstration waste facilities	Separation of single licence into individual licences for each site, February 2019 • CMD 18-H107 • Record of Decision	New LCHs issued, one applicable to each site: • NPD issued April 2019 • DP issued June 2019 • G-1 issued July 2019

As CNSC regulatory documents are published, CNSC staff update the LCHs as applicable for each site, taking into consideration the licensee's implementation plans. CNSC staff verify the implementation as part of ongoing compliance verification activities. Appendix B provides a list of CNSC regulatory documents implemented at CNL sites and used by CNSC staff for compliance verification.

International Atomic Energy Agency (IAEA) Safeguards Activities

Under the terms of the Canada-IAEA safeguards agreements, the IAEA has the right to perform independent verification activities at various types of sites in Canada. The PGP is the only site covered by this ROR which is not under IAEA safeguards, as the PGP site does not possess safeguarded materials. IAEA activities are not CNSC compliance inspections, but CNSC staff accompany the IAEA in roughly 75% of their activities.

In 2019, the IAEA carried out activities at CRL, WL, PHP, DP, and G-1 to verify nuclear material inventories and assure the absence of undeclared nuclear material and activities. No significant issues were identified.

3.2 Performance Ratings 2019

Performance ratings result from regulatory oversight activities. CNSC staff have rated CNL's performance in each SCA as either "satisfactory" (SA) or "below expectations" (BE).

SCA	CRL	WL	PHP	PGP	DP	G-1	NPD
Management system	SA	SA	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA	SA	SA
Security	SA	BE	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA	SA	SA

Appendix C provides SCA ratings for each site from 2015 to 2019.

For 2019, CNSC staff rated all SCAs for all CNL sites as "satisfactory", with the exception that CNSC staff have evaluated the Security SCA at WL as 'below expectations'.

Update on Repatriation of Highly Enriched Uranium (HEU)

Under the joint regulatory oversight of the CNSC and the United States Nuclear Regulatory Commission (USNRC), CNL has been safely returning materials which contain HEU to the United States. The HEU originates from materials imported to Canada for research and medical isotope production at CRL. The movement of HEU is also monitored by the IAEA. In 2019, CNL continued fuel and liquid HEU repatriation activities, with six shipments completed. CNSC staff have assessed CNL's repatriation work and concluded that it continues safely.

Update on Security SCA at WL

CNSC staff have evaluated CNL's 2019 performance at the WL site for the Security SCA as "below expectations", the same rating as 2018. In 2018, CNSC staff raised concerns regarding CNL's security program at Whiteshell Laboratories. These concerns led to the CNSC issuing an Order to CNL to implement changes to CNL's security posture at the site. In September of 2019, CNL submitted a corrective action plan to the CNSC to address identified deficiencies, while implementing interim compensatory measures that were reviewed and accepted by CNSC staff. CNL is providing regular progress updates on the status of the actions identified in the corrective action plan.

Closure of the CNSC Order is contingent on CNL completing the implementation of the corrective action plan. CNL has made significant progress, and CNSC staff expect that CNL will complete all actions identified in the corrective action plan, as well as additional response force training and procurement, by the end of September 2020.

4 THE CNSC'S ASSESSMENT OF SAFETY AT CNL SITES

The CNSC regulates all aspects of safety at nuclear sites in Canada, including risks to workers, the public and the environment. Information related to the SCAs of radiation protection, environmental protection and conventional health and safety are most representative of CNL's overall safety performance. In particular, the SCAs of radiation protection and conventional health and safety are a good measure of the safety of workers at CNL sites, while the SCA of environmental protection is a good measure of the safety of the public and the environment.

For both the radiation protection and environmental protection SCAs, the concept of Action Levels (ALs) is used. ALs are a specific dose of radiation or other parameter that serve as an early warning to safeguard against exceedances of radiation dose limits and environmental release limits. Action level exceedances are reportable to the CNSC.

4.1 Environmental Protection

Protection of the environment and the public are linked in the SCA of environmental protection. This SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances, and the effects on the environment from facilities or as a result of licensed activities.

Currently, all CNL sites covered by this ROR have acceptable environmental protection programs in place to ensure the protection of the public and the environment. For 2019, CNSC staff rated the environmental protection SCA at all CNL licensed sites as “satisfactory”.

Appendix D provides the total annual releases of radionuclides for each CNL site from 2015 to 2019. Appendix E contains data on dose to the public for each CNL site from 2015 to 2019.

Effluent and Emissions Control at CNL sites

CNL implements effluent and environmental monitoring programs at all sites covered by this ROR.

Emissions: CNL reported three action level exceedances at CRL for releases of radioactive substances to air. Two of the exceedances were in adjacent weeks at the Waste Management facilities and were related to the transfer of waste bags with higher than normal quantities of tritium. The third was related to work in the Universal Cells facility due to internal cross contamination from a higher activity cell to a lower activity cell. CNSC staff have assessed that the risk to the public and the environment from these exceedances is negligible.

Effluents: There was one exceedance of the *Wastewater Systems Effluent Regulations* (WSER) limits at CRL in 2019. This was an exceedance of total suspended solids applicable to the B1425 Sanitary Sewage Treatment Facility effluent. CNL reported one action level exceedance at PGP for arsenic, uranium, molybdenum and radium-226 in effluent due to higher influent feed water concentration and temperature. CNL also reported a release of untreated water from the PGP to Lake Ontario and the Port Granby Creek following a heavy rain event in July 2019.

At all CNL sites, airborne and waterborne releases of radioactive and hazardous substances remained below their respective regulatory limits in 2019. CNSC staff conclude that the effluent verification monitoring programs in place for CNL facilities protect the environment and the public.

CNL’s Environmental Management System

The CNSC requires that licensees develop and maintain an Environmental Management System (EMS) in order to provide a documented framework for integrated activities related to environmental protection. CNL has established a corporate EMS which applies to all CNL sites in Canada. Through regular compliance verification activities, CNSC staff confirmed that CNL’s corporate EMS conforms to International Standards Organization (ISO) 14001: *Environmental Management Systems*, and the EMSs for CRL and WL are registered to ISO 14001:2015.

Assessment and monitoring

CNL has implemented an Environmental Monitoring Program (EMP) at its facilities, which complies with the CSA N288.4: *Environmental Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills*.

Through compliance activities conducted during 2019, CNSC staff concluded that environmental monitoring conducted at CNL sites and the discharge of treated effluent from CNL sites met regulatory requirements. CNSC staff assessment of CNL's EMP annual report results for the year 2019 confirm that the EMP in place for CNL facilities protects the environment and the public.

Environmental Risk Assessment

The Environmental Risk Assessment (ERA) is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment to human and non-human (biological) receptors.

In 2019, CNL submitted an ERA for DP and an updated ERA for CRL. CNSC staff determined that the ERAs are compliant with the CSA Standard N288.6-12: *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*. CNSC staff's assessment of the DP ERA can be found in CMD 20-H4, related to the DP licence amendment request.

A Safety Analysis Report (SAR) was submitted for G-1 in 2019 that included information demonstrating that operations do not pose an unreasonable risk to human health and the environment.

Protection of the Public

CNL is required to demonstrate that the health and safety of the public are protected from exposures to hazardous substances released from its licensed operations. The effluent and environmental monitoring programs are used to verify that releases of hazardous substances do not result in environmental concentrations that may affect public health.

The CNSC receives reports of discharges to the environment through the reporting requirements outlined in CNL's licences and LCHs. CNSC staff assessment of CNL's Environmental Monitoring Program annual report results for non-radiological (hazardous substances) at CNL facilities for the year 2019, conclude that CNL met regulatory requirements.

Estimated dose to the public

As part of annual reporting to the CNSC, CNL provides data on dose to a hypothetical member of the public that is representative of someone who spends considerable time in proximity to the licensed site.

In all cases, CNL's data indicates that doses to the public resulting from CNL's operations are well below the 1 mSv limit prescribed in the *Radiation Protection Regulations*. At no point during 2019 did the emissions from the CRL site exceed the constraint for dose to the public of 0.30 mSv/year (y) indicated in the CRL LCH. Additionally, the maximum estimated doses to the public from CNL sites were from the PGP at 0.0396 mSv and the PHP at 0.0360 mSv, which are both less than 4% of the regulatory annual dose limit of 1 mSv.

4.2 Radiation Protection

The Radiation Protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. CNL sites are required to implement and maintain a radiation protection program to ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

For 2019, CNSC staff rated the radiation protection SCA at all CNL licensed sites as "satisfactory".

Appendix F contains data on dose to workers for each CNL site from 2015 to 2019.

Application of ALARA

CNL's application of ALARA within the radiation protection program includes management commitment and oversight, personnel qualification and training, design analyses of facilities and systems, provision of protective equipment and ALARA assessments/reviews of radiological activities.

In 2019, CNL continued to effectively implement the ALARA program at its sites. This program integrates ALARA into design, planning, management and control of radiological activities, and is based on current industry best practices and operating experience. Of note in 2019, CNL introduced a new Radiological Work Permit form that identifies radiological hazards and radiation protection controls in a consistent manner, which in turn increases the effectiveness of pre-job briefings.

WL Decommissioning ALARA Assessment

In the Record of Decision from the October 2019 WL licence renewal Commission Hearing, the Commission requested that CNSC staff provide a systematic assessment of the potential effects on the collective occupational dose from the proposed accelerated decommissioning. In order to provide this information to the Commission, CNSC staff requested that CNL perform an ALARA assessment addressing the impacts of accelerated decommissioning. CNL submitted this assessment to the CNSC on July 30, 2020. This assessment included the potential impact of accelerated decommissioning on both collective and individual doses.

The total collective dose for the accelerated decommissioning approach is estimated to be 520 person-millisieverts[3] (p-mSv), compared to a total collective dose estimate of 205 p-mSv for the alternative selected in the 2002 Comprehensive Study Report (end-state achieved in a 60 year period). This 520 p-mSv collective dose estimate includes workers at both WL and CRL and assumes in situ decommissioning of the WR-1 Reactor and low-level waste management trenches, with the activities concluding in the year 2027.

CNSC staff's preliminary conclusion is that the current suite of action levels (which includes a maximum annual dose of 6 mSv) are appropriate to provide assurance that worker exposures will be managed and controlled during the proposed period of accelerated decommissioning. CNSC staff will provide another update to the Commission after CNSC staff have completed their analysis of CNL's ALARA assessment.

Worker dose control

Workers, including employees and contractors, conducting work activities which present a reasonable probability that the worker may receive an occupational dose greater than 1 mSv/y, are identified as Nuclear Energy Workers (NEWs). Workers, whose job function do not present a reasonable probability of receiving an occupational dose greater than 1 mSv/y are considered non-NEWs.

In 2019, no worker received a radiation dose in excess of the CNSC regulatory dose limits. The maximum dose received by a NEW at CNL sites was at CRL, with a dose of 8.23 mSv, which is approximately 16 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period.

Radiation protection program performance

Radiation protection program performance at CNL sites was assessed in 2019 through CNSC staff compliance activities.

CNSC staff approved revisions to the PHAI RP Plan for the PHP and PGP in February 2019, which included updates to the action levels for radiological exposures to be more aligned with current work activities. CNL revised the action levels at DP and G-1 based on reviews of historical dosimetry results and planned activities. The revised actions levels for both sites were submitted to the CNSC in December 2019 and accepted by CNSC staff in March 2020.

In 2019, no radiation protection action levels were exceeded.

Radiological hazard control

Radiation and contamination monitoring programs continued to be implemented at CNL's sites in 2019, to control and minimize radiological hazards and the spread of radioactive contamination. Dose rate measurements and, where appropriate, in-plant air monitoring are routinely performed to confirm that radiation exposures are kept ALARA.

[3] Person-millisieverts is a unit of measurement for the annual collective dose for workers (the sum of the effective doses received by all the workers at a facility in a year)

The radiological hazard surveys conducted in 2019 by CNL's staff did not identify any adverse trends, and were consistent with expected radiological conditions.

In April 2019, CNL had 4 skin contamination events occur within a 1 week period associated with the removal of contaminated piping at WL. While the respiratory protection specified provided adequate protection against inhalation intakes, CNL determined that improvements in protective clothing were necessary to prevent worker body contamination. Based on this operating experience, CNL suspended work, changed the suits used during these activities, and provided further training to staff on dress/undress procedures to ensure all proper protocols were being followed. Work resumed in September 2019, and no further skin contaminations were reported. CNSC staff is satisfied with CNL's corrective actions. None of these skin contamination events resulted in an action level exceedance.

4.3 Conventional Health and Safety

The conventional health and safety SCA covers the implementation of a program to manage workplace safety hazards and protect workers. CNL licenced sites must develop, implement and maintain effective safety programs to promote safe and healthy workplaces and minimize incidences of occupational injuries and illnesses.

For 2019, CNSC staff rated the conventional health and safety SCA at all CNL licenced sites as "satisfactory".

Appendix G contains health and safety information for each CNL site from 2015 to 2019.

Practices

During 2019, CNSC staff verified CNL safety practices during compliance inspections and site walk-downs, as well as during desktop reviews and technical assessments.

CNL conducted a company-wide safety stand down on May 30, with that day dedicated to raising safety awareness and strengthening work practices.

Performance

The key performance indicators for conventional health and safety are the number of recordable lost-time injuries (RLTI) that occur per year, RLTI severity and RLTI frequency. An RLTI is defined as a workplace injury that results in the worker being unable to return to work for a period of time.

In 2019, there was 1 RLTI at CRL, 2 at PHP, and 1 at PGP. The RLTI at PGP involved a worker who was injured by the unloading mechanism of a roll-off bin truck and was airlifted to a hospital in Toronto for medical treatment. This event was presented to the Commission in CMD 19-M9, and is discussed further in Section 5.1 of this report.

There were no RLTIs at WL, NPD, G-1, and DP in 2019.

5 EVENTS AND OTHER MATTERS OF REGULATORY INTEREST

5.1 Reportable Events

Detailed requirements for reporting unplanned situations or events at CNL licensed sites to the CNSC are included in the applicable LCH. CNSC Regulatory Document 3.1.2 Reporting Requirements for Non-Power Reactor Class I Facilities and Uranium Mines and Mills came into force for applicable CNL sites in January 2019. Over the period covered by this report, CNL has complied with the requirements for submission of these reports.

For reportable events which occurred in 2019, CNSC staff are satisfied with CNL's corrective actions.

Events which CNSC staff assess as meeting specific risk criteria are the subject of "Event Initial Reports" from CNSC staff to the Commission. In 2019, there were two Event Initial Reports which were both presented to the Commission on February 20, 2019:

1. Worker injured on January 9, 2019 at Port Granby Project, in which a contractor was pinned by the unloading mechanism of a roll-off bin truck, presented to the Commission in CMD 19-M9. Immediately following the event, CNL suspended the use of trucks with roll-off bins at all of its operations in Canada while it conducted an investigation and developed corrective actions to prevent recurrence. Corrective actions included bulletins regarding safety around remotely operated mechanisms at all sites, and training for persons operating such mechanisms. CNSC staff subsequently verified implementation of these corrective actions during an inspection.
2. Power Outage on February 3, 2019 at Chalk River Laboratories, presented to the Commission in CMD 19-M10. CNL determined that the power outage was the result of an electrical malfunction of a 2400V distribution cable. CNSC staff reviewed CNL's Root Cause Analysis for this event and found it to be a thorough assessment of the root causes of the event, which relate to aging infrastructure at the CRL site. CNSC staff also assessed that CNL's corrective and remedial actions will reduce the risk of a similar event in the future, and the consequences of such an event should one occur. CNSC staff performed an inspection at CRL in March 2020 that followed up on the site-wide power outage that confirmed the implementation of CNL's corrective actions.

CNSC staff are satisfied that CNL responded appropriately to these incidents and implemented appropriate corrective actions in response to each event.

5.2 Public Engagement

The area of public engagement has two aspects, those of activities carried out directly by CNSC staff, and of activities carried out by CNL.

5.2.1 CNSC

The NSCA mandates the CNSC to disseminate objective scientific, technical and regulatory information to the public concerning its activities and the activities it regulates. CNSC staff fulfill this mandate in a variety of ways, including hosting in-person and virtual information sessions and through annual regulatory reports. CNSC staff also participate in local community events as well as CNL led public meetings. CNSC staff also seek out other opportunities to engage with the public and Indigenous groups, often participating in meetings or events in communities with interest in nuclear sites. These allow CNSC staff to answer questions about the CNSC's mandate and role in regulating the nuclear industry, including CNL's sites.

CNSC staff carried out over a dozen outreach activities in 2019, which were targeted at, or otherwise relevant to, CNL sites. Some of these activities were targeted to specific regulatory review processes underway, including the WL licence renewal, DP licence amendment, CNL ROR, NSDF and the WL and NPD in situ decommissioning projects. CNSC staff hosted webinars and attended open houses, trade fairs, public markets, municipal Fairs, environmental stewardship meetings such as:

- Lac du Bonnet Trade Fair
- WL Open House (at WL site)
- Pinawa Birthday Celebrations Town Market
- Manitoba Metis Federation Annual General Assembly
- Petawawa Showcase weekend
- Renfrew fair
- Port Hope Fall Fair
- CNSC WL licence renewal webinar
- CNSC ROR webinar

These outreach activities are separate from CNSC staff's Indigenous engagement activities.

CNSC awarded over $41,000 in participant funding to assist Indigenous peoples, members of the public and stakeholders in reviewing this ROR and submitting comments to the Commission, as detailed in Appendix H. CNSC staff is also hosting public webinars to provide information on this ROR and the CNSC.

5.2.2 Canadian Nuclear Laboratories

To ensure open and transparent information about nuclear facilities is available to the public, the CNSC requires licensees to implement and maintain a public information program and disclosure protocol (PIDP).

CNSC staff monitor CNL's implementation of its public information and disclosure programs to verify CNL communicates regularly with its audiences in a way that is meaningful to them. CNSC staff review yearly program updates to verify CNL is taking audience feedback into consideration and taking steps to implement program adjustments to meet the evolving needs of its audiences.

Of note in 2019, CNSC staff performed an in-depth inspection of CNL's public information program for the PHAI. This inspection ran over a two-month period. During this period, CNSC staff assessed the information provided to the public by CNL for the PHP and the PGP for accessibility and content. CNSC staff observed CNL's interactions with the public by attending multiple community engagement activities performed by CNL. This inspection concluded that CNL effectively implements public information program requirements for the PHAI.

5.3 Indigenous Consultation and Engagement

5.3.1 CNSC

As an agent of the Government of Canada and as Canada's nuclear regulator, the CNSC recognizes and understands the importance of consulting and building relationships with Indigenous peoples in Canada. CNSC staff are committed to building long-term relationships with Indigenous groups who have interest in CNSC-regulated facilities within their traditional and/or treaty territories. By pursuing informative and collaborative ongoing interactions, the CNSC's goal is to build partnerships and trust. The CNSC's Indigenous engagement practices, which include information sharing and funding support (through the CNSC's Participant Funding Program) for Indigenous peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities, are consistent with the principles of upholding the honour of the Crown and reconciliation.

CNL sites fall within the traditional and treaty territories of many Indigenous communities, as listed in Appendix I. CNSC staff efforts in 2019 supported the CNSC's ongoing commitment to meeting its consultation obligations and building relationships with Indigenous peoples. In particular, CNSC staff continued to work to meet its Duty to Consult obligations with regards to CNL's proposed projects undergoing environmental assessments and licence amendments or renewals. CNSC staff also continued to identify opportunities for formalized and regular engagement throughout the lifecycle of CNL sites, including meetings and workshops upon request. Through this engagement, CNSC staff welcomed the opportunity to discuss and address all topics of interest and concern to the Indigenous communities.

5.3.2 Canadian Nuclear Laboratories

CNSC staff note that CNL has a dedicated Indigenous engagement program that covers CNL's operations and activities. CNL met and shared information with interested Indigenous communities and organizations throughout 2019.

CNSC staff continue to be satisfied with the level and quality of Indigenous engagement conducted by CNL with regards to its operations and proposed projects at its different sites. CNSC staff encourages CNL to continue to remain flexible and responsive to the requests and needs of the communities that have an interest in its sites, facilities and proposed projects.

5.4 Waste and Decommissioning

CNL's activities at each of the sites covered by this report involve the generation, storage and management of radioactive wastes. CNL has pursued accelerated decommissioning strategies at many of its sites, resulting in an actual or planned increase in the rate of generation of radioactive wastes.

Radioactive wastes stored on the sites covered by this report consist of high, intermediate and low-level radioactive waste. The inventory of wastes stored at CNL sites is included in the sixth *Canadian National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2017)*. The report can be found on the CNSC's website. The next meeting of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management will take place in May 2021. Canada's Seventh National Report will be released in the spring of 2021 and will be available on the CNSC's website.

During the reporting period, CNL enhanced its decommissioning program with the release of the Environmental Remediation Process, which is initiated when an environmental remediation is required or a CNL site requires investigation. In terms of reducing its legacy liability, throughout 2019 CNL continued to execute decommissioning and remediation activities at all of its sites.

CNSC staff maintain oversight of CNL's current and future management of radioactive wastes via inspections, desktop reviews, and technical assessments. During 2019, CNL employed effective programs to safely manage radioactive and hazardous wastes from CNL's licensed activities and decommissioning of its facilities as authorized by the Commission.

5.5 Independent Environmental Monitoring Program (IEMP)

In addition to licensees carrying out required monitoring of their operations, the CNSC carries out its IEMP to verify and confirm that the public and the environment around licensed nuclear facilities remain safe. Further information on the CNSC's IEMP, including sampling results and associated standards, can be found on the CNSC's Website at: http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm.

In 2019, CNSC staff conducted independent environmental monitoring around the CRL, DP, PHP and PGP sites. IEMP results for the areas surrounding these sites indicate that the public and the environment in the vicinity of these sites are protected.

6 OVERALL CONCLUSIONS

CNSC staff conclude that the CRL, WL, PHAI, DP, G-1 and NPD sites operated safely in 2019. This conclusion is based on CNSC staff's assessments of licensee activities that included site inspections, reviews of reports submitted by licensees, and event and incident reviews, supported by follow-up and general communication with the licensee.

For 2019, the performance in all 14 SCAs was rated as "satisfactory" with the exception of the Security SCA at WL, which was rated "below expectations".

CNSC staff's compliance activities confirmed that:

- Environmental protection programs at all CNL sites were effective in protecting the environment;
- Radiation protection programs at all CNL sites adequately controlled radiation exposures, keeping doses ALARA; and
- Conventional health and safety programs at all CNL sites continue to protect workers.

CNSC staff will continue to provide regulatory oversight at all CNL sites, to ensure that CNL continues to make adequate provision to protect the health, safety and security of workers, Canadians and the environment, and continues to implement Canada's international obligations on the peaceful use of nuclear energy.

ACRONYMS

AECL	Atomic Energy of Canada Limited
AL	Action Level
ALARA	As Low As Reasonably Achievable
BE	Below Expectations
Bq	Becquerel
CANDU	Canada Deuterium Uranium
CMD	Commission Member Document
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DP	Douglas Point
DRL	Derived Release Limits
EMP	Environmental Monitoring Program
EMS	Environmental Management System
EPD	Electronic Personal Dosimeters
ERA	Environmental Risk Assessment
G-1	Gentilly-1
HEU	Highly Enriched Uranium
Hrs	Hours
HTO	Hydrogenated tritium oxide; also called tritiated water
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program
ISO	International Standards Organization
Kg	Kilogram
Km	Kilometers
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
LTWMF	Long-Term Waste Management Facility
MBq	Megabecquerel

MeV	Megaelectron Volt
mSv	Millisievert
MWe	Megawatt Electric
MWth	Megawatt Thermal
NEW	Nuclear Energy Worker
NPD	Nuclear Power Demonstration
NSDF	Near-Surface Disposal Facility
NSCA	Nuclear Safety and Control Act
NRU	Nuclear Reactor Universal
PGP	Port Granby Project
PHAI	Port Hope Area Initiative
PHP	Port Hope Project
p-mSv	Person-Millisieverts
PIDP	Public Information and Disclosure Program
RLTI	Recordable Lost-Time Injuries
ROR	Regulatory Oversight Report
SA	Satisfactory
SAR	Safety Analysis Report
SCA	Safety and Control Area
SWS	Storage with Surveillance
USNRC	United States Nuclear Regulatory Commission
WL	Whiteshell Laboratories
WR-1	Whiteshell Reactor No. 1
WSER	Wastewater Systems Effluent Regulations
Y	Year

A. LIST OF INSPECTIONS AT CNL SITES IN 2019

Table A-1: List of inspections at Chalk River Laboratories

Inspection	Dates	SCAs Covered
CNL-CRL-2019-01: Transportation of Dangerous Goods	March 21 - 22, 2019	• Packaging and Transport
CNL-CRL-2019-02: ZED 2	September 4 - 5, 2019	• Fitness for Service • Operating Performance • Radiation Protection • Waste Management • Management System • Security • Conventional Health and Safety
Security Field Inspection	May 16, 2019	• Security
Security Field Inspection	May 17, 2019	• Security
CNL-CRL-2019-03: Waste and Decommissioning	September 4 - 5, 2019	• Operating Performance • Radiation Protection • Waste Management
Security Field Inspection	September 18, 2019	• Security
CNL-CRL-2019-04: Emergency Transport Exercise	October 9, 2019	• Emergency Management and Fire Protection • Radiation Protection • Management System

Table A-2: List of inspections at Whiteshell Laboratories

Inspection	Dates	SCAs Covered
CNL-WL-2019-01: Packaging and Transport	June 6 - 7, 2019	• Management System • Operating Performance • Radiation Protection • Conventional Health and Safety • Human Performance Management • Waste Management • Packaging and Transport
CNL-WL-2019-02: Fire Protection	August 6 - 8, 2019	• Fitness for Service • Operating Performance • Radiation Protection • Human Performance Management • Emergency Management and Fire Protection • Security • Conventional Health and Safety • Waste Management
Security Field Inspection	August 26 - 28, 2019	• Security
Security Exercise	November 28, 2019	• Security

Table A-3: List of inspections at the Port Hope Project

Inspection	Dates	SCAs Covered
CNL-PHAI-PHP-2019-01: Waste Water Treatment Plant	January 23 - 25, 2019	• Environmental Protection
CNL-PHAI-PHP-2019-02: Training	March 11 - 13, 2019	• Environmental Protection • Radiation Protection • Conventional Health and Safety • Human Performance Management
CNL-PHAI-PHP-2019-03 and CNL-PHAI-PHP-2019-04: Waste Movement RP Transport	March 26 - 27, 2019	• Radiation Protection • Packaging and Transport
CNL-PHAI-PHP-2019-05: General Inspection	August 15 - 16 2019	• Environmental Protection • Radiation Protection • Conventional Health and Safety
CNL-PHAI-PHP-2019-06: Public Information Program	September 30 - November 29, 2019	• Public Information Program
CNL-PHAI-PHP-2019-07: Small Scale Site Remediation Verification	October 1 - 2, 2019	• Environmental Protection • Radiation Protection • Conventional Health and Safety
CNL-PHAI-PHP-2019-08: Cell Integrity	November 14 - 15, 2019	• Physical Design

Table A-4: List of inspections at the Port Granby Project

Inspection	Dates	SCAs Covered
CNL-PHAI-PGP-2019-01: Waste Water Treatment Plant	January 23 - 25, 2019	• Environmental Protection
CNL-PHAI-PGP-2019-02: Cell Capping	May 29 - 30, 2019	• Physical Design
CNL-PHAI-PGP-2019 -03: Slope Stability	May 29 - 30, 2019	• Physical Design
CNL-PHAI-PGP-2019-04: Public Information Program	September 30 - November 29, 2019	• Public Information Program
CNL-PHAI-PGP-2019-05: Remediation Verification	October 2 - 4, 2019	• Environmental Protection
CNL-PHAI-PGP-2019-06: Radiation Protection	October 2 - 4, 2019	• Radiation Protection
CNL-PHAI-PGP-2019-07: Cell Capping	November 13 - 14, 2019	• Physical Design

Table A-5: List of inspections at Gentilly-1

Inspection	Dates	SCAs Covered
CNL-G1-2019-01: General Type II Inspection	August 27, 2019	• Fitness for Service • Operating Performance • Environmental Protection • Radiation Protection • Conventional Health and Safety • Emergency Management and Fire Protection • Waste Management • Security

Table A-6: List of inspections at DP

Inspection	Dates	SCAs Covered
Security Field Inspection	May 30, 2019	• Security

B. REGDOC IMPLEMENTATION

Table B-1: Regulatory Documents - CRL

Document Number	Document Title	Version	Status
REGDOC-2.1.2	Management System: Safety Culture	2018	Implemented
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	Implemented
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use, version 2	2017	Implemented
REGDOC-2.2.4	Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	2018	Implemented
REGDOC-2.4.1	Deterministic Safety Analysis	2014	Implemented
REGDOC-2.5.7	Design, Testing and Performance of Exposure Devices	2017	Implemented
REGDOC-2.6.3	Aging Management	2014	Implemented
REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Gap analysis due December 2020
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016	Implemented
REGDOC-2.12.1 (prescribed information)	High-Security Sites, Volume I: Nuclear Response Force	2013	Implemented
REGDOC-2.12.1 (prescribed information)	High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	2018	Implemented
REGDOC-2.12.2	Site Access Security Clearance	2013	Implemented
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	2013	Implemented
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	Implemented
REGDOC-3.1.2	Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	2018	Implemented
REGDOC-3.2.1	Public Information and Disclosure	2018	Gap analysis due December 2020

Table B-2: Regulatory Documents - WL

Document Number	Document Title	Version	Status
REGDOC-2.1.2	Management System: Safety Culture	2018	Implemented
REGDOC-2.2.2	Personnel Training, version 2	2016	Effective January 1, 2020
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	Effective January 1, 2020
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use, version 2	2017	TBD
REGDOC-2.2.4	Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	2018	Effective October 2020
REGDOC 2.4.3	Nuclear Criticality Safety	2018	Effective January 1, 2020
REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Gap analysis due December 2020
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016	Effective January 1, 2020
REGDOC-2.12.1 (prescribed information)	High-Security Sites, Volume I: Nuclear Response Force	2013	Effective January 1, 2020
REGDOC-2.12.1 (prescribed information)	High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	2018	Effective January 1, 2020
REGDOC-2.12.2	Site Access Security Clearance	2013	Effective January 1, 2020
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	2013	Effective January 1, 2020
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	Effective January 1, 2020
REGDOC-3.1.2	Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	2018	Implemented
REGDOC-3.2.1	Public Information and Disclosure	2018	Gap analysis due December 2020

Table B-3: Regulatory Documents - PHP

Document Number	Document Title	Version	Status
REGDOC-2.2.2	Personnel Training, version 2	2016	Effective October 2021
REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Gap analysis due December 2020

Table B-4: Regulatory Documents - PGP

Document Number	Document Title	Version	Status
REGDOC-2.2.2	Personnel Training, version 2	2016	Effective October 2021
REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Gap analysis due December 2020

Table B-5: Regulatory Documents - DP, G-1 and NPD

Document Number	Document Title	Version	Status
REGDOC-2.1.2	Management System: Safety Culture	2018	Implemented
REGDOC-2.2.2	Personnel Training, Version 2	2016	Effective June 1, 2020
REGDOC-2.6.3	Aging Management	2014	Implemented
REGDOC-2.9.1	Environmental Protection: Environmental Protection Policies, Programs and Procedures (2013)	2013	Implemented
REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Gap analysis due December 2020 Effective December 2021
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016	Effective July 1, 2020
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	Implemented
REGDOC-3.1.2	Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	2018	Implemented
REGDOC-3.2.1	Public Information and Disclosure	2018	Gap analysis due December 2020

C. SAFETY AND CONTROL AREA RATINGS, 2015-2019

The following acronyms are used in this appendix:

SA = satisfactory, BE = below expectations

Table C-1: Safety and control area summary, Chalk River Laboratories, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	BE	BE	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-2: Safety and control area summary, Whiteshell Laboratories, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	BE	BE
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-3: Safety and control area summary, Port Hope Project, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-4: Safety and control area summary, Port Granby Project, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-5: Safety and control area summary, Douglas Point Waste Facility, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-6: Safety and control area summary, Gentilly-1 Waste Facility, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table C-7: Safety and control area summary, Nuclear Power Demonstration Waste Facility, 2015 - 2019

Safety and control areas	2015	2016	2017	2018	2019
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

D. TOTAL ANNUAL RELEASE OF RADIONUCLIDES

Licensees are required to demonstrate that their releases are below their Derived Release Limits (DRL) and that the sum of their release are below 1 mSv/y, which is the public regulatory dose limit. To ensure these limits are respected, licensees also are required to develop action levels significantly below their DRLs as a means of detecting elevated releases meriting follow-up investigations and actions to ensure releases are adequately controlled.

The following tables provide the annual load of key radionuclides directly released to atmosphere or to surface waters from licensed facilities operated by CNL for the reporting period of 2015-2019. Applicable DRLs are also presented where they exist. There are no comparisons to limits and guidelines for the PHP or PGP as the limits in licences are based on either monthly mean, weekly mean, or grab samples.

Over this reporting period, there have been no licence limit exceedances.

As CNL is the licence holder for the G-1 waste facility, releases would be reported in this ROR. However, an effluent monitoring plan assessment conducted in 2016 confirmed that there is minimal or no source of airborne radioactivity at G-1. Therefore, airborne emissions are no longer monitored. Furthermore, all liquids from facility sumps were transferred to the Gentilly-2 facility effluent system to be managed and discharged by Hydro-Quebec.

CNSC staff have commenced publishing annual releases of radionuclides to the environment from nuclear facilities on the CNSC Open Government Portal: https://open.canada.ca/data/en/dataset/6ed50cd9-0d8c-471b-a5f6-26088298870e.

Chalk River Laboratories

Table D-1: Chalk River Laboratories annual radionuclide releases to atmosphere for 2015 - 2019

Year	Elemental Tritium (Bq)	Tritium: (HTO: Bq)	Carbon-14 (Bq)	Iodine-131 (Bq)	Noble Gas (Bq-MeV)	Argon-41 (Bq)	Xenon-133 (Bq)
DRL	**3.84E+17**	**1.25E+16**	**2.14E+15**	**3.96E+12**	**4.96E+16**	**6.50E+16**	**8.35E+17**
2019	5.51E+12	1.98E+14	3.44E+10	2.14E+07	N/A [a]	N/A [b]	N/A [c]
2018	6.86E+12	2.29E+14	2.54E+11	1.02E+08	6.50E+12	2.59E+15	N/A [c]
2017	4.64E+12	2.50E+14	4.90E+11	3.82E+08	6.50E+12	1.16E+16	N/A [c]
2016	2.55E+12	2.30E+14	4.84E+11	5.17E+10	8.50E+14	1.07E+16	3.12E+15
2015	4.77E+12	2.77E+14	3.77E+11	1.03E+11	1.20E+15	1.29E+16	4.89E+15

a After the safe shutdown of the Molybdenum Production Facility, there are no airborne releases of noble gases

b After the safe shutdown of the Nuclear Reactor Universal (NRU) reactor, there are no airborne releases of Argon-41

c After the safe shutdown of the Molybdenum Production Facility, there are no airborne releases of Xenon-133

Table D-2: Chalk River Laboratories annual radionuclide releases to surface water for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**1.03E+17**	**1.32E+12**	**2.70E+13**
2019	1.37E+13	4.62E+08	2.75E+10
2018	1.93E+13	6.88E+08	2.84E+10
2017	3.81E+13	7.66E+08	4.17E+10
2016	3.50E+13	6.60E+08	3.22E+10
2015	3.94E+13	6.94E+08	3.96E+10

<u>Whiteshell Laboratories</u>

Table D-3: Whiteshell Laboratories annual radionuclide releases to atmosphere for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**8.58E+16**	**9.00E+10**	**3.60E+11**
2019	3.34E+10	9.31E+04	3.27E+05
2018	1.31E+10	9.13E+04	1.70E+05
2017	5.03E+10	9.34E+04	2.24E+05
2016	3.24E+10	9.46E+04	2.12E+05
2015	9.88E+10	9.79E+04	2.26E+05

Table D-4: Whiteshell Laboratories annual radionuclide releases to surface water for 2015 - 2019

Year	Gross Alpha (Bq)	Uranium-total (Bq)	Plutonium -239/240 (Bq)	Plutonium -238 (Bq)	Americium-241 (Bq)	Gross Beta (Bq)	Strontium -90 (Bq)	Cesium-137 (Bq)
DRL	**1.33E+10**	**1.50E+11**	**1.33E+10**	**1.39E+10**	**1.25E+10**	**a**	**1.56E+11**	**1.39E+11**
2019	5.82E+07	1.49E+07	4.70E+07	4.86E+07	2.01E+07	3.43E+08	5.95E+07	2.11E+07
2018	3.90E+07	1.16E+07	2.32E+07	1.84E+07	4.21E+06	1.94E+08	3.21E+07	1.51E+07
2017	3.88E+07	1.69E+07	1.20E+07	8.69E+06	5.10E+06	2.97E+08	6.67E+07	1.89E+07
2016	4.59E+07	N/A[b]	N/A[b]	N/A[b]	N/A[b]	2.83E+08	6.08E+07	1.28E+07
2015	4.08E+07	N/A[b]	N/A[b]	N/A[b]	N/A[b]	2.23E+08	3.96E+07	1.65E+07

a There is no DRL for gross beta because there is a DRL for the regulated components of gross beta (cesium-137 and strontium-90)
b Monitoring of uranium-total, Plutonium-239/240, Plutonium-238, and Americium-241 began in 2017

Port Hope Area Initiative

Table D-5 shows releases from the Port Granby Project and Table D-6 shows releases from the Port Hope Project. For both projects, the loadings were calculated by multiplying the monthly total volume released by the monthly average concentrations. The total annual loadings are a sum of the monthly loads. There were no exceedances of regulatory limits.

Port Granby Project

CNL began using the new Waste Water Treatment Plant in 2016 to treat contaminated water at the PGP.

Table D-5: Port Granby Project annual radionuclide releases to surface water for 2015 - 2019

Year	Radium-226 (MBq)	Uranium (kg)
2019	2.2	2.7
2018	1.0	1.3
2017	1.0	1.4
2016	2.4	15.6
2015	4.6	29.0

Port Hope Project

CNL began using the new Waste Water Treatment Plant in 2017 to treat contaminated water, in place of the old Water Treatment Building. During heavy rainfall events in 2017, 2018, and 2019, CNL restarted the old Water Treatment Building to treat excess contaminated water, in accordance with their water contingency plan, in order to avoid a release of untreated water to the environment.

Table D-6: Port Hope Project annual radionuclide releases to surface water for 2015 - 2019

Year	Radium-226 (MBq)	Uranium (kg)
2019	13.6	6.9
2018	6.2	14.3
2017	16.6	110.2
2016	3.3	19.3
2015	4.5	20.7

Douglas Point

Table D-7: Douglas Point annual radionuclide releases to atmosphere for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)	Carbon-14 (Bq)
DRL	**5.46E+17**	**N/A**	**3.69E+12**	**3.22E+15**
2019	2.41E+11	4.90E+03	3.90E+04	N/A[c]
2018	7.96E+11	3.07E+03	4.55E+04	1.51E+09
2017	1.12E+11	1.64E+03	2.29E+04	N/A[b]
2016	1.59E+11	1.68E+03	1.91E+04	N/A[b]
2015	1.33E+10	N/A[a]	N/A[a]	N/A[b]

a Monitoring of gross alpha and gross beta began in 2016

b Monitoring of Carbon-14 was completed in 2018 for activities that had potential for a measurable release of C-14

c C-14 was not measured in 2019 because there were no projects identified that had the potential to generate C-14 emissions

Table D-8: Douglas Point annual radionuclide releases to surface water for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Alpha (Bq)	Gross Beta (Bq)
DRL	**2.04E+17**	**N/A**	**3.43E+13**
2019	3.73E+10	6.75E+06	4.52E+07
2018	2.73E+10	1.18E+07	1.97E+07
2017	3.57E+10	1.12E+07	2.56E+07
2016	2.23E+10	9.00E+06	1.05E+07
2015	4.24E+10	N/A[a]	7.31E+07

a Monitoring of gross alpha began in 2016

<u>Nuclear Power Demonstration</u>

Table D-9: Nuclear Power Demonstration annual radionuclide releases to atmosphere for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
DRL	**4.52E+16**	**3.83E+12**
2019	1.59E+11	4.21E+04
2018	3.08E+11	4.23E+04
2017	1.48E+12	1.84E+05
2016	2.53E+11	4.30E+04
2015	2.15E+11	4.81E+04

Table D-10: Nuclear Power Demonstration annual radionuclide releases to surface water for 2015 - 2019

Year	Tritium: (HTO: Bq)	Gross Beta (Bq)
DRL	**4.33E+17**	**2.56E+13**
2019	2.52E+10	4.06E+07
2018	1.80E+09	5.91E+07
2017	7.21E+10	1.80E+08
2016	6.57E+10	3.33E+07
2015	6.61E+10	4.13E+06

E. ESTIMATED DOSE TO THE PUBLIC

This appendix contains information on the estimated dose to the public around CNL sites. Regulatory release limits known as derived release limits or DRLs are site-specific calculated releases that could, if exceeded, expose a member of the public of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/y. DRLs are calculated using CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities*.

As per the *Radiation Protection Regulations* subsection 1(3), and considering the fact that the radiological releases from all the sites covered by this ROR have remained small fractions of the DRLs applicable to those sites, the contribution to the dose to the public from these releases remains a very small fraction of the prescribed limit for the general public.

Chalk River Laboratories

The maximum dose in each year since 2015 has been well below the dose limit of 1 mSv/y. Furthermore, at no point during this period have the emissions from the CRL site exceeded the constraint for dose to the public of 0.30 mSv/y.

Table E-1: CRL maximum effective dose to a member of the public from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Maximum Effective Dose (mSv)	0.0820	0.0780	0.0870	0.0360	0.0039	1 mSv/y

Whiteshell Laboratories

The dose to critical groups from releases from CNL-WL in 2019 was 0.00009 mSv, which is well below the regulatory dose limit of 1 mSv/y.

Table E-2: WL maximum effective dose to a member of the public from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Maximum effective dose (mSv)	0.00004	0.00007	0.00005	0.00004	0.00009	1 mSv/y

Port Hope Area Initiative

A modified approach for calculating estimated dose to the public was performed by CNL for PHAI sites in 2019, and included both radon monitoring and fence line dosimeter measurements at both PHP and PGP sites.

The annual estimated doses to the public in 2019 were 0.0396 mSv/y at PGP and 0.036 mSv/y at PHP, which are well below the annual regulatory dose limit of 1 mSv.

Table E-3: PGP maximum effective dose to a member of the public from 2015 - 2019

Dose data	2015	2016	2017	2018	2019	Regulatory limit
Maximum effective dose (mSv)	0.0084	0.0054	0.0057	0.0200	0.0396	1 mSv/y

Table E-4: PHP maximum effective dose to a member of the public from 2015 - 2019

Dose data	2015	2016	2017	2018	2019	Regulatory limit
Maximum effective dose (mSv)	0.0935	0.0120	0.0045	0.0275	0.0360	1 mSv/y

Douglas Point Waste Facility

In 2016, CNL conducted a gap analysis against CSA N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, and determined that given the very low levels of contaminants in airborne and waterborne effluents, there was no regulatory requirement for an Environmental Monitoring Program at DP. CNSC staff reviewed and accepted this gap analysis. All releases of radioactive material in DP effluents are a small fraction of their respective DRLs and thus, continue to indicate minimal impact on the public or the environment.

Gentilly-1 Waste Facility

The effluent monitoring plan assessment conducted in 2016 by CNL determined that there is minimal or no source of airborne radioactivity from routine operations at G-1. In addition, all liquid releases were discharged through Gentilly-2 effluent system, operated by Hydro-Québec, and represent a small fraction of the total releases from the larger Gentilly site. The Hydro-Québec’s Gentilly-2 environmental monitoring program captures any environmental impacts from the small contribution from G-1. The dose to the public from the Gentilly-2 nuclear site, including contributions from G-1, remain below 0.01 mSv/y.

Nuclear Power Demonstration Waste Facility

NPD is no longer discharging liquid effluents from the facility sumps to the Ottawa River, and there were no such releases during the 2019 reporting period. All other releases of radioactive material in NPD effluents are a small fraction of their respective DRLs and thus, continue to indicate minimal impact on the public or the environment. CNL’s environmental monitoring at CRL will regionally overlap with the NPD waste facility, so information from CRL’s off-site environmental monitoring program could also be considered. CNSC staff have determined that the public dose from NPD remains at a very small fraction of the public dose limit.

F. DOSES TO NUCLEAR ENERGY WORKERS AND NON-NUCLEAR ENERGY WORKERS AT CNL SITES

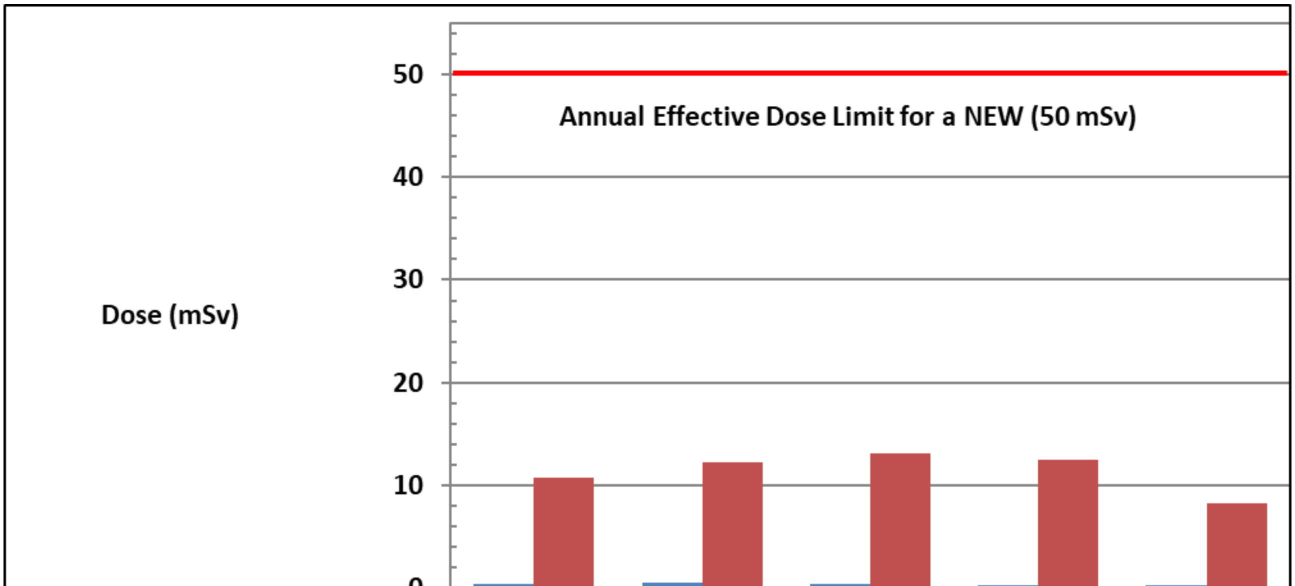
This appendix presents information on doses to Nuclear Energy Workers (NEWs) and non-NEWs at CNL sites.

Chalk River Laboratories

Figure F-1 provides the average effective doses and the maximum effective doses to NEWs at CRL from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at CRL was 8.23 mSv; approximately 16 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period.

The dose fluctuations from year to year are attributed to the scope and duration of the radiological work conducted, along with the dose rates associated with the work. No adverse trends were identified in 2019.

Figure F-1: Average and maximum effective doses to NEWs at CRL from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.45	0.49	0.44	0.34	0.27
Maximum Effective Dose (mSv)	10.72	12.24	13.13	12.48	8.23
Number of Persons Monitored	4410	4387	4515	4227	4071

As shown in tables F-1a and F-1b, equivalent doses (skin and extremity) at the CRL site were below the CNSC regulatory equivalent dose limits for a NEW of 500 mSv/y. The maximum equivalent (skin) dose received by a NEW in 2019 was 9.65 mSv; approximately 2 percent of the regulatory limit for equivalent dose to the skin of 500 mSv in a one-year dosimetry period. The maximum equivalent (extremity) dose received by a NEW in 2019 was 21.38 mSv; approximately 4 percent of the regulatory limit for equivalent dose to the hands and feet of 500 mSv in a one-year dosimetry period.

Table F-1a: Equivalent (skin) doses to NEWs at CRL from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.55	0.60	0.53	0.40	0.29	n/a
Maximum skin dose (mSv)	15.75	16.54	19.95	15.84	9.65	500 mSv/y

Table F-1b: Equivalent (extremity) doses to NEWs at CRL from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average extremity dose (mSv)	2.84	3.71	6.10	4.85	2.21	n/a
Maximum extremity dose (mSv)	29.32	41.59	85.06	44.83	21.38	500 mSv/y

Non-NEWs at CRL

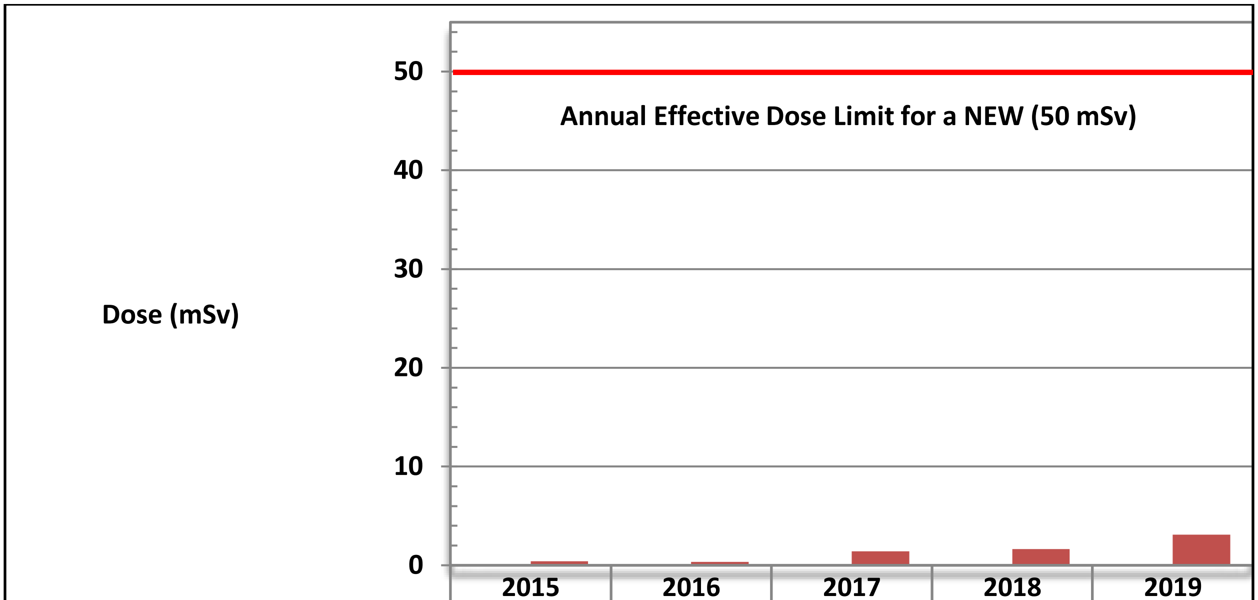
In 2019, the maximum annual effective dose received by a non-NEW was 0.3 mSv; 30 percent of the regulatory limit for effective dose of 1 mSv in a one-year dosimetry period.

Whiteshell Laboratories

Figure F-2 provides the average effective doses and the maximum effective doses received by NEWs at WL from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at WL was 3.09 mSv; approximately 6 percent of the regulatory limit for effective dose of 50 mSv in a one-year dosimetry period.

The dose fluctuations from year to year are attributed to the scope and duration of the radiological work conducted, along with the dose rates associated with the work. No adverse trends were identified in 2019.

Figure F-2: Average and maximum effective doses to NEWs at WL from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.04	0.02	0.03	0.07	0.10
Maximum Effective Dose (mSv)	0.42	0.36	1.41	1.65	3.09
Number of NEWs Monitored	753	659	607	595	489

As shown in tables F-2a and F-2b, equivalent doses (skin and extremity) at the WL site were below the CNSC regulatory equivalent dose limits for a NEW of 500 mSv/y. The maximum equivalent (skin) dose received by a NEW in 2019 was 7.47 mSv; approximately 1.5 percent of the regulatory limit for equivalent dose to the skin of 500 mSv in a one-year dosimetry period. The maximum equivalent (extremity) dose received by a NEW in 2019 was 37.77 mSv; approximately 7.5 percent of the regulatory limit for equivalent dose to the hands and feet of 500 mSv in a one-year dosimetry period.

Table F-2a: Equivalent (skin) doses to NEWs at WL from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.04	0.02	0.05	0.12	0.20	n/a
Maximum skin dose (mSv)	0.65	0.36	2.90	3.72	7.47	500 mSv/y

Table F-2b: Equivalent (extremity) doses to NEWs at WL from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average extremity dose (mSv)	0.09	0.05	1.51	5.02	4.80	n/a
Maximum extremity dose (mSv)	0.72	0.11	11.35	36.71	37.77	500 mSv/y

Non-NEWs at WL

In 2019, external dosimeters issued to non-NEWs at WL did not record any measureable doses.

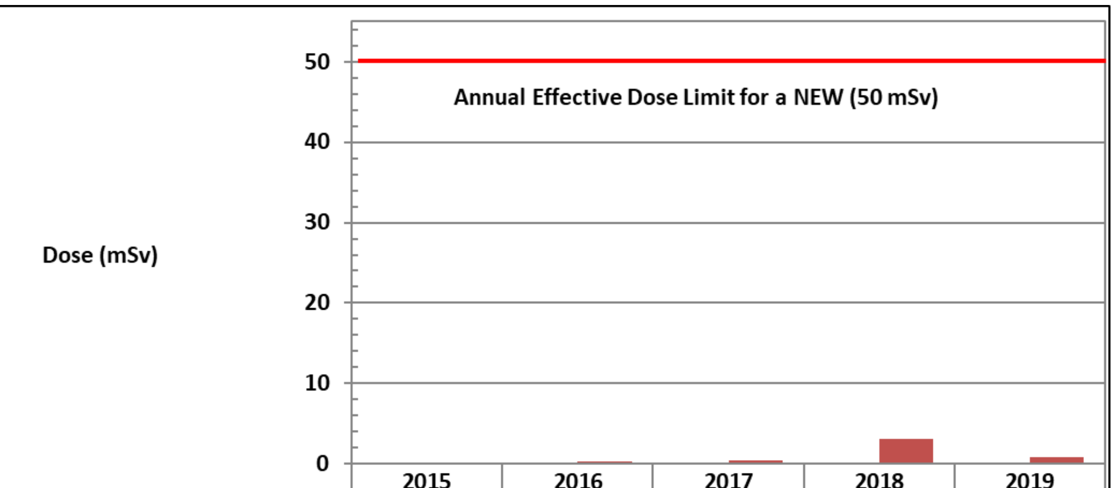
Port Hope Area Initiative

<u>Port Granby</u>

Figure F-3 provides the average effective doses and the maximum effective doses for NEWs at the PGP from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at the PGP was 0.79 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv. The total number of NEWs includes all contractors involved in work at the PGP as well as CNL staff.

Effective doses were trending down in 2019 due to work activities at the PGP nearing completion of excavation activities, and with the focus turning to capping of the Long-Term Waste Management Facility (LTWMF).

Figure F-3: Average and maximum effective doses to NEWs at PGP from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.01	0.01	0.03	0.06	0.05
Maximum Effective Dose (mSv)	0.16	0.30	0.39	3.13	0.79
Number of NEWs Monitored	118	309	430	489	560

As shown in Table F-3, skin doses at the PGP were well below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/y. The maximum skin dose for a NEW at the PGP in 2019 was 0.79 mSv, and the average skin dose for all NEWs was 0.05 mSv.

Table F-3: Equivalent (skin) doses to NEWs at PGP from 2015 - 2019

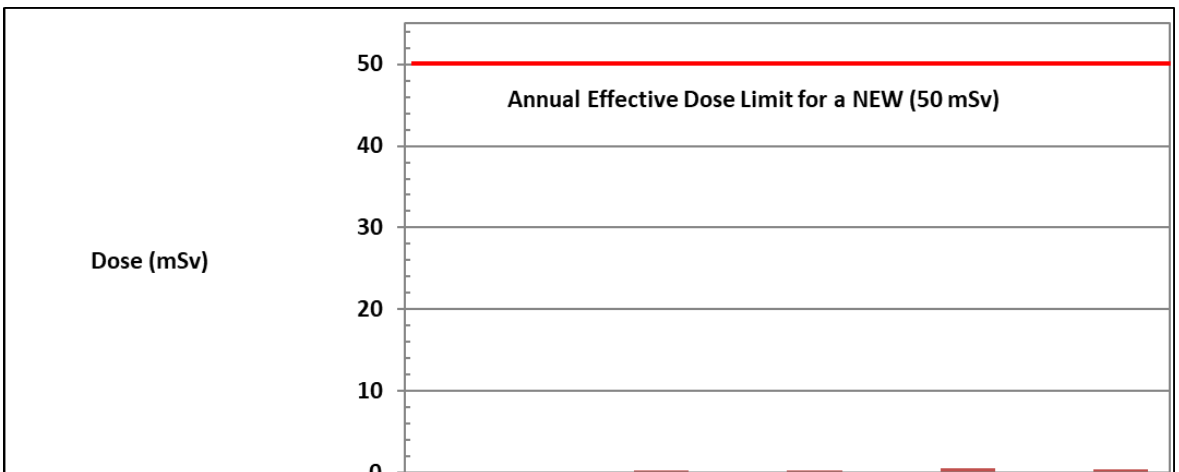
Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.01	0.01	0.04	0.05	0.05	n/a
Maximum skin dose (mSv)	0.16	0.30	0.34	2.44	0.79	500 mSv/y

Port Hope

Figure F-4 provides the average effective doses and the maximum effective doses for NEWs at the PHP from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at the PHP was 0.38 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv. The total number of NEWs includes all contractors involved in work at the PHP as well as CNL staff.

Effective doses remained low in 2019 as there were no significant changes in the scope of work activities at the PHP.

Figure F-4: Average and maximum effective doses to NEWs at PHP from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.01	0.01	0.03	0.04	0.04
Maximum Effective Dose (mSv)	0.16	0.30	0.34	0.59	0.38
Number of NEWs Monitored	118	309	343	656	932

As shown in Table F-4, skin doses at the PHP were also well below the CNSC regulatory equivalent dose limit for a NEW of 500 mSv/y. The maximum skin dose for a NEW at the PHP in 2019 was 0.60 mSv, and the average skin dose for all NEWs was 0.04 mSv.

Table F-4: Equivalent (skin) doses to NEWs at PHP from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.01	0.01	0.04	0.04	0.04	n/a
Maximum skin dose (mSv)	0.16	0.30	0.34	0.33	0.60	500 mSv/y

Non-NEWs at Port Hope Area Initiative

Doses to non-NEWs at the Port Hope Area Intitiative are either estimated based on radiological conditions of areas visited, or directly monitored by using electronic personal dosimeters (EPDs).

In 2019, the maximum annual effective doses received by non-NEWs were 0.02 mSv at the PGP, and 0.04 mSv at the PHP. These doses are well below the annual regulatory dose limit of 1 mSv in a one-year dosimetry period.

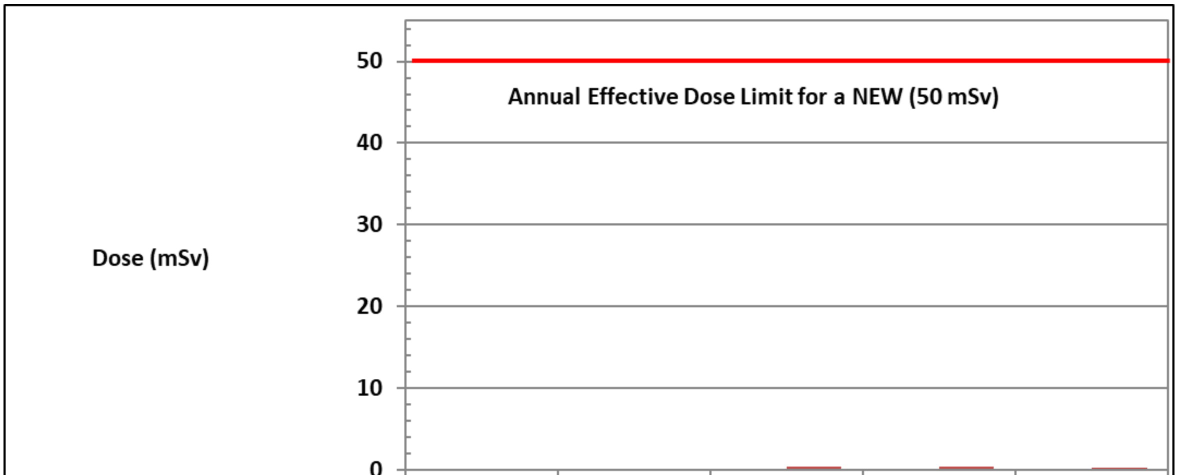
DP, G-1 and NPD Waste Facilities

Douglas Point Waste Facility

Figure F-5 provides the average effective doses and the maximum effective doses for NEWs at DP from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at DP was 0.24 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv.

There has been an increase in the number of workers since 2015 at DP, mainly attributed to an increase in the execution of planned hazard reduction work activities such as the Spent Resin Removal Project and dry active waste removal campaigns. These work activities resulted in slight increases in the maximum effective doses observed in 2017 and 2018.

Figure F-5: Average and maximum effective doses to NEWs at DP from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.00	0.01	0.01	0.01	0.02
Maximum Effective Dose (mSv)	0.06	0.11	0.37	0.43	0.24
Number of NEWs Monitored	64	80	92	123	74

Annual average and maximum equivalent (skin) dose results for NEWs at DP from 2015 to 2019 are provided in Table F-5. In 2019, the maximum skin dose received by a NEW at DP was 0.24 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv/y.

Table F-5: Equivalent (skin) doses to NEWs at DP from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.00	0.01	0.01	0.01	0.02	n/a
Maximum skin dose (mSv)	0.06	0.11	0.37	0.43	0.24	500 mSv/y

Non-NEWs at DP

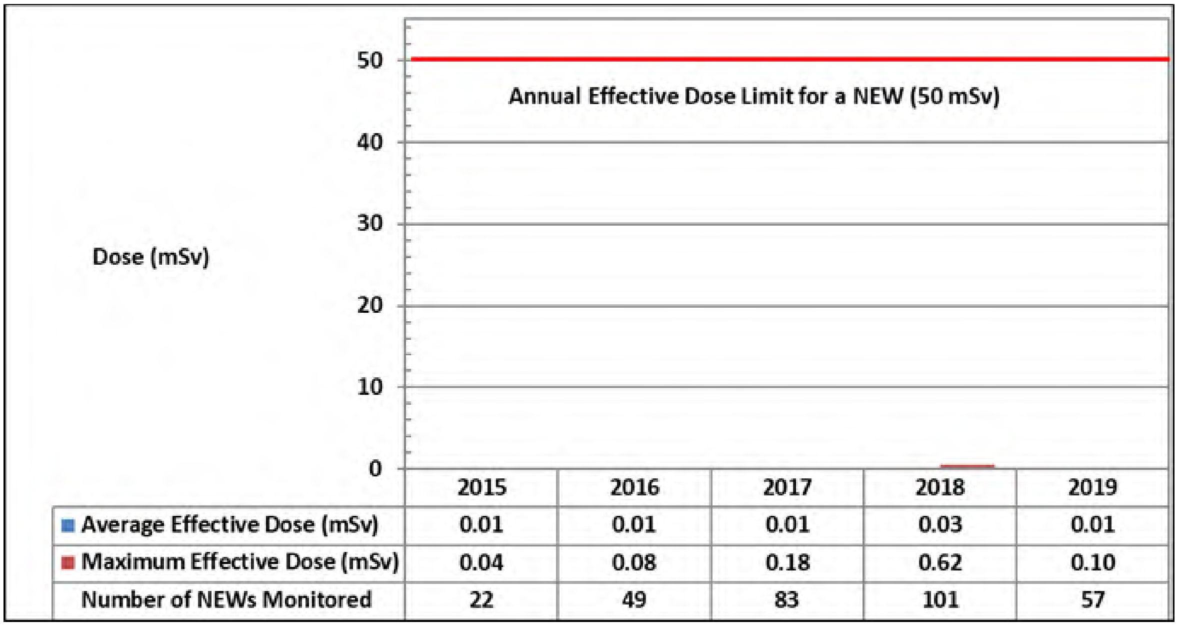
In 2019, external dosimeters issued to non-NEWs at DP did not record any measureable doses.

Gentilly-1 Waste Facility

Figure F-6 provides the average effective doses and the maximum effective doses for NEWs at Gentilly-1 from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at Gentilly-1 was 0.10 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv.

Since 2015, there has been an increase in the number of workers on site at G-1, along with slight increases in radiation doses for NEWs, due to an increase in planned work activities (both maintenance tasks and project activities), including the Spent Resin Removal Project in 2018.

Figure F-6: Average and maximum effective doses to NEWs at G-1 from 2015 - 2019



Annual average and maximum equivalent (skin) dose results for NEWs at G-1 from 2015 to 2019 are provided in Table F-6. In 2019, the maximum skin dose received by a NEW at G-1 was 0.16 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Table F-6: Equivalent (skin) doses to NEWs at G-1 from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.01	0.01	0.01	0.03	0.01	n/a
Maximum skin dose (mSv)	0.04	0.08	0.18	0.62	0.16	500 mSv/y

Non-NEWs at Gentilly-1

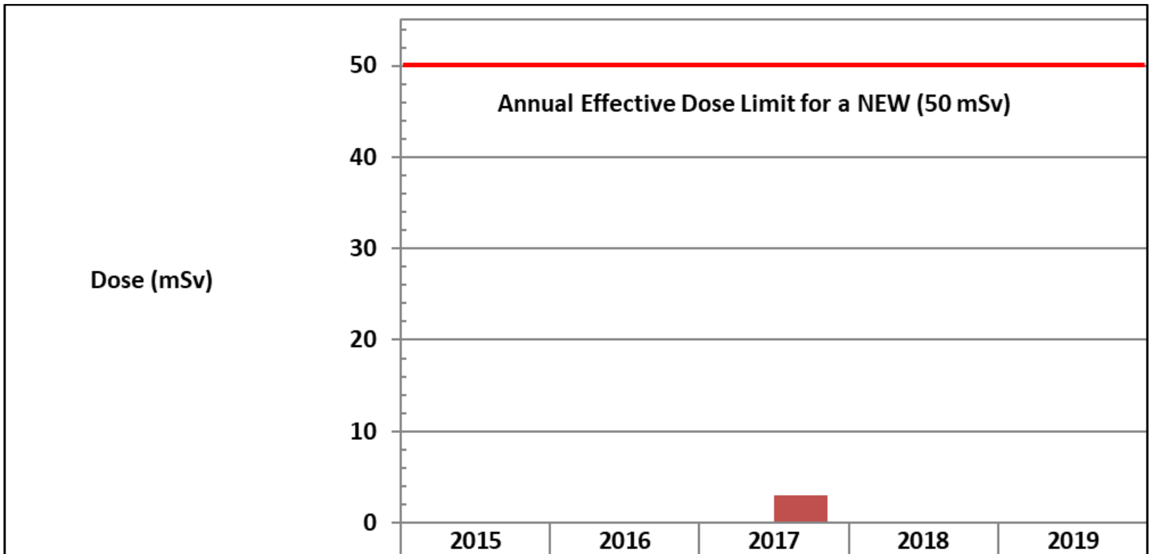
In 2019, external dosimeters issued to non-NEWs at G-1 did not record any measureable doses.

Nuclear Power Demonstration Waste Facility

Figure F-7 provides the average effective doses and the maximum effective doses for NEWs at NPD from 2015 to 2019. In 2019, the maximum effective dose received by a NEW at NPD was 0.05 mSv, which is well below the CNSC's annual regulatory effective dose limit of 50 mSv.

Effective doses during the years 2015 and 2016 were consistently low and reflect storage with surveillance (SWS) activities such as routine inspection and maintenance, as well as some hazard reduction activities. Doses in 2017 saw a sharp increase due to planned work activities involving engineering assessments, thorough facility characterization and large scale hazard reduction activities (asbestos abatement). Following the 2017 increase, doses in 2018 and 2019 have returned to levels seen previously during SWS activities, while remaining characterization and engineering activities occurred.

Figure F-7: Average and maximum effective doses to NEWs at NPD from 2015 - 2019



	2015	2016	2017	2018	2019
Average Effective Dose (mSv)	0.00	0.00	0.05	0.00	0.03
Maximum Effective Dose (mSv)	0.12	0.05	3.02	0.09	0.05
Number of NEWs Monitored	211	212	265	186	167

Annual average and maximum equivalent (skin) dose results for NEWs at NPD, from 2015 to 2019, are provided in Table F-7. In 2019, the maximum skin dose received by a NEW at NPD was 0.05 mSv, which is well below the CNSC's annual regulatory equivalent dose limit of 500 mSv.

Table F-7: Equivalent (skin) doses to NEWs at NPD from 2015 - 2019

Dose Data	2015	2016	2017	2018	2019	Regulatory Limit
Average skin dose (mSv)	0.00	0.00	0.04	0.00	0.03	n/a
Maximum skin dose (mSv)	0.12	0.05	3.03	0.09	0.05	500 mSv/y

Non-NEWs at NPD

In 2019, external dosimeters issued to non-NEWs at NPD did not record any measureable doses.

G. LOST-TIME INJURY INFORMATION

This appendix contains information on the number, frequency and severity of recordable lost-time injuries at the CNL sites covered by this ROR, with information presented separately for CNL employees and contractors.

CNL Employees

Frequency and severity are calculated per 100 full-time workers (equivalent to 200,000 worker-hours per year) using the following formulas:

Frequency rate = (# of Lost-Time Injuries) x (200 000 hrs of exposure) / (person hours worked)

Severity rate = (# of Working Days Lost) x (200 000 hrs of exposure) / (person hours worked)

Table G-1: Summary of CRL's recordable lost time injuries (RLTI), frequency and severity *(Source: CNL)*

Year	2015	2016	2017	2018	2019
Person Hours Worked (all CNL)	6 294 295	6 405 670	-	-	-
Person Hours Worked	-	-	5 597 015	5 396 450	5 729 010
Lost-Time Injuries	2	6	4	5	1
Working Days Lost	7	47	10	69	75
Frequency	0.06	0.19	0.14	0.19	0.03
Severity	0.22	1.47	0.36	2.56	2.62
Note that prior to 2017, CNL did not provide data for person-hours worked on CRL site alone, therefore total CNL hours worked are used in place of that data. This skews frequency and severity data for the CRL site for the 2014-2016 years, and makes comparison between pre- and post-2017 data for CRL difficult.					

For 2019, 75 working days were lost at CRL, the most since 2015. The majority of these days are attributable to one CNL employee who sustained a shoulder injury that required subsequent surgery.

Table G-2: Summary of WL's recordable lost time injuries (RLTI), frequency and severity *(Source: CNL)*

CNL employees at WL did not have any recordable lost-time injuries in 2019

Year	2015	2016	2017	2018	2019
Person Hours Worked	741 000	684 450	706 000	688 000	642 000
Lost-Time Injuries	0	1	3	1	0
Working Days Lost	0	5	27	5	0
Frequency	0	0.29	0.85	0.28	0
Severity	0	1.46	7.67	1.45	0

Table G-3: Summary of PHPs recordable lost time injuries (RLTI), frequency and severity *(Source: CNL)*

Year	2015	2016	2017	2018	2019
Person Hours Worked	N/A	N/A	N/A	N/A	340 000
Lost-Time Injuries	0	0	0	0	1
Working Days Lost	0	0	0	0	33
Frequency	0	0	0	0	0.68
Severity	0	0	0	0	22.57

CNL staff at the DP, G-1 PGP, and NPD sites have not recorded a lost-time injury since 2015.

Contractors at CNL sites

The number of contractor recordable lost-time incidents reported to CNL in 2019 is shown in Table G-4.

CNL records the number of lost time incidents reported to CNL by their contractors. However, contractor employee hours worked is considered sensitive information and the contractors do not divulge the specific number of hours worked to CNL as their client. Therefore, CNL does not provide frequency and severity rates for contractors since these calculations require hours worked.

Table G-4: Contractor lost time incidents in 2019 *(Source: CNL)*

Site	CRL	WL	NPD	G-1	DP	PHP	PGP
Lost -Time Injuries	0	0	0	0	0	1	1

H. PARTICIPANT FUNDING AWARDED FOR THE 2019 CNL REGULATORY OVERSIGHT REPORT

Recipient	Amount (up to)
Algonquins of Ontario	$11,700
Canadian Environmental Law Association	$5,880
Grand Council Treaty #3	$4,000
Manitoba Métis Federation	$11,700
Concerned Citizens of Renfrew County	$2,500
Curve Lake First Nation	$5,676

I. INDIGENOUS COMMUNITIES AND GROUPS WHOSE TRADITIONAL AND/OR TREATY TERRITORIES ARE IN PROXIMITY TO CNL SITES

Chalk River Laboratories and Nuclear Power Demonstration

- Algonquins of Ontario
- Algonquins of Pikwàkanagàn
- Métis Nation of Ontario
- Algonquin Anishinabeg Nation Tribal Council
- Kebaowek First Nation
- Kitigan Zibi Anishinabeg First Nation
- Anishinabek Nation
- the Algonquin Nation Secretariat
- Williams Treaties First Nations:
  - Alderville First Nation
  - Beausoleil First Nation
  - the Chippewas of Georgina Island First Nation
  - Chippewas of Rama First Nation
  - Curve Lake First Nation
  - Hiawatha First Nation
  - Mississaugas of Scugog Island First Nation

Whiteshell Laboratories

- Sagkeeng First Nation
- Manitoba Metis Federation
- Brokenhead Ojibway Nation
- Black River First Nation
- Hollow Water First Nation
- Northwest Angle #33
- Shoal Lake #40 First Nation
- Wabaseemoong Independent Nations
- Iskatewizaagegan #39 Independent First Nation
- Grand Council of Treaty 3

Port Hope Project and Port Granby Project

- Mohawks of the Bay of Quinte
- Métis Nation of Ontario
- Williams Treaty First Nations:
    - Alderville First Nation
    - Beausoleil First Nation
    - the Chippewas of Georgina Island First Nation
    - Chippewas of Rama First Nation
    - Curve Lake First Nation
    - Hiawatha First Nation
    - Mississaugas of Scugog Island First Nation

Douglas Point

- Saugeen Ojibway Nation (SON):
    - Chippewas of Nawash Unceded First Nation
    - Saugeen First Nation
- Métis Nation of Ontario (MNO)
- Historic Saugeen Métis (HSM)

Gentilly

- Abénakis of Wôlinak and Odanak, represented by the Grand Conseil de la Nation Waban-Aki
- Nation huronne-wendat

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD : 23-M30

Date signed/Signé le : 02 AUGUST 2023

Regulatory Oversight Report

Rapport de surveillance réglementaire annuel

Canadian Nuclear Laboratories

Laboratoires Nucléaires Canadiens

Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2022

Rapport de surveillance réglementaire pour les sites des Laboratoires Nucléaires Canadiens : 2022

Public Meeting

Réunion publique

Scheduled for:

November 1, 2023

Prévue pour :

le 1 novembre 2023

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

e-Doc 6948590 (WORD)
e-Doc 7067398 (PDF)

Summary

This Commission member document (CMD) concerns the regulatory oversight report for sites operated by Canadian Nuclear Laboratories (CNL) for the 2022 calendar year. CNL is the licensee for each of these sites.

No actions are required of the Commission. This CMD is for information only.

Résumé

Le présent document à l’intention des commissaires (CMD) porte sur le Rapport de surveillance réglementaire pour les sites exploités par les Laboratoires Nucléaires Canadiens (LNC) durant l’année civile 2022. Les LNC sont le titulaire de permis pour chacun de ces sites.

Aucune mesure n’est requise de la part de la Commission. Ce CMD est fourni à titre d’information seulement.

Signed/signé le

02 August 2023

Kavita Murthy

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice générale

Direction de la réglementation du cycle et des installations nucléaires

TABLE OF CONTENTS

PLAIN LANGUAGE SUMMARY

The *Regulatory Oversight Report for Canadian Nuclear Laboratories Sites: 2022* describes the safety performance of the sites that are licensed to Canadian Nuclear Laboratories (CNL) by the Canadian Nuclear Safety Commission (CNSC). It also provides details on CNSC staff's work to ensure the safety and protection of the people and the environment around the sites.

CNSC staff evaluated CNL's performance across the CNSC's standard set of 14 safety and control areas (SCAs). This report provides the resulting performance ratings for the following sites for the 2022 calendar year:

- Chalk River Laboratories (CRL) – an operating nuclear research laboratory
- Whiteshell Laboratories (WL) – a nuclear research laboratory undergoing decommissioning
- Port Hope Area Initiative
    - Port Hope Project (PHP) – a long-term low-level radioactive waste remediation project
    - Port Granby Project (PGP) – a long-term low-level radioactive waste remediation project
    - Port Hope Pine Street Extension Temporary Storage Site – a temporary storage site for low-level radioactive waste
    - Port Hope Radioactive Waste Management Facility – a temporary storage facility for low-level radioactive waste
- Douglas Point Waste Facility – a shutdown prototype power reactor
- Gentilly-1 Waste Facility – a shutdown prototype power reactor
- Nuclear Power Demonstration Waste Facility – a shutdown prototype power reactor

The CNL sites continued to operate safely in 2022, and monitoring data demonstrates that both the water and any food grown in proximity to these sites are safe to consume. There were no releases that could have harmed the health or safety of people or the environment.

Each year, CNSC inspectors conduct inspections at CNL sites. The number of inspections and their focus depend on the individual site and its performance. The CNSC uses a risk-informed approach when planning inspections. In 2022, CNSC staff performed a total of 21 inspections at the CNL sites; those inspections are covered in this report. The inspections resulted in the issuance of 73 notices of non-compliance (NNCs), which all related to issues identified as being of low safety significance. All NNCs have been closed or have an appropriate corrective action plan in place to prevent recurrence.

The CNSC assesses the safety performance of licensees by conducting regulatory oversight activities, including inspections, technical assessments of licensee reports, reviews of events and incidents, and general communication and exchanges of information with licensees. While the CNSC evaluates licensees across all 14 SCAs, the main focus of this report is the following 3 SCAs, as these provide a good overview of safety performance at CNL sites:

- **Radiation protection:** In 2022, the maximum individual effective radiation dose to a worker at any of the CNL sites occurred at the CRL site and was 5.48 mSv, which is 11% of the CNSC's regulatory limit for effective dose of 50 mSv in a 1-year dosimetry period. The maximum estimated dose to the public from a CNL site was from the PGP, at 0.033 mSv/year (3.3% of the 1 mSv/year prescribed dose limit).
- **Conventional health and safety:** All CNL sites must report any workplace-related lost-time injuries to the CNSC and to federal/provincial agencies. In 2022, there were a total of 4 lost-time injuries reported, 1 less than in the previous year and well below the frequency in comparable industries.
- **Environmental protection:** CNSC licensees are required to report to the CNSC and other regulatory authorities any unauthorized releases of hazardous substances or nuclear materials to the environment. In 2022, in the composite effluent sample from the PHP waste water treatment plant, there was 1 exceedance of the weekly release limit for copper, 1 exceedance of the weekly action level limit for zinc, and 1 exceedance of the weekly action level limit for arsenic. These exceedances did not pose a risk to human health or the environment. Airborne and waterborne releases of radioactive and hazardous substances at all other CNL sites remained below their respective regulatory limits and action levels in 2022. In compliance with applicable regulatory requirements, CNL has implemented environmental protection programs at its licensed facilities in Canada that are protective of the environment and the public.

Indigenous Nations and community engagement

CNL sites are located on the traditional and/or treaty territories of many Indigenous peoples. The CNSC is committed to building relationships and trust with Indigenous Nations and communities interested in CNSC-regulated facilities. In 2022, CNSC staff undertook ongoing and meaningful engagement activities with Indigenous Nations and communities in relation to the facilities covered by this regulatory oversight report. These engagement activities support the CNSC's commitment to meeting its consultation responsibilities and to continuing to build and strengthen positive relationships with Indigenous Nations and communities and respond to their issues and concerns. The CNSC is also making efforts to follow up with public stakeholders and previous intervenors to explore how to address issues raised.

Summary

For this reporting year, CNSC staff rated all SCAs as “satisfactory”, with the exception of the emergency management and fire protection SCA at WL and the security SCA at CRL (these were rated as “below expectations”). Details on these ratings can be found in sections 4.10.3 and 4.12.2, respectively.

Despite the 2 ratings of below expectations, CNSC staff conclude that the CNL sites continued to perform licensed activities safely in 2022. This conclusion was supported by safety performance measures and observations, including the fact that CNL:

- operated within the bounds of its operating policies and principles
- followed approved procedures and took adequate corrective actions for all events reported to the CNSC

And CNL confirmation that:

- the health and safety of Indigenous Nations and communities and the public near the CNL sites, as well as the surrounding environment, continue to be protected
- workers at each CNL site have conducted the licensed activities safely and are properly protected
- there were no releases from CNL sites that could have harmed the environment or the health and safety of people

The referenced documents in this Commission member document are available to the public upon request, subject to confidentiality considerations.

1 INTRODUCTION

In accordance with the *Nuclear Safety and Control Act* [1], and its associated regulations, the Canadian Nuclear Safety Commission (CNSC) regulates Canada's nuclear industry to protect the health, safety of the people, security and the environment; to implement Canada's international commitments on the peaceful use of nuclear energy; and to disseminate objective scientific, technical and regulatory information to the public. Licensees are responsible for operating their facilities safely and are required to implement programs that make adequate provision for meeting legislative and regulatory requirements.

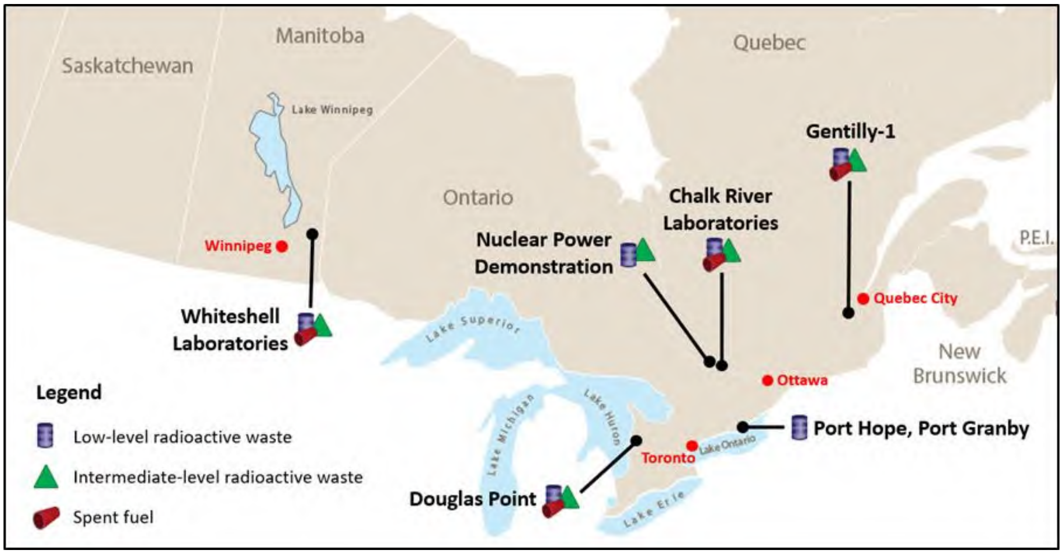
The Commission has directed CNSC staff to report to the Commission annually on the safety performance of sites operated by Canadian Nuclear Laboratories (CNL) in the form of a regulatory oversight report (ROR). This ROR provides an overview of CNSC regulatory effort and staff's assessment of licensee performance at sites operated by CNL for the 2022 calendar year.

The CNL sites covered by this report are located in many different parts of the country (Figure 1). CNSC staff would like to acknowledge the Indigenous Nations and communities (Appendix A) whose traditional and/or treaty territories are within proximity to the CNL sites covered by this report.

These CNL sites include:

- Chalk River Laboratories (CRL)
- Whiteshell Laboratories (WL)
- Port Hope Area Initiative (PHAI)
    - Port Hope Project (PHP)
    - Port Granby Project (PGP)
    - Port Hope Pine Street Extension Temporary Storage Site
    - Port Hope Radioactive Waste Management Facility
- Douglas Point Waste Facility (DPWF)
- Gentilly-1 Waste Facility (G1WF)
- Nuclear Power Demonstration Waste Facility (NPDWF)

Figure 1: Sites covered by this report



This ROR discusses all safety and control areas (SCAs), but focuses on radiation protection, conventional health and safety and environmental protection. The report also provides an overview of licensee operations, licence changes, major developments at licensed facilities and sites, and reportable events. In addition, the report includes information on the CNSC's and CNL's engagement with Indigenous Nations and communities, and the public.

2 CANADIAN NUCLEAR LABORATORIES

CNL is responsible for the operation and management of nuclear sites owned by Atomic Energy of Canada Limited (AECL) under a Government-Owned, Contractor-Operated model. While AECL owns the sites and nuclear substances, CNL is the CNSC licensee for activities at those sites.

A brief overview of each CNL site is provided below, with a link to the CNSC web page that contains more details such as facility information, announcements, regulatory reporting and other key topics.

2.1 Chalk River Laboratories

Chalk River Laboratories (CRL) is located in Chalk River, Ontario, 160 kilometers northwest of Ottawa (Figure 2), on the traditional unceded territory of the Algonquin Anishinabeg People. CRL operates under a single licence that includes Class I and Class II nuclear facilities, waste management areas, radioisotope laboratories, support facilities and offices. CNL safely manages low-, intermediate- and high-level radioactive waste at the site. The CRL site continues to undergo a period of change. Where permitted by the current licensing basis, CNL is continuing to shut down and decommission legacy facilities and constructing and commissioning replacement facilities throughout the site. Further information on CRL is available on the CNSC's website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/nuclear-facilities/chalk-river/index.cfm.

Figure 2: View of the CRL built-up area *(Source: CNL)*

2.1.1 Major Activities at CRL

The National Research Universal (NRU) reactor ceased operating on March 31, 2018, and remains in a permanently shut down, defueled and dewatered state in 2022. CNL continues its work in the NRU reactor and its associated systems to place the facility in a permanently safe shut down state. CNL performed a total of 63 work packages since 2018, however no additional work packages were completed in 2022 due to ongoing electrical and ventilation projects needed to support the shutdown. Further activities will continue until the NRU reactor and facility can be placed in a state of storage with surveillance.

In September 2022, construction officially began on the Advanced Nuclear Materials Research Centre (ANMRC) and included mass excavation and shoring work. The detailed design for ANMRC is ongoing and construction of the main building elements has commenced. The ANMRC will consolidate existing laboratories and hot cells located at CRL and is anticipated to be one of the largest active research laboratories in Canada.

CNL continued work on the proposal to construct a Near Surface Disposal Facility (NSDF) at the CRL site. This project underwent a review by CNSC staff and was subject to an Environmental Assessment (EA) [2] pursuant to the *Canadian Environmental Assessment Act, 2012* (CEAA, 2012) [3]. CNSC accepted the Final Environmental Impact Statement [4], leading to a two-part public hearing to consider CNL's application to authorize the construction of the proposed NSDF. The public hearings occurred on February 22, 2022 (Part I) and May 30 to June 3, 2022 (Part II). On July 5, 2022, the Commission announced its direction to leave the NSDF hearing record open to allow more time for engagement and consultation with Kebaowek First Nation (KFN) and the Kitigan Zibi Anishinabeg (KZA), and for the filing of additional information about these consultative efforts. In response to requests from KFN [5] and the KZA [6] in December 2022, the Commission extended the deadline for filing submissions to May 1, 2023 and final submissions will be considered during an oral public hearing. On May 17, 2023, the Commission announced that it reviewed the additional submissions from KFN, KZA, AECL, CNL and CNSC staff and is satisfied with the information received and does not require any additional information. The Commission announced that it is ready to receive final written submissions from intervenors and CNL by June 6 and June 21, 2023, respectively, with an oral public hearing scheduled for August 10, 2023.

2.2 Whiteshell Laboratories

Whiteshell Laboratories (WL) is a former nuclear research and test facility located near Pinawa, Manitoba that was established in the early 1960s (Figure 3). It is located in the homeland of the Red River Métis, Treaty 1 and Treaty 3 territories, and the traditional territory of Anishinaabe and Ojibway Peoples. The WL site is also located in the vicinity of Treaty 5 territory. The site hosts the 60-megawatt thermal (MWth) Whiteshell Reactor No. 1 (WR-1), a SLOWPOKE demonstration reactor, other research and support facilities, and a waste management area that contains low-, intermediate- and high-level radioactive waste. The WR-1 and

SLOWPOKE reactors were permanently shut down in 1985 and 1990, respectively. Decommissioning activities at WL commenced in 2003. Further information on WL is available on the CNSC's website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/whiteshell-laboratories.cfm.

Figure 3: Whiteshell Laboratories main campus *(Source: CNL)*

2.2.1 Major Activities at WL

Demolition of the Active Liquid Waste Treatment Centre and the Health and Safety Facilities began in 2021 and was completed in early 2022. The Shielded Modular Above Ground Storage facility is being converted to the Cask Loading Facility. The Cask Loading Facility will be used to handle, stage and load waste into appropriate shipping packages for transportation off-site. The removal, characterization and packaging of low-level radioactive waste packages from storage facilities in the waste management area continues.

CNL also prepared a Recoverable Surface Storage and Staging Area (RSSSA) consisting of an outdoor, above ground storage pad to enable the storage and loading of solid low-level waste in sea land containers and storage of oversized low-level waste items awaiting further processing, characterization and/or packaging prior to off-site disposition. The RSSSA was placed into service in early 2022.

A safety-stand down was performed at the WL site following a near-miss in which equipment was not properly electrically isolated prior to work. The safety-stand down. began on June 13, 2022. Activities at the site resumed in a phased manner, with the stand-down officially ending on December 9, 2022.

In April 2023, CNL performed a planned self-assessment of the WL fire protection program, which included the review of fire protection records for calendar years 2020, 2021 and 2022. Through the self-assessment, CNL identified a number of non-compliances and reported this to the CNSC. CNL immediately placed the WL site into a safe shutdown state, where only essential compliance and maintenance work could be conducted. As a result of this event, CNL has received a below expectations rating for the emergency management and fire protection SCA. Further details on this can be found in section 4.10.3 of this report.

CNL continues to work on the proposal to change the decommissioning approach for WR-1 from full dismantlement to in-situ decommissioning. This proposed approach is currently under review by CNSC staff, and is subject to an EA [7] pursuant to CEAA, 2012 [3], which will require authorization from the Commission. As these are not currently CNSC-licensed activities and will be the subject of separate Commission decisions, they are not specifically discussed further in this report.

2.3 Port Hope Area Initiative

The Port Hope Area Initiative (PHAI) is a federal government initiative based on a community proposal, which includes the Port Hope Long-Term Low-Level Waste Management Project (Port Hope Project) and Port Granby Long-Term Low-Level Waste Management Project (Port Granby Project) (Figure 4 and Figure 5). The Government of Canada, through Natural Resources Canada, has committed to clean up low-level radioactive waste in the Port Hope area and provide long-term safe management of the historic low-level radioactive wastes in the Port Hope area. These wastes arose from the activities of a former federal Crown Corporation (Eldorado Nuclear) and its private sector predecessors. The PHAI is on the traditional territory of the Michi Saagig Anishinaabe People. These lands are covered by the Williams Treaty between Canada and the Mississauga and Chippewa Nations.

Through its Historic Waste Program Management Office, CNL is implementing the PHAI on behalf of AECL.

For the 2022 reporting period CNL had 4 licences associated with the PHAI. The 4 licences include:

- WNSL-W1-2310.02/2022 for the Port Hope Project (PHP)
- WNSL-W1-2311.00/2022 for the Port Granby Project (PGP)
- WNSL-W1-182.0/2022 for the Port Hope Pine Street Extension Temporary Storage Site
- WNSL-W1-344-1.8/ind. for the Port Hope Radioactive Waste Management Facility

Following a one-day hearing on November 22, 2022, the Commission announced its decision, which can be found in DEC 22-H13 [8], to renew the PHP licence, for a 10-year period beginning January 1, 2023. As part of the decision, a single licence that consolidates the licensed activities previously authorized under CNL's 4 waste nuclear substance licences was issued. The new licence, Port Hope Area Initiative Waste Management Project, WNSL-W1-2310.00/2032 is valid from January 1, 2023 until December 31, 2032.

Further information on the PHAI is available on the CNSC's Website at: http://nuclearsafety.gc.ca/eng/waste/historic-nuclear-waste/port-hope-area-initiative/index.cfm.

Figure 4: Work in Port Hope - Waterfront Sites *(Source: CNL)*

Figure 5: Port Granby – Remediation Completed *(Source: CNL)*

2.3.1 Major Activities at PHAI

In 2022, the PHP and PGP Long-Term Waste Management Facilities (LTWMF) and associated Waste Water Treatment Plants (WWTP) continued their operations safely and as required by their respective licences.

In 2022, the PHP LTWMF remained open to receive offsite shipments of PHAI related low-level radioactive waste (LLRW). This included LLRW from residential properties, municipal road allowances, temporary storage sites, waterfront sites, industrial sites and locations within the municipality known to have LLRW from historical records.

CNL announced in May 2022 that the PGP is now in long-term maintenance and monitoring following the emplacement of 1.3 million tonnes of LLRW into the LTWMF that was capped and closed in late 2021. Final grading, erosion control measures and the construction of the east gorge groundwater collection system were completed in the fall of 2022. CNSC staff continue its regulatory oversight of the PGP to ensure the protection of the public and environment.

2.4 Prototype Power Reactors

The Douglas Point Waste Facility (DPWF), Gentilly-1 Waste Facility (G1WF) and Nuclear Power Demonstration Waste Facility (NPDWF) are 3 prototype power reactors. They are currently in a safe shutdown state and undergoing decommissioning activities. G1WF and NPDWF are in storage with surveillance, which includes hazard reduction and waste characterization. DPWF has started active decommissioning of the non-nuclear structures, in line with plans reviewed and accepted by CNSC staff. For these prototype reactors, CNL continues to implement and maintain programs such as radiation protection, conventional health and safety, security and emergency management and fire protection.

2.4.1 Douglas Point Waste Facility

Douglas Point Waste Facility (DPWF) located in Tiverton, Ontario on the Bruce nuclear site is a partially decommissioned prototype power reactor (Figure 6). The DPWF is located within the traditional territory of the Saugeen Ojibway Nation (SON), and the harvesting areas of the Georgian Bay Métis Nation of Ontario (MNO) and the Historic Saugeen Métis (HSM) Peoples. The 200-megawatt electric (MWe) prototype Canada deuterium uranium (CANDU) power reactor was put into service in 1968 and permanently shut down in 1984. CNL safely manages low- and intermediate-level radioactive wastes, as well as spent nuclear fuel stored in concrete dry storage canisters at the DPWF site. CNL is also undertaking decommissioning activities. Further information on DPWF is available on the CNSC's website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/douglas-point-waste-facility.cfm.

In its Record of Decision DEC 20-H4, *Application to amend the Waste Facility Decommissioning Licence for the Douglas Point Waste Facility to include phase 3 decommissioning activities* [9], the Commission granted a licence amendment effective March 12, 2021 authorizing the phase 3 decommissioning activities, including the decommissioning and dismantlement of certain facilities and structures at the DPWF site. Decommissioning work is ongoing on the non-nuclear buildings to facilitate the safe dismantling and demolition of the buildings.

Figure 6: Douglas Point Waste Facility *(Source: CNL)*

2.4.2 Gentilly-1 Waste Facility

Gentilly-1 (G1WF), located in Bécancour, Québec within Hydro-Québec's Gentilly-2 site, is a partially decommissioned prototype power reactor (Figure 7). The site is located on the traditional and unceded territory of the Abenaki People and the Wabanaki Confederacy and the traditional land of the Huron-Wendat. The 250 MWe boiling water reactor was put into service in 1972 and shut down in 1984. At G1WF, CNL safely manages low- and intermediate-level radioactive wastes, as well as spent nuclear fuel in concrete dry storage canisters. Additionally, CNL is undertaking decommissioning planning activities. Further information on G1WF is available on the CNSC's website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/gentilly-1-facility.cfm.

Figure 7: Gentilly-1 Waste Facility, outlined in yellow *(Source: CNL)*

2.4.3 Nuclear Power Demonstration Waste Facility

The Nuclear Power Demonstration Waste Facility (NPDWF) is a partially decommissioned prototype power reactor located in Rolphton, Ontario (Figure 8) on the traditional unceded territory of the Algonquin Anishinabeg Peoples. The 20 MWe prototype CANDU power reactor was placed into service in 1962 and operated until 1987. At NPDWF, CNL safely manages low- and intermediate-level radioactive wastes. Additionally, CNL is undertaking decommissioning planning activities. Further information on NPDWF is available on the CNSC's website at: http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/nuclear-power-demonstration.cfm.

CNL continues to work on the proposal to modify the decommissioning approach for NPDWF from full dismantling to in-situ decommissioning. This application is under review by CNSC staff, and is subject to both an EA [10] pursuant to CEAA, 2012 [3] and a licence amendment. As CNL's proposal will be the subject of future Commission decisions on the EA and licence amendment, they are not discussed further in this report.

Figure 8: Nuclear Power Demonstration Waste Facility *(Source: CNL)*

3 CNSC'S REGULATORY OVERSIGHT OF CNL

The CNSC performs regulatory oversight of licensed facilities to verify compliance with the requirements of the *Nuclear Safety and Control Act* [1] and associated regulations, each site's conditions of licence and licence conditions handbook (LCH), and any other applicable standards and regulatory documents (REGDOCs) forming part of the licensing basis.

CNSC staff use the safety and control area (SCA) framework to assess, evaluate, review, verify and report on licensee performance. The SCA framework includes 14 SCAs, which are subdivided into specific areas that define its key components. Further information on the CNSC's SCA framework can be found on the CNSC's website at: http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm.

http://www.nuclearsafety.gc.ca/eng/resources/news-room/feature-articles/safety-and-control-areas.cfm.

3.1 Regulatory Activities

CNSC staff conducted many risk-informed regulatory oversight activities in 2022.

Licensing

CNSC staff activities for licensing includes drafting new licences, preparing Commission Member Documents (CMDs), and drafting or revising LCHs. Appendix B provides a summary of licensing activities for 2022.

As CNSC REGDOCs are published, CNSC staff request implementation plans for each site and update the LCHs as applicable. CNSC staff verify REGDOC implementation as part of ongoing compliance verification activities. Appendix C provides a list of CNSC REGDOCs implemented at CNL sites and used by CNSC staff for compliance verification.

Compliance

The CNSC ensures licensee compliance through verification, enforcement and reporting activities. CNSC staff implement compliance plans for each site by conducting regulatory activities including inspections, desktop reviews, and technical assessments of licensee programs, processes, and reports.

Appendix D contains a list of CNSC inspections carried out at each CNL site in 2022. All notices of non-compliance (NNCs) resulting from non-compliance with legislation, regulations and licensing basis requirements noted during these inspections were considered low-risk and did not have an impact on the health, safety and environment. CNSC staff determined that all NNCs were adequately addressed either through closure or an appropriate corrective action plan. Appendix E contains a list of reportable events at each CNL site in 2022. For these events, CNSC staff were satisfied with CNL's corrective actions to prevent recurrence.

3.2 Performance Ratings

The safety assessments presented in this report are based on the results of activities planned through the CNSC compliance verification program. In 2022, these activities included inspections as well as technical assessments of submissions. CNSC staff use the results of these activities to assign performance ratings to licensees. CNSC staff use the following 3 ratings to grade licensee performance in each applicable SCA:

- satisfactory (SA)
- below expectations (BE)
- unacceptable (UA)

The definitions of the ratings can be found in Appendix F.

For 2022, CNSC staff have rated CNL’s performance in each SCA as satisfactory, with the exception of the emergency management and fire protection SCA at WL and security SCA at CRL, which are rated as below expectations. Details on these ratings can be found in sections 4.10.3 and 4.12.2, respectively. Appendix G provides SCA ratings for each site from 2018 to 2022.

4 THE CNSC'S ASSESSMENT OF SAFETY AT CNL SITES

The CNSC regulates all aspects of safety at nuclear sites in Canada, including risks to workers, the public and the environment. CNSC staff assess performance in all SCAs by verifying licensee compliance through planned or reactive desktop reviews and inspections. Although all 14 SCAs are covered in the following sections, the radiation protection, conventional health and safety, and environmental protection SCAs are considered the most relevant in determining CNL's overall safety performance. In particular, the SCAs of radiation protection, and conventional health and safety are a good measure of the safety of workers at CNL sites, while the SCA of environmental protection is a good measure of the safety of the public and the environment. If the performance of a specific CNL site is not discussed under a particular SCA in this report, that means there were no findings related to this SCA in 2022 as a result of CNSC staff's oversight activities.

CNSC staff have determined that all NNCs from inspections were adequately addressed either through closure or an appropriate corrective action plan, and that the NNCs did not impact safety at CNL sites. CNSC staff conclude that CNL has met regulatory requirements and for 2022 have rated all SCAs at all CNL licensed sites as satisfactory, with the exception of the emergency management and fire protection SCA at WL and security SCA at CRL, which are rated as below expectations.

For both the radiation protection and environmental protection SCAs action levels (ALs) are used. ALs are a specific dose of radiation or other parameter that serve as an early warning to safeguard against exceedances of radiation dose limits and environmental release limits. AL exceedances are reportable to the CNSC. Further information on ALs is available on the CNSC's website at: http://www.nuclearsafety.gc.ca/eng/resources/news-room/feature-articles/radiation-dose-limits-release-limits-and-action-levels.cfm.

4.1 Management System

The management system SCA covers the framework that establishes the processes and programs required to ensure that an organization achieves its safety objectives, continuously monitors its performance against these objectives and fosters a healthy safety culture.

CNSC staff assess CNL's performance in the management system SCA through desktop reviews of program documents, reportable events (Appendix E) and through the course of inspections (Appendix D). There were no management system focused inspections conducted by CNSC staff at CNL sites in 2022. However, there were some findings related to the management system SCA found through regular licensing and compliance activities conducted at WL, DPWF and PHAI.

4.1.1 Whiteshell Laboratories

In an inspection conducted at WL in October 2022, CNSC staff identified 2 NNCs pertaining to the management system SCA. During this inspection, CNSC staff reviewed a selection of waste management daily operating logs to ensure they contained the required information. CNSC staff found the operating logs to be inconsistent in the information they contained, not following a prescribed format, not containing a CNL identification number and difficult to read. As a result of this finding, CNSC staff requested CNL to take corrective action to ensure that operating logs are compliant with the necessary requirements. Additionally, CNSC staff reviewed governing documents for the waste management program and found that several documents were beyond the required 5-year revision cycle. As a result, CNSC staff issued a second NNC requesting that CNL take corrective action to ensure their waste management suite of documents are reviewed and revised based on current practices and site operations. These findings were of low safety significance and did not pose an imminent risk to people or the environment. CNSC staff is satisfied with the corrective actions taken by CNL to address these 2 NNCs and they are now considered closed.

4.1.2 Douglas Point Waste Facility

During an inspection conducted by CNSC staff at DPWF in February 2022, 2 NNCs pertaining to the management system SCA were identified by CNSC staff, which related to the clarity of storage with surveillance (SWS) records and accuracy of documents. In order to verify that monitoring, testing and surveillance activities were performed in accordance with the SWS, CNSC inspectors requested that CNL map the SWS activities to an Operator Rounds Database (ORD) tag. CNSC staff also reviewed operating procedures that guide SWS activities and noted that monthly inspection instructions did not reference the ORD tags, and that the instructions did not cover the same scope as the SWS document. Overall, CNSC staff found that the tags in the ORD system did not clearly align with activities in the SWS. As a result, CNSC staff issued a NNC requesting that CNL take corrective action to ensure there is a clear link between the field monitoring, testing, and surveillance activities, and the activities listed in the SWS document. Additionally, CNSC staff found that the SWS document and the Detailed Decommissioning Plan Volume 2 did not accurately capture how work was being conducted. As a result, CNSC staff issued a second NNC requesting that CNL take corrective action to ensure that these documents accurately described how work is conducted. Both NNCs were considered of low safety significance and did not pose an imminent risk to people or the environment. CNSC staff is satisfied with the corrective actions taken by CNL to address these 2 NNCs and they are now considered closed.

4.1.3 Port Hope Area Initiative

In 2022, CNSC staff identified, through regular licensing and compliance activities, non-compliances with CNL's management oversight of changes and its adherence to the change control process with respect to the PHAI. CNL is required by each of its licences to implement and maintain a management system, which includes implementing and maintaining adequate measures for change control. Additionally, as per its licences, CNL is required to give written notification of changes to the licensed activities or operation, including deviation from design, operating conditions, policies, programs and methods referred to in the current licensing basis. On 2 separate occasions during the 2022 calendar year, CNSC staff found that CNL failed to provide the required written notification of changes with respect to the PHAI. In addition, it was also found that CNL applied its change control process retroactively in both cases, which CNSC staff finds to be unacceptable as this demonstrates a lack of management oversight for the implementation and maintenance of the change control process.

Previous to these occurrences, in January 2021, CNSC staff conducted inspections at the PHP and PGP with a focus on management system. One of the findings, as a result of these inspections, was that there were no clear criteria when design changes must be submitted to CNSC for acceptance. CNSC staff issued a NNC for CNL to address this finding. In response to this NNC, CNL revised applicable documentation to include clear criteria for when a notification is required, as per its licences. CNSC staff reviewed the revised document and were satisfied with the corrective actions taken by CNL. This NNC was closed by CNSC staff in October 2022. CNSC staff expect CNL to use this document notification process and criteria moving forward to ensure that the change control process is applied correctly. Despite the changes CNL has made to strengthen its process, CNSC staff will continue to monitor procedural adherence in this area. CNSC staff requested CNL to conduct a causal analysis into why these failures occurred, for the management of changes at the PHP and PGP.

In March 2023, CNL submitted a root cause analysis report on its adherence to the change control program. The root cause was determined to be a lack of management direction. Leadership had not defined the accountabilities for having intimate knowledge of the licensing basis and the responsibilities involved in reviewing and approving equipment and process changes. The main corrective actions resulting from the root cause analysis include documenting the accountability for having intimate knowledge of the licensing basis and developing and documenting the skills and competencies and training requirements for management. CNL has committed to completing these corrective actions by October 2023 and conducting an effectiveness review by May 2024.

CNSC staff have reviewed the root cause analysis report and proposed corrective actions and found them to be acceptable. In addition, CNSC staff have planned management system inspections in fiscal year 2023-2024 to ensure CNL's management system program remains effective.

4.1.4 Overall Conclusion

Despite the issues identified with respect to CNL's management oversight of changes and adherence to the change control process with respect to the PHAI, overall, CNSC staff conclude that CNL continues to implement and maintain effective management system programs in accordance with regulatory requirements.

4.2 Human Performance Management

The human performance management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

CNSC staff assess CNL's performance in the human performance management SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). In 2022, CNSC staff conducted focused inspections on the human performance management SCA at both CRL and PHP.

4.2.1 Chalk River Laboratories

In March 2022, CNSC staff conducted a focused inspection on the human performance management SCA as part of the baseline compliance plan for CRL. The scope of the inspection included an evaluation of CNL's Human Performance Program and Training Program. This inspection resulted in 6 NNCs, which were raised to CNL to address. All findings resulting from this inspection were of low safety significance and did not pose an imminent risk to people or the environment.

Of the 6 NNCs, 2 of them pertained to CNL's Human Performance Program and related to reporting hours of work exceedances and managing worker fatigue. CNSC staff found that hours of work exceedances for safety-sensitive positions were not being routinely reported to the CNSC and were not submitted to CNSC as part of the previous annual compliance monitoring report. This finding was of low safety significance because there is no requirement for CNL to report each instance of an exceedance individually. However, the CNSC expects exceedances to be reported, at minimum, via the annual compliance monitoring report as per CNSC's REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [11]. This would allow CNL to demonstrate that regulatory requirements associated with its Human Performance Program are being met. Additionally, CNSC staff found that CNL was maintaining records of work exceedances for safety-sensitive positions and there were no reported incidences of the minimum shift complement not being met for safety-sensitive positions. The second NNC issued was related to managing worker fatigue, as it was not evident from records reviewed of hours of work exceedances and the interviews conducted with CNL staff, what measures were being taken to manage and mitigate the effects of worker fatigue in safety-sensitive positions and whether workers are aware of the options available to them to manage fatigue at work. CNSC staff requested CNL take corrective action to ensure that safety-sensitive positions at CRL comply with the limits on hours and recovery periods as per CNSC's REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* [12]. This finding was of low safety significance since it is acknowledged that exceptional circumstances may warrant exceeding the limits on hours of work and recovery periods for workers in safety-sensitive positions to limit the risk to nuclear safety and security may arise if the minimum shift complement was not maintained.

The remaining 4 NNCs pertained to CNL's Training Program and related to job and task analyses and training plans, the training change management process, and application of the Systematic Approach to Training (SAT). CNSC staff requested CNL take corrective actions to update its relevant training program documentation to ensure the identified tasks and required training are valid and accurate for radiation protection surveyors. CNSC staff also requested CNL take corrective actions to update SAT documentation to accurately list all positions/roles that require SAT-based training and ensure the updated SAT documentation adheres to the annual review requirement to make sure that the SAT positions identified in the controlled list are kept up to date.

CNL has addressed 5 out of the 6 NNCs resulting from this inspection. CNSC staff is satisfied with the corrective actions taken by CNL to address the 5 NNCs and they are now considered closed. CNL has identified corrective actions to be taken to address the remaining NNC related to managing worker fatigue. The deadline to address this NNC is by Q4 of the 2023 calendar year. This NNC will remain open until CNL addresses it to CNSC staff's satisfaction.

4.2.2 Port Hope Project

In December 2022, CNSC staff conducted a focused inspection on the human performance management SCA as part of the baseline compliance plan for the PHP. The scope of the inspection focused on CNL's training program, including CNL's implementation of corrective actions in response to a previous CNSC inspection in 2019 and CNL's implementation of actions to address its gap analysis against the requirements of CNSC's REGDOC-2.2.2, *Personnel Training* [13]. This inspection resulted in 6 NNCs, which were raised to CNL to address. The NNCs pertained to the use of a training system, documentation, training analysis and change management, design, development and evaluation of training, and training records. All findings were of low safety significance and did not pose an imminent risk to people or the environment. These findings were of low safety significance, as CNL does have a documented training system that is being implemented for all their training programs. CNSC staff have received the initial responses to the 6 NNCs and the NNCs will remain open until CNL addresses them to CNSC staff's satisfaction. The deadline to address these NNCs is by Q3 of the 2023 calendar year.

4.2.3 Overall Conclusion

CNSC staff conclude that CNL continues to implement and maintain effective human performance management programs in accordance with regulatory requirements.

4.3 Operating Performance

The operating performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

CNSC staff assess CNL's performance for the operating performance SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). CNL also submits annual reports on compliance monitoring and operational performance of facilities.

CNSC staff were notified of revisions to compliance verification criteria documents as outlined in CNL site LCHs. CNL's corporate-wide management system consists of high-level documentation supported by lower-level procedures. CNL maintains a comprehensive suite of procedures across all programs and sites. CNL continually updates the facility-specific procedures relating to operations, maintenance, and emergency response as needed and supports ongoing process improvements across all sites. CNSC staff regularly review procedure level documents as part of ongoing compliance verification activities. At CRL, procedures specifically related to Conduct of Operations, Commissioning, and Configuration Management were reviewed. The procedures were deemed to be acceptable by CNSC staff. CNL facility authorization (FA) and storage with surveillance (SWS) documents were submitted to the CNSC as required by the site LCHs. CNSC staff deemed submitted FAs and SWSs acceptable before being implemented by CNL.

CNSC staff were notified of reportable events (Appendix E) as required and CNL submitted annual reports as required. No significant regulatory issues were identified during CNSC staff's review of these reports. CNL revised their overarching Management Control Procedure (MCP), *CNL Reporting to Regulatory Agencies*, 900-514300-MCP-006, to further clarify and improve reporting requirements. CNSC staff have access to CNL's Improvement Action System reports which are utilized for trending purposes by CNL.

4.3.1 Chalk River Laboratories

In 2022, there was an unplanned Class IV power outage at the CRL site related to a weather event that damaged electrical infrastructure off-site. Class III power initiated as required and operated as intended. As a cautionary measure CNL-CRL's Emergency Operations Centre (EOC) was activated. CNSC staff were notified by CNL. CNSC staff is satisfied with CNL's event response. In June 2022, CNL successfully executed an annual electrical site-wide outage at CRL to perform testing, inspections, cleaning, and maintenance and repairs.

In May 2022, CNSC staff conducted an inspection at the CRL Universal Hot Cells facility that resulted in a NNC pertaining to the FA document being out of date. The FA referred to all facility work being conducted on work permits, but CNL staff had noted that facility work is no longer conducted on work permits, but rather using CNL's integrated work control system. This finding was of low safety significance as CNL's on-site work activities continue to be managed under a system and this NNC pertains to documentation to be updated. CNSC staff requested CNL to take corrective action to update the Universal Hot Cells FA document to refer to CNL's integrated work control system. CNL is working to address this NNC by Q3 of the 2023 calendar year via an FA document revision and it will remain open until it is addressed to CNSC staff's satisfaction.

In June 2022, CNSC staff conducted an inspection at the CRL Combined Electrolysis and Catalytic Exchange Upgrading and Detritiation (CECEUD) test facility that resulted in 2 NNCs pertaining to the documentation of operator surveillance on equipment monitoring, and regular performance monitoring and periodic testing of CECEUD systems, structures, and components. CNSC staff noted that the details of daily operator surveillance were not recorded in the facility daily logbook, in addition to a facility exhaust fan that was found not to be regularly maintained as required. CNSC staff requested CNL to take corrective action. CNL is working to address these NNCs by Q3 of the 2023 calendar year and they will remain open until they are addressed to CNSC staff's satisfaction.

In December 2022, CNSC staff conducted an inspection at the CRL Recycle Fuel Fabrication Laboratories (RFFL) facility that resulted in a NNC pertaining to an air flow testing station in the facility exhaust ventilation line being 2 days past due for calibration according to the calibration sticker. This finding was of low safety significance. CNSC staff requested CNL to take corrective action. CNL determined that their radiation protection program does not require air flow testing stations to undergo calibration and that the calibration sticker was mistakenly placed on the air flow testing station. CNL has since removed the calibration sticker and ensured that there were no other misplaced calibration stickers in the facility. CNSC staff determined that the corrective actions taken by CNL to address the NNC were acceptable, and the item is now closed.

4.3.2 Overall Conclusion

CNL continued to meet its reporting requirements including those associated with annual reports and reportable events, which demonstrates that facilities were operated and maintained according to the licensing basis. CNSC staff assessments conclude that CNL has conducted its activities in compliance with regulatory requirements.

4.4 Safety Analysis

The safety analysis SCA covers maintenance of the safety analysis that supports the overall safety case for the facilities. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

CNSC staff assess CNL's performance in the safety analysis SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

There were no safety analysis focused inspections conducted by CNSC staff at CNL sites in 2022. However, there were a total of 5 NNCs pertaining to safety analysis resulting from general inspections performed at CNL facilities.

4.4.1 Chalk River Laboratories

In May 2022, an inspection of the Universal Hot Cells facility at CRL resulted in a NNC pertaining to an expired training certification requirement of a Nuclear Criticality Control Officer (NCCO). CNL confirmed that the NCCO's required training was expired but clarified that the NCCO had not acted as the Universal Hot Cells' NCCO designate since the training had expired. CNSC staff requested CNL to take corrective action to ensure that NCCOs and designates have completed the required training. CNSC staff determined that the corrective actions taken by CNL to address the NNC were acceptable and the item is now closed.

In November 2022, an inspection of Building 429 at CRL resulted in a NNC pertaining to CNL not tracking an overall inventory of U-235 in the facility and being unable to determine whether the amount of U-235 in the facility exceeded the maximum 100 gram limit for non-nuclear criticality controlled areas (NCCA). CNSC staff requested CNL to take corrective action to determine the amount of U-235 in the facility and to maintain an accurate inventory of fissionable material at all times. CNL immediately determined the amount of U-235 in the facility to be less than the limit for non-NCCAs after the inspection and informed CNSC staff. CNL has since developed an accurate tracking inventory for fissionable material in the facility and the NNC has since been closed.

In June 2022, an inspection of the CECEUD facility at CRL resulted in 2 NNCs pertaining to safety analysis reports and facility operations documentation not being maintained and kept up to date to reflect the current operating status and configuration of the facility. CNSC staff requested CNL take corrective action to ensure facility operations documentation and safety analysis reports are updated. These NNCs are of low safety significance as the facility is in a safe shutdown state since April 2001 and there are no heavy water processing activities taking place in the facility. CNL is working to address these NNCs by Q4 of the 2023 calendar year and they will remain open until they are addressed to CNSC staff's satisfaction.

In September 2022, an inspection conducted on Waste Management Areas (WMA) D and H resulted in a NNC pertaining to the lack of required signage for non-NCCAs in the WMAs. CNL had recently re-organized a non-NCCA into smaller non-NCCAs but did not have signage at the point of entry to each individual non-NCCA. CNSC staff requested CNL take corrective action to ensure that there is signage posted at the point of entry of each of the non-NCCAs. CNL has since confirmed that posting the required signage is not feasible due to the movement of heavy equipment in the area and multiple outdoor storage areas. CNL has notified CNSC staff that they have revised the Nuclear Criticality Safety for Operations Standards with the constraints at WMA D and H while maintaining compliance with the requirements of CNSC's REGDOC-2.4.3, *Nuclear Criticality Safety* [14]. CNSC staff determined that the corrective actions taken by CNL to address the NNC were acceptable and the item is now closed.

4.4.2 Overall Conclusion

CNSC staff conclude that CNL continues to implement and maintain safety analysis programs in accordance with regulatory requirements.

4.5 Physical Design

The physical design SCA relates to activities that impact the ability of structures, systems, and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

CNSC staff assess CNL's performance in the physical design SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). CNSC staff have reviewed CNL's conduct of design engineering documents, to ensure activities are planned, controlled and monitored in accordance with regulatory requirements and applicable codes and safety standards.

4.5.1 Port Hope Area Initiative

In 2022, CNSC staff conducted a desktop review of the construction activities at the Port Hope Harbour which is part of the PHAI. The review focused on the design details of the harbour wall rehabilitation. CNSC staff found that the design and construction of the harbour walls are satisfactory with respect to their integrity and stability.

4.5.2 Overall Conclusion

CNSC staff conclude that CNL's programs related to the physical design SCA continue to meet regulatory requirements.

4.6 Fitness for Service

The fitness for service SCA covers activities that impact the physical condition of structures, systems, and components to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so. Regulatory oversight of the fitness for service SCA includes specific areas of equipment performance, maintenance, aging management, structural integrity and chemistry control.

CNSC staff assess CNL's performance in the fitness for service SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

4.6.1 Chalk River Laboratories

Throughout 2022, CNSC staff conducted inspections of CRL facilities including NRU, Molybdenum-99 Production Facility (MPF), Nuclear Fuel Fabrication Facility (NFFF), RFFL, CECEUD, and WMA D and H with one of the foci being on the fitness for service SCA. In total there were 10 NNCs raised for CNL to address that are related to fitness for service.

Of the 10 NNCs, 3 of them pertained to equipment or instrumentation that remained installed past their designated lifetime or calibration due date, or not meeting field installation requirements. In an inspection of NFFF in October 2022, CNSC staff found High Efficiency Particulate Air (HEPA) filters on active workstations installed beyond their 10-year allowable life. This finding was of low safety significance, as CNL continues to perform monitoring daily and testing of the HEPA filters on an annual frequency, where a failed test would prompt a filter replacement. In another inspection of the CECEUD facility conducted in June 2022, CNSC staff found installed instrumentation equipment with expired and/or faded calibration information labels. This finding was of low safety significance, as the instrumentation equipment was no longer in operation at the CECEUD facility. In an inspection at a CRL GC60 Class II irradiation facility in March 2022, CNSC staff found a room area radiation monitoring system without a backup power supply. CNSC staff requested CNL to take corrective action to address the non-compliances. CNSC staff determined that the corrective actions taken by CNL to address these 3 NNCs were acceptable and the items are now closed.

The remaining 7 NNCs pertain to the aging management program implementation in accordance with CNSC REGDOC-2.6.3, *Aging Management* [15] at CNL's Universal Hot Cells, NFFF and MPF. CNSC staff noted that several aging management requirements were not being met as required by the licence. These requirements included performing regular periodic reviews of conditions assessments of structures, systems and components (SSC), evaluating methods for monitoring and trending operating and maintenance data of SSCs, documenting corrective actions resulting from aging management field walkdowns in CNL's corrective action program and maintaining up to date facility SSC documentation. CNSC staff have requested CNL to take corrective action to address the non-compliances. CNSC staff determined that the corrective actions taken by CNL to address the NNCs were acceptable and the items are now closed.

CNSC staff also observed that facility aging management plans were not implemented at the MPF and NFFF during inspections conducted in March 2022 and October 2022, respectively. CNSC staff have requested CNL to take corrective action to address these NNCs. In 2022, CNL conducted a self-assessment on CRL's aging management and provided a summary to CNSC staff for review. CNL had identified several programmatic and implementation non-compliances with CRL's licence requirements as per CNSC's REGDOC 2.6.3, *Aging Management* [15]. These non-compliances comprise of partial or no implementation of several integrated aging management requirements as per CNSC's REGDOC 2.6.3, *Aging Management* [15] at several CNL facilities including WL, NPDWF, DPWF and G1WF. CNL is working to revise their aging management program standard documentation and has created an aging management implementation gap plan. The NNCs pertaining to the aging management plans at MPF and NFFF have since been closed with the submission of CNL's aging management implementation plan. CNSC staff will be reviewing CNL's implementation plan and will plan future regulatory oversight activities to verify their implementation.

All these findings were of low safety significance. Despite the issues identified with respect to the fitness for service specific area of aging management and CNL's aging management program, CNL has been performing preventative maintenance tasks, condition-based maintenance on categorized SSCs and routine monitoring of facility data that mitigates the risk of component failure due to age related degradation mechanisms.

4.6.2 Overall Conclusion

Overall, CNSC staff conclude that CNL continues to operate and maintain the facilities in accordance with regulatory requirements with respect to the equipment performance, maintenance, structural integrity and chemistry control. However, CNSC staff will be performing regulatory oversight of CNL's aging management implementation plan at CRL.

4.7 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations* [16]. CNL has successfully implemented and maintained a radiation protection program which ensures that contamination levels and radiation doses received by individuals are monitored, controlled and maintained as low as reasonably achievable (ALARA).

CNSC staff assessed CNL's performance in the radiation protection SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). These compliance activities confirmed that the facilities and its processes were operated and maintained by CNL in accordance with their licensing basis.

In addition, data on dose to workers for each CNL site from 2018 to 2022 can be found in Appendix H.

CNL continues to demonstrate compliance and have been satisfactory in the radiation protection SCA. CNSC staff conclude that CNL's radiation protection performance meets regulatory requirements.

4.7.1 Application of ALARA

CNL's application of ALARA within the radiation protection program includes management commitment and oversight, personnel qualification and training, design analyses of facilities and systems, provision of protective equipment and ALARA assessments/reviews of radiological activities.

In 2022, CNSC staff confirmed that all CNL sites continued to implement radiation protection measures to keep radiation exposures and doses received by persons ALARA. CNL continued to effectively implement the corporate ALARA process at its sites. This process integrates ALARA into design, planning, management and control of radiological activities.

At CNL sites, dose control points (DCP) are used as a dose management tool for nuclear energy workers' (NEWs) radiological exposures. If a NEW's dose exceeds their assigned DCP by more than 1 mSv, an ALARA assessment is documented to assess whether the dose received was justified and optimized, as applicable. In 2022, no NEWs exceeded their assigned DCP by more than 1 mSv.

4.7.2 Worker Dose Control

Workers, including employees and contractors, conducting work activities which present a reasonable probability that the worker may receive an occupational dose greater than 1 mSv/year, are identified as NEWs.

In 2022, no worker received a radiation dose in excess of the CNSC's regulatory dose limits. The maximum individual effective dose received by a NEW across CNL sites was at the CRL site, with a dose of 5.48 mSv, which is approximately 11% of the CNSC's regulatory limit for effective dose of 50 mSv in a 1-year dosimetry period.

4.7.3 Radiation Protection Program Performance

CNSC staff conducted regulatory oversight activities at CNL sites to verify that CNL's radiation protection programs complied with regulatory requirements. These oversight activities included inspections, desktop reviews and compliance verification activities specific to radiation protection. Through these activities, CNSC staff confirmed that CNL has effectively implemented their radiation protection programs to control occupational exposures to workers and keep doses ALARA.

Action levels for radiological exposures are established as part of CNL's radiation protection program. If an action level is reached, it triggers CNL staff to establish the cause and, if applicable, restore the effectiveness of the radiation protection program. In 2022, there were no action levels reached at CNL sites.

4.7.4 Radiological Hazard Control

Radiation and contamination monitoring programs continued to be implemented at CNL sites in 2022, to control and minimize radiological hazards and the spread of radioactive contamination. Dose rate measurements, surface contamination monitoring and, where appropriate, in-plant air monitoring are routinely performed to confirm that radiation exposures are kept ALARA. The radiological hazard surveys conducted in 2022 by CNL did not identify any adverse trends and were consistent with expected radiological conditions.

4.8 Conventional Health and Safety

The conventional health and safety SCA covers a program to manage workplace safety hazards and protect workers. As CNL sites are federally regulated, they are subject to the requirements of the *Canada Labour Code* [17] and *Canada Occupational Health and Safety Regulations* [18]. CNL has developed and implemented a program to manage the workplace safety hazards and protect workers on the job while ensuring compliance with the *Canada Labour Code* [17] and *Canada Occupational Health and Safety Regulations* [18].

Many activities at CNL sites may be performed by contractors, most of which are provincially regulated, and as such contractors are subject to the provincial requirements. In most cases, contractors work under their own health and safety programs, which are reviewed and accepted by CNL. Contractor programs must meet or exceed the requirements of CNL's licences.

CNSC staff assessed CNL's performance in the conventional health and safety SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). These compliance activities demonstrate that the facilities and activities were operated and maintained by CNL according to their licensing basis.

CNSC staff conclude that CNL continues to implement and maintain effective conventional health and safety programs in accordance with regulatory requirements.

4.8.1 Performance

The key performance indicators for conventional health and safety are the number of recordable lost-time injuries (RLTI) that occur per year, and the RLTI severity and frequency. A RLTI is defined as a workplace injury that results in the worker being unable to return to work for a period of time. RLTI severity and frequency provide context to the number of RLTIs. Severity quantifies the number of lost workdays experienced per 100 employees, while frequency quantifies the number of lost-time injuries relative to the number of hours worked. Data on RLTI, and RLTI frequency and severity from 2018 to 2022 are included in Appendix I for all sites covered by this ROR. In 2022, there were 4 RLTIs at CNL sites, 2 were CRL employees, 1 was a CRL contractor and 1 was a PHP contractor. The total number of RLTIs decreased by 1 between 2021 to 2022. Collectively, these events led to 56 lost working days, 46 of which were related to the RLTI for the PHP contractor. Of the 2 CRL employee RTLIs, 1 involved a worker performing a routine lift which resulted in back strain and the other involved a worker who experienced pain and swelling of their knee which occurred after sustained kneeling to install flooring. For CRL employees the RLTI frequency was 0.07 and the RLTI severity was 0.15. Contractor RLTI data is based on information voluntarily provided to the CNL Health Centre by contracting companies and only includes the number of lost time injuries and working days lost. There were no RLTIs at WL, PGP, DPWF, G1WF or NPDWF in 2022.

For comparison, CNL's reported RLTI frequency for CNL employees is lower than the 2022 lost-time injury rates for comparable industries in Ontario like specialty trades construction (1.03) and printing, petroleum and chemical manufacturing (0.55), as per Ontario Workplace Safety and Insurance Board data in the 2022 Workplace Safety and Insurance Board Statistical Report [19]. CNSC staff consider this to be a conservative comparison because Ontario lost-time injury data includes only injuries for which compensation claims were allowed, rather than all reportable injuries, as is included in CNL data.

4.8.2 Practices

When evaluating safety practices at a site, CNSC staff do not distinguish between the licensee's own staff and those of contractors or visitors, considering all to be 'workers' and equally subject to CNSC requirements and licensee policies. This is notable for CNL, as many CNL sites employ contractors to perform a wide variety of tasks. CNL's Improvement Action System is used by CNL to record all events, including injuries, at CNL sites. CNSC staff review CNL's Improvement Action data to determine trends and monitor actions.

4.8.3 Awareness

CNL's COVID-19 pandemic response consisted of 5 phases. In 2022, CNL was in Phase 4, "New Normal Operations". Daily COVID-19 screening continued for all CNL staff and contractors. Masking requirements were paused in June 2022, in accordance with provincial government recommendations. During 2022, CNSC and CNL continued to have a protocol in place with respect to COVID-19 notification. The intent of the protocol was for CNL to provide notification to CNSC of confirmed COVID-19 cases that could potentially impact its ability to meet minimum shift. CNL provided proactive notification of all COVID-19 cases affecting positions defined within the protocol; however, there were no instances where CNL did not meet minimum shift complement. CNL reported COVID-19 cases to the CNSC until December 2022. Effective March 31, 2023, all CNL sites ceased all remaining COVID-19 controls due to low risk reported by public health agencies and a third-party epidemiologist, as well as the removal of public health restrictions. CNL moved from Phase 4 to Phase 5 of the CNL Pandemic Recovery Plan, with Phase 5 representing normal site operations.

4.9 Environmental Protection

Protection of the environment and the public are both assessed in the environmental protection SCA. This SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances, and the effects on people and the environment from facilities or as a result of licensed activities.

CNSC staff assess CNL's performance in the environmental protection SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

The CNSC publishes annual radionuclides loadings to the environment from nuclear facilities on the CNSC Open Government Portal. The data from CNL sites is available on the CNSC Open Government Portal.

Based on the review and assessment of CNL's submitted monitoring results, past performance history and the regulatory oversight to date, CNSC staff conclude that the environmental protection SCA performance for CNL facilities operated in Canada has been consistent with the previous years, with satisfactory ratings given for 2022.

4.9.1 Effluent and Emissions Control

CNL has implemented and maintains an effluent verification monitoring program that meets regulatory requirements at all sites covered by this report.

Regulatory Limit Exceedances in 2022

- Week ending June 1, 2022: There was an exceedance of the weekly release limit for copper in a composite effluent sample at PHP's waste water treatment plant (WWTP). CNL staff reported the exceedance to the CNSC, investigated the event, confirmed the source was corroded brass components on the cooling loop, and CNSC staff presented an Event Initial Report to the Commission in CMD 22-M38 [20] on June 28, 2022. This exceedance did not pose a risk to workers, the public or the environment.

Action Level Exceedances in 2022

- Week ending June 1, 2022: There was an exceedance for zinc in a composite effluent sample at PHP's WWTP. CNL staff reported the event to the CNSC, investigated the event, confirmed the source was corroded brass components on the cooling loop, and this information was included in CNSC staff's Event Initial Report presentation to the Commission in CMD 22-M38 [20] on June 28, 2022. This event did not pose a risk to workers, the public or the environment.
- Week ending June 7, 2022: There was an exceedance for arsenic in a composite effluent sample at PHP's WWTP. CNL staff reported the event to the CNSC and took immediate corrective action to successfully reduce the arsenic concentration in the effluent to return to levels below action levels. CNL found the elevated arsenic was due to a combination of old

reverse osmosis membrane filters, high water temperatures, low water levels and high proportions of arsenic in the primary collection ponds. This event was not expected to pose a risk to human health or the environment.

Airborne and waterborne releases of radioactive and hazardous substances at all other CNL sites remained below their respective regulatory limits in 2022. All these exceedances were reported to CNSC staff as per the reporting requirements of CNL's licences. Details on these events are also captured in Appendix E.

In 2022, CNL revised the CRL effluent verification program. CNSC staff reviewed the revision and determined that it met regulatory requirements.

Overall, CNSC staff determined that the effluent verification monitoring programs at CNL's sites continue to be protective of the environment and the public.

4.9.2 Assessment and Monitoring

In compliance with CSA standard N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* [21], CNL has environmental monitoring programs at CRL and WL. CNL provided rationale for not triggering requirements under CSA N288.4 for DPWF, G1WF and NPDWF; thus determining that environmental monitoring programs at these facilities were not required. CNSC staff assessed CNL's information and concluded as such. Of note, environmental monitoring programs are required and have been implemented at the PHP and PGP.

In 2022, CNL revised the CRL environmental monitoring program. CNSC staff reviewed the revision and determined that it met regulatory requirements.

Additionally, CNL has comprehensive groundwater monitoring programs at applicable CNL sites consistent with CSA standard N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills* [22].

CNSC staff conclude that the environmental monitoring programs in place at CRL, WL, PHP and PGP are compliant with applicable regulatory requirements and are protective of the environment and the public.

4.9.3 Environmental Management System

The CNSC requires that licensees develop and maintain an Environmental Management System to provide a documented framework for integrated activities related to environmental protection. An Environmental Management System includes activities such as establishing annual environmental objectives, goals and targets. CNL has established a corporate level Environmental Management System that is part of the overall CNL management system which applies to all CNL sites. CNL's corporate Environmental Management System conforms to International Organization for Standardization (ISO) standard 14001:2015, *Environmental Management Systems* [23], and the Environmental Management Systems for CRL and WL are registered to ISO 14001:2015.

4.9.4 Environmental Risk Assessment

The environmental risk assessment (ERA) conducted by licensees is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors to the environment and human health. An ERA includes an Ecological Risk Assessment and a Human Health Risk Assessment. Most CNL facilities have CNSC REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [24] in their LCH as compliance verification criteria. An ERA is a requirement in the REGDOC for Class I facilities, such as CRL, WL, DPWF, G1WF and NPDWF.

CNSC staff reviewed the submitted ERAs for the CRL, DPWF and G1WF sites and have determined that they are compliant with the requirements in CNSC's REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures* [24], and CSA standard N288.6-12, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills* [25].

An ERA for the WL lagoon and landfill areas was submitted by CNL in 2021, taking into consideration current site conditions. CNSC staff provided comments on the ERA and are expecting CNL to submit a revised WL lagoon and landfill areas ERA, as well as the initial submission of the WL site-wide ERA in 2023.

CNSC staff conclude that CNL continues to maintain and implement an effective ERA at applicable sites in accordance with regulatory requirements.

4.9.5 Protection of the Public

The protection of the public within the environmental protection SCA is related to ensuring that members of the public are not exposed to unreasonable risk with respect to hazardous and nuclear substances released from the licensed facilities. CNL provides their results of monitoring of releases of hazardous and nuclear substances within their annual environmental and compliance monitoring reports.

Based on CNSC staff assessment of the results in CNL's 2022 environmental monitoring programs, CNSC staff conclude that the releases of hazardous and nuclear substances from CNL sites met the regulatory requirements.

Estimated Dose to the Public

As part of annual reporting to the CNSC, CNL provides data on dose to a hypothetical member of the public that is representative of someone who spends considerable time in proximity to the licensed site.

In all cases, CNL's data indicates that doses to the public resulting from CNL's operations remained well below the 1 mSv/year limit prescribed in the *Radiation Protection Regulations* [16]. At no point during 2022 did the emissions from the CRL site exceed the constraint for dose to the public of 0.30 mSv/year indicated in the CRL LCH. The maximum estimated dose to the public from a CNL site was estimated to be from PGP, at 0.033 mSv/year (3.3% of the 1 mSv/year dose limit).

Further details on the estimated dose to the public are available in Appendix J.

4.10 Emergency Management and Fire Protection

The emergency management and fire protection SCA covers emergency plans and emergency preparedness programs that exist in case of emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

CNSC staff assess CNL's performance in the emergency management and fire protection SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

4.10.1 Chalk River Laboratories

CRL conducts drills and exercises to test their emergency procedures and evaluate their response capabilities. This includes an annual emergency preparedness exercise.

In June 2022, CNL performed a stay-in exercise to test their emergency preparedness and response program at CRL. The exercise was designed to test the response capabilities of the CRL site internal response organizations during a simulated high radiation incident in the Universal Cells Facility, resulting in a site stay-in condition. CNSC on-site inspectors observed the exercise and noted no areas of non-compliance.

4.10.2 Gentilly-1 Waste Facility

In December 2022, a fire drill was conducted at the G1WF site to simulate a fire drill at G1WF. CNSC staff reviewed the CNL G1WF After Action Report and were satisfied with G1WF staff's emergency preparedness capabilities, both from CNL G1WF building emergency staff, and the non-emergency staff.

4.10.3 Whiteshell Laboratories

Background

In April 2023, CNL performed a planned self-assessment of the WL fire protection program against the requirements of CSA N393-13, *Fire Protection For Facilities That Process, Handle, Or Store Nuclear Substances* [26]. The self-assessment involved CNL reviewing fire response training, equipment and response capability for compliance with CSA N393-13 [26] and included the review of fire protection records for calendar years 2020, 2021 and 2022.

This assessment determined that training records for members of the on-site fire brigade were incomplete, and therefore CNL could not demonstrate that fire response staff were adequately trained and competent to provide fire suppression activities consistent with the fire protection program for the WL site. Deficiencies were also identified with the procedures for equipment inspection, testing, and maintenance and the use of incomplete or expired personal protective equipment. The deficiencies identified in the training and equipment of fire response staff had a direct impact on CNL's ability to maintain minimum complement of fire response personnel at the WL site.

As a result of these findings, on April 27, 2023, CNL contacted the CNSC Duty Officer to report this event in accordance with section 29(1)(a) of the *General Nuclear Safety and Control Regulations* [27] and paragraph 27(b)(ii) of the *Nuclear Safety and Control Act* [1]. CNL immediately placed the WL site into a safe shutdown state, where only essential compliance and maintenance work could be conducted.

Pursuant to CNSC’s REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [11], CNL submitted the required event reports. The full event report identified additional non-compliances with the fire protection program linked to training of firefighters, the conduct of drills, the maintenance and availability of personal protective equipment for firefighters, annual inspection and maintenance for fire extinguishers, and the supply of firewater (i.e., pressure and flow). Several fire hydrants were also identified as unavailable, fixed suppression systems (sprinklers) had not been properly maintained and tested in Whiteshell Reactor-1 (WR-1), and emergency lighting in buildings had not been tested to National Fire Protection Association standards.

This event was presented to the Commission as an Event Initial Report in CMD 23-M25 [28] on June 28, 2023.

Regulatory Actions

On May 8, 2023, CNSC staff held a focused technical meeting with CNL to discuss the preliminary event report, CNL’s immediate measures taken, impacts on CRL fire response capabilities as a result of providing support to WL, next steps and timelines for action completion. Given the number and significance of the non-compliances, CNSC staff determined additional timely information was required to assess whether any enforcement response was needed in alignment with the CNSC’s graduated enforcement strategy. As a result, on May 15, 2023, a CNSC designated officer issued a 12(2) request, as outlined in CMD 23-M25 [28], requesting a number of actions be taken by CNL.

CNL responded to the 12(2) request as required by May 19, 2023. CNSC staff found CNL’s response to be acceptable, and as a result, the CNSC designated officer closed the 12(2) request on May 26, 2023.

On May 30, 2023, CNSC staff conducted a site visit to WL. The purpose of this visit was to determine if CNL had in place a safe, effective and sustainable fire response and adequate implementation of compensatory measures to address the fire protection system non-compliances and ensure the protection of all workers, responders, facilities and the environment.

CNSC staff confirmed that fire extinguishers had been replaced, signage was in place regarding emergency lighting, fire hoses had been pre-deployed to areas lacking operational hydrants and new firefighting gear was present in the firehall. CNSC staff raised a concern regarding the presence of metal halide lighting as a potential ignition source and CNL took immediate actions to mitigate the risk of the presence of these lights and has initiated the process to have them replaced. CNSC staff and CNL had productive discussions regarding the minimum shift complement of firefighters at WL, and CNL has committed to maintaining a complement that CNSC staff confirm meets regulatory requirements. During the site visit, CNSC staff requested records regarding firefighter training, shift complement, the fire screening process and the status of fire hydrants. These records were provided on June 6, 2023 and are currently under review by CNSC staff.

Following the WL site visit and closure of the 12(2) request, CNSC staff are:

- reviewing all submissions from CNL related to this matter
- waiting for the submission of the Multi-Phase Re-Start Plan for CNSC staff review and acceptance
- developing a reactive compliance plan and follow-up activities for the WL site, whereby all compliance activities in the plan will be performed by end of March 2024.

CNSC staff will be providing an update to the Commission of the progress made and status of the WL safety stand-down during the ROR presentation for CNL sites scheduled for November 1, 2023. Additionally, CNSC staff will review the event and draft a lesson learned report which will focus on CNSC’s regulatory oversight of WL from 2019 to 2022. This report and its findings will be shared with the Commission once finalized.

Conclusion

As a result of these findings, CNSC staff has rated the emergency management and fire protection SCA at WL as below expectations in 2022. CNSC staff will continue to conduct oversight in this area to ensure WL comes into compliance with regulatory requirements.

4.10.4 Overall Conclusion

Apart from WL, which received a below expectations rating, CNSC staff conclude that CNL continues to implement and maintain effective emergency management and fire protection programs at CNL sites in accordance with regulatory requirements.

4.11 Waste Management

The waste management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility, location or site. This area also covers the planning for decommissioning.

CNSC staff assess CNL's performance in the waste management SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

CNL's activities involve the management of radioactive wastes, from generation to storage. Radioactive and other hazardous wastes have been previously generated from reactor operations and radioisotope production, and waste continues to be generated from on-going site operations, research and development, decommissioning and environmental remediation activities at CNL sites. CNSC staff maintain oversight of CNL's current and future management of radioactive wastes through compliance activities, including desktop reviews and inspections.

CNSC staff conclude that CNL met the applicable regulatory requirements for the waste management SCA at all CNL sites in 2022. CNSC staff were satisfied with the information provided by CNL in the annual compliance reports for all CNL sites in 2022.

Waste from institutions, including hospitals and universities from across Canada, are received at CRL on a commercial basis for safe long-term storage. This service ensures that wastes are managed in a safe, secure and environmentally-sound manner. CRL received a total of 111.6 m^3 of radioactive waste from external organizations in 2022. This includes 45.6 m^3 of commercial waste and 66 m^3 of waste returned from off-site treatment of CNL waste (for example, ash from incineration). In comparison, in 2021, CNL received a total of 61.3 m^3 of radioactive waste from external sources.

Radioactive wastes stored on the sites consist of high-, intermediate- and low-level radioactive wastes. The inventory of wastes stored at CNL sites as of December 31, 2019 is included in the seventh *Canadian National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2020)* [29].

In 2022, CNSC staff conducted a technical review of a proposed revision of the Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 – Whiteshell Reactor #1: Building 100 for the in-situ decommissioning of WR-1, and concluded that the plan did not meet all of the necessary criteria of CNSC's REGDOC-2.11.2, *Decommissioning* [30] and CSA N294-19, *Decommissioning of facilities containing nuclear substances* [31]. CNSC staff sent the review comments to CNL for their disposition. The current approved decommissioning strategy for WR-1 is deferred decommissioning (complete removal), as set out in the approved version of the Detailed Decommissioning Plan for WR-1.

In 2022, CNSC staff conducted a technical review of the Preliminary Decommissioning Plan for the PGP and concluded that the plan did not meet all the regulatory requirements of CNSC's REGDOC-2.11.2, *Decommissioning* [20], CSA N294-19, *Decommissioning of facilities containing nuclear substances* [31] and CNSC's REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities* [32]. CNSC staff sent review comments to CNL for their disposition. CNL was requested to provide clarity or additional information on a number of areas including: anticipated post-operational conditions; decommissioning strategy and work plan; waste management strategy; and cost estimate for the financial guarantee. CNL provided responses to CNSC staff's comments, which are currently undergoing review. Additionally, as part of the recent licence renewal for the PHAI, CNL has committed to submitting a Preliminary Decommissioning Plan for the PHP by June 30, 2024, at which point CNSC staff will conduct a technical review for its acceptance.

CNSC staff conducted 7 inspections at CNL sites in 2022 that had a focus on waste management; 2 at DPWF, 1 at WL and 4 at CRL. As a result of these inspections, there were 5 NNCs. There was 1 to DPWF for a waste container label non-compliance; 2 to WL, 1 for a waste container label non-compliance and 1 for an incomplete site wide inventory; and 2 to CRL, 1 for vegetation growth near waste containers in the WMA and 1 for waste package removal from rooms without monitoring for radiation from Fe-55 as required. All NNCs were of low safety significance, and all are closed except the NNC issued to WL for the incomplete site wide inventory, for which CNL is implementing corrective actions to be completed by Q4 of the 2023 calendar year.

4.11.1 Overall Conclusion

CNSC staff conclude, during 2022, CNL maintained effective programs to safely manage radioactive and hazardous wastes from CNL's licensed activities and the decommissioning of its facilities.

4.12 Security

The security SCA covers the programs required to implement and support the security requirements stipulated in the in the *General Nuclear Safety and Control Regulations* [27], *Nuclear Security Regulations* [33], the licence, orders and regulatory expectations for the facility or activity.

CNSC staff assess CNL's performance in the security SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D).

4.12.1 Whiteshell Laboratories

Background

On September 27-29, 2021, CNSC staff identified areas of improvement in the implementation of the security program in relation to Tactical Response Force (TRF) equipment and training following an on-site security inspection at WL.

These areas did not pose any immediate risk to the security of nuclear substances at WL. CNL implemented a corrective action plan (CAP) with milestones and timelines to address these areas by May 27, 2022, that were accepted by CNSC staff. All actions identified in the CAP have been completed.

CNL received a rating of below expectations from 2018 to 2021 in the security SCA. However, as a result of the significant progress made by CNL during the 2022 calendar year, CNSC staff have determined that the security SCA is now rated as satisfactory at WL, which will be discussed in the next section of this report.

Regulatory Actions

On June 15, 2022, CNSC staff conducted an inspection to verify the implementation of CNL's CAP. During the inspection, CNSC staff reviewed procurement documents related to the receipt of TRF equipment and training related actions completed by CNL. CNSC staff's review of CNL's documents demonstrated that training-related corrective actions have either been completed or have been recorded on the training calendar. In addition, CNSC staff noted that all required equipment has been procured and most were received. CNSC staff concluded that CNL was monitoring the timelines of the CAP closely (from the 2021 inspection) and taking appropriate actions including maintaining regular communications with the suppliers and providing regular updates to CNSC staff as procured equipment was being received.

On September 14-16, 2022, a planned inspection was conducted by CNSC staff to assess CNL's compliance with the regulatory requirements through verification of its physical protection program that included: the protected area, physical barriers and associated systems, security practices, as well as response arrangements, drills and exercises. CNSC staff also reviewed training records that included security drills that had occurred since CNSC staff inspected the site in June 2022 and records of official qualification of fitness, firearms and use of force. CNSC staff also followed up on the progress made by CNL with the open NNCs from the 2021 inspection related to procurement of security equipment. CNL provided documentation and demonstrated that most security equipment was received and commissioned, with the remaining few to be ready and commissioned by the end of December 2022. CNSC staff were satisfied with CNL's actions and closed all NNCs from the 2021 inspection.

Conclusion

As a result of CNSC staff verification activities conducted in 2022, and the review of CNL's submissions, CNSC staff have determined that CNL has demonstrated compliance with regulatory requirements at WL and there is no immediate risk to security of the nuclear substances at WL.

CNSC staff assessed that CNL met applicable regulatory requirements in 2022, and therefore assigned a satisfactory rating for the security SCA at WL.

4.12.2 Chalk River Laboratories

Background

CNSC staff assess CNL's performance in the security SCA through desktop reviews of documents, reportable events and through the course of inspections. Following a review of CNL's Tactical Response Arrangements, CNSC staff held technical meetings with CNL focusing on the security arrangements at Waste Management Areas (WMAs) at CRL.

At the request of CNSC, CNL provided a Tactical Response Plan (TRP) with timelines that reflected all training of the Nuclear Response Force (NRF). CNSC staff determined that CNL's submission did not meet regulatory requirements. CNSC staff also indicated that CNL must ensure that it always maintains an on-site NRF capable of providing an effective intervention at the WMAs and that CNL re-submit its updated TRP for CNSC staff review.

CNSC staff was not satisfied with the timelines and the measures being proposed by CNL, which resulted in the issuance of Order 6656254 in October 2021 (amended in November 2021 by the Designated Officer), that included the immediate implementation of compensatory measures. On October 18-19, 2021, CNSC staff conducted an on-site inspection and observed multiple deficiencies in the deployment of the compensatory measures, as required by the Order. From this inspection, CNSC staff also issued several NNCs related to physical protection measures at the WMAs.

In November 2021, CNL met the compensatory measures required by the Order, and continued to provide periodic updates including submissions and status reports on their progress.

Regulatory Actions

In February 2022, during a site visit to verify compensatory measures at the WMAs, and to follow up on CNL's progress with regards to the NNCs from the October 2021 inspection, CNSC staff determined that CNL's compensatory measures and CNL's corrective measures to address the enforcement actions were satisfactory. As a result, all open NNCs from the October 2021 inspection were confirmed closed.

Following a CNL submission in May 2022 of a revised TRP corresponding with the requirements of the Order, CNSC staff held multiple in-person technical meetings with CNL to provide comments on CNL's final TRP and performed walkdowns of the WMAs. CNSC staff requested additional information on various areas of the submissions, more specifically details on CNL-CRL's response ability and CNL's approach to assuring security objectives are being met. Furthermore, CNSC staff re-iterated their concerns of the lack of adequate security measures in WMAs.

In September 2022, CNSC staff performed an unannounced security field inspection of the Protected Areas at the WMAs in order to verify the physical protection measures in place. The inspection identified non-compliances and resulted in multiple follow-up actions involving the physical protection measures at this particular WMA. CNL took immediate actions to correct these non-compliances.

In October 2022, CNSC staff communicated their concerns with regards to CNL's overall performance of security at CRL and its lack of implementation of corrective measures. CNL was directed by CNSC staff to undertake a programmatic review of the security program to better understand the circumstances behind the failures at CRL. CNL was required to identify actions to strengthen the program and prevent the recurrence of the failures. CNL's response included immediate programmatic measures that consisted of the creation of a special forum for a Nuclear Performance Assurance Review Board, implementation of project management and change control actions as well as a commitment to provide a more detailed Security Program Oversight Plan (SPOP) by December 16, 2022.

On December 15, 2022, CNL submitted a detailed SPOP that identified issues resulting from performing CNL quality assurance audits, extent of condition reviews and security management workshops. The SPOP contained a set of 17 actions broken into three themes (Management System Oversight, Audit and Assessment and Security Program Resource Review) for CNL to address, with a goal to strengthen the security program and prevent recurrence. CNL committed to monitor the performance of the SPOP actions and to provide quarterly updates to CNSC on the progress of the activities starting in 2023.

During a quarterly SPOP meeting held in April 2023, CNL provided updates on the progress of the actions as defined in the plan, the outcomes that are achieved as well as the status of focused actions taken by CNL to meet the intent of the open Security Order. At the time of writing this report, CNL confirmed closure of 12 actions, with the 5 remaining actions in progress consisting of revising program documents and completing performance reviews. CNL committed to a target date of completion of the remaining actions by November 2023. With regards to the status of the TRP, CNL submitted the revised TRP for CNSC staff review in mid-May 2023, with a formal request to close the Order. CNL committed to submitting the TRP implementation plan by end of July which will outline timelines and steps for full implementation. CNSC staff accepted CNL's revised TRP.

CNL has made significant progress since the issuance of the Order; however, continue to be rated as below expectations in 2022. During 2023, CNL has made significant improvements to the security program for addressing the Order and CNSC staff are satisfied with the progress being made.

Conclusion

The security program at CRL was assessed at below expectations in 2022. CNL has implemented adequate compensatory measures and there is no immediate risk to security of the nuclear substances at CRL. CNSC staff will continue to conduct oversight in this area to ensure CRL comes into compliance with the regulatory requirements and the effectiveness of the program is improved.

4.12.3 Overall Conclusion

Apart from CRL, which received a below expectations rating, CNSC staff conclude that CNL continues to implement and maintain effective security programs at CNL sites in accordance with regulatory requirements.

4.13 Safeguards and Non-Proliferation

The safeguards and non-proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements, as well as other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons* [34].

CNSC staff assessed CNL's performance in the safeguards and non-proliferation SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). These compliance activities demonstrated that facilities were operated and maintained according to the licensing basis.

Under the terms of the Canadian-IAEA safeguards agreements, the IAEA has the right to perform independent verification activities at various types of sites in Canada, including all the CNL sites covered by this report. IAEA activities are not CNSC compliance inspections, however CNSC staff accompanied IAEA staff on 11 of their activities at the sites covered by this report in 2022. CNSC staff also provided support remotely to an additional 17 IAEA activities carried out at CNL sites in 2022.

In 2022, the IAEA carried out activities at CRL, WL, PHP, PGP, DPWF and G1WF to verify nuclear material inventories and confirm the absence of undeclared nuclear materials and activities. As a result of the inspections conducted by the IAEA, no significant issues were identified. Appendix D contains a list of IAEA lead inspections carried out at each CNL site in 2022. The safeguards program at NPDWF is limited to providing access and assistance to IAEA inspectors in the event of a complementary access request. There was no IAEA complementary access at the NPDWF in 2022.

The CNSC, IAEA and CNL continue to work together to ensure that Canada's requirements under the *Treaty on the Non-Proliferation of Nuclear Weapons* [34] are fulfilled.

4.13.1 Overall Conclusion

CNSC staff conclude that CNL continues to implement and maintain effective safeguards programs in accordance with regulatory requirements.

4.14 Packaging and Transport

The packaging and transport SCA includes the programs that cover the safe packaging and transport of nuclear substances to and from licensed facilities.

CNSC staff assessed CNL's performance in the packaging and transport SCA through desktop reviews of documents, reportable events (Appendix E) and through the course of inspections (Appendix D). There were no transport focused inspections conducted in 2022.

CNL has developed and implemented a packaging and transport program that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* [35] and *Transportation of Dangerous Goods Regulations* [36]. This program covers elements of package design, package maintenance and the registration for use of certified packages as required by the regulations.

In 2022, 342 m^3 of low-level waste and 2.5 m^3 of intermediate-level waste was transported from WL and safely delivered to CRL.

4.14.1 Overall Conclusion

CNSC staff conclude that CNL continues to implement and maintain effective packaging and transport programs in accordance with regulatory requirements.

5 INDIGENOUS CONSULTATION AND ENGAGEMENT

5.1 CNSC Consultation and Engagement Activities

The CNSC is committed to building long-term relationships and conducting ongoing engagement with Indigenous Nations and communities who have an interest in CNSC-regulated facilities within their traditional and/or treaty territories. The CNSC's Indigenous engagement practices include sharing information, discussing topics of interest, seeking feedback and input on CNSC processes, responding to addressing issues and concerns, ongoing collaboration and two-way dialogue, collaboratively drafting relevant sections of CNSC reports, including RORs, and providing opportunities to participate in environmental monitoring through the Independent Environmental Monitoring Program (IEMP). The CNSC also makes funding support available through the CNSC's Participant Funding Program (PFP) for Indigenous Peoples to meaningfully participate in Commission proceedings and ongoing regulatory activities.

CNL's sites fall within the traditional and treaty territories of many Indigenous Nations and communities, as listed in Appendix A. The majority of the engagement and consultation activities with Indigenous Nations and communities with an interest in CNL's sites, operations and activities in 2022 occurred via both in-person and remote means. CNSC staff welcomed the opportunity to discuss and address topics of interest and concern to the Indigenous Nations and communities through various engagement activities and conduct collaborative in-person activities to continue to build and strengthen the relationships between the CNSC and each Nation.

CNSC Engagement Efforts

In 2022, CNSC staff engagement efforts in relation to CNL sites were largely focused on consultation activities for the ongoing EAs and licensing processes for the NSDF Project and the NPDWF Decommissioning Project, as well as the renewal of the PHP licence. Indigenous Nations and communities were also provided updates on ongoing licensed activities at the DPWF, WL, G1WF, PHAI, NPDWF and CRL sites.

CNSC staff ensure that all Indigenous Nations and communities with a potential interest in CNL sites, facilities and activities, are aware of the CNL ROR process and how they can get involved. As was done in 2021, the CNSC continued to hold an annual CNL ROR virtual engagement session with Indigenous Nations and communities on September 8, 2022. There were over 20 participants representing approximately 11 Indigenous Nations, communities and organizations with an interest in CNL sites and the ROR. The goal of the engagement session was to provide an overview of the ROR, CNSC staff's findings with regards to CNL's performance in 2021 as well as discuss and address feedback, concerns, comments and recommendations submitted by interested Nations and communities in relation to the 2021 CNL ROR. CNSC staff appreciated the feedback and discussions and worked to include and reflect a number of the recommendations in the 2022 CNL ROR. Based on the continued success of these virtual engagement sessions, CNSC staff plan to host another CNL ROR engagement session for the 2022 ROR in September 2023.

CNSC Communications with Indigenous Nations and Communities

In addition to the outreach and engagement sessions, CNSC staff ensure that all interested Indigenous Nations and communities are made aware of the opportunities to review the ROR and submit interventions to the Commission, including the opportunity to intervene orally, as well as opportunities to receive funding through the CNSC's PFP to support their participation in the process. As well, in 2022 CNSC staff continued to keep Indigenous Nations and communities up to date and informed with regards to CNSC staff's regulatory oversight activities at CNL sites including specific meetings on topics of interest, and ongoing discussions with regards to responding to and addressing issues, concerns and recommendations raised in their interventions to the Commission. In 2022, CNSC staff followed up with each Indigenous Nation and community who intervened with regards to the 2021 CNL ROR and offered to have specific meetings and discussions to address their concerns, comments and recommendations. In response to concerns raised by Indigenous Nations and communities, CNSC staff committed to taking the following actions to continue to improve the CNL ROR:

- Provide more detailed event descriptions for reportable events.
- Provide more information on NNCs arising from inspections.
- Include details on the CNSC's oversight strategy on climate change resiliency.
- Include an annex summarizing the issues, concerns and requests, and the status of the CNSC's responses/work to address them from intervenors from last year's ROR, including Indigenous Nations and communities.
- Continue working with Indigenous Nations and communities to address their recommendations in their interventions on the 2021 CNL ROR.
- Collaborate with Indigenous Nations and communities with whom the CNSC has a Terms of Reference (ToR) for long-term engagement on drafting summaries of engagement activities.
- Collaborate with Indigenous Nations and communities on summarizing their feedback and perspectives on engagement with CNL in 2022.

More information on the ToR engagement summaries and each Nation's perspective on CNSC staff's and CNL's engagement during 2022 can be found in Appendix L and section 5.2 of this report.

Issues and Concerns Tracking

In order to effectively track and respond to requests and recommendations from interventions submitted by Indigenous Nations and communities, CNSC staff have established an internal tracking process to capture issues, concerns and recommendations raised by each Indigenous Nation or community. This process includes populating internal tracking tables, in which CNSC staff document responses and proposed action items as needed. CNSC uses this tool to summarize the requests, concerns and recommendations included in the interventions in relation to each ROR, or other Commission proceedings as appropriate.

In response to the Commission's request for information on issues and concerns tracking, CNSC staff have included Appendix M in this report that provides key information about the number of issues, concerns and recommendations submitted by each Indigenous Nation and community in relation to the 2021 CNL ROR. Additionally, the appendix presents the number of issues and concerns that the CNSC has responded to, as well as the current status and CNSC staff's path forward to meaningfully address and close out specific requests, concerns and comments, where possible. Overall, the CNSC has been able to respond to all of the requests, concerns and comments raised by Indigenous Nations from the 2021 CNL ROR and is actively working with each intervenor to resolve or close out each request and recommendation, where possible.

CNSC staff also reached out to all Indigenous Nations and communities who intervened in the 2021 ROR, offering to meet and discuss the requests, concerns, and comments from their interventions, as well as how to address them. For Indigenous Nations and communities that have a ToR with CNSC, requests, concerns and comments raised in the ROR will be further discussed in agreed-upon regular meetings, and CNSC staff will work with the Nation or community to share and verify the data in their respective issues tracking table.

Overall, the interventions in relation to the 2021 ROR were categorized into 14 different themes including consultation and engagement, improvements to the ROR process and ROR content, and environmental monitoring.

Engagement on Monitoring Activities

In 2022, CNSC staff continued to engage and collaborate with Indigenous Nations and communities on the CNSC's IEMP. CNSC staff have made it a priority to ensure that IEMP sampling reflects Indigenous Knowledge, land use and values, where possible. In addition to IEMP sampling activities, CNSC staff sought input from Indigenous Nations and communities in the 2022 IEMP sampling plans and participation in the sampling process in-person alongside CNSC staff.

In advance of the 2022 IEMP sampling campaign around CRL, the Bruce Power site (DPWF) and WL, notification emails were sent to Indigenous Nations and communities near the sites to notify them of the sampling campaigns and to seek input on the applicable sampling plans. CNSC staff invited each interested Nation and community to provide and share Indigenous Knowledge, as well as suggestions for species of interest, valued components and potential sampling locations where traditional practices and activities may take place.

Representatives from the Algonquins of Pikwakanagan First Nation (AOPFN), Algonquins of Ontario, the Métis Nation of Ontario (MNO), Curve Lake First Nation (CLFN) and Kitigan Zibi Anishinabeg (KZA) First Nation joined the sampling team around the CRL site for sampling activities in August 2022. Representatives from Sagkeeng Anicinabe First Nation, Manitoba Métis Federation (MMF), Black River First Nation and Hollow Water First Nation joined the sampling team around WL. Representatives from the MNO, the Historic Saugeen Métis (HSM) and the Saugeen Ojibway Nation (SON) joined the sampling team at the Bruce Power site in areas surrounding the DPWF site. CNSC awarded funding through the PFP to each participating Indigenous Nation and community to support these collaborative efforts on the 2022 IEMP.

As part of the sampling field work, CNSC staff and the participating Indigenous Nations and communities discussed the IEMP in more detail and related aspects of the CNSC's Environmental Protection Framework. The CNSC's sampling team demonstrated sampling techniques as well as packaging and chain of custody procedures. Participants helped to gather samples of water, soil, sand and vegetation. CNSC staff truly appreciated the engagement, input and participation by the Indigenous Nations and communities in the CRL, Bruce Power site/DPWF and WL sampling campaigns and look forward to future collaboration on the IEMP and other sampling initiatives. Once the results are available for each of the sampling campaigns, CNSC staff will work with each Indigenous Nation and community to communicate the results to their respective leadership and community members, including collaboration on easy-to-read results cards that can be shared with community members. The CNSC is committed to continuing to engage with interested Indigenous Nations and communities with regards to the IEMP, to ensure that sampling plans and activities are reflective of and incorporate Indigenous Knowledge, values and perspectives.

In 2022, CNSC and Environment and Climate Change Canada (ECCC) engaged with participating Indigenous Nations and communities and Environmental Non-Government Organizations in Phase 1 of the Regional Information and Monitoring Network for the Ottawa River Watershed (RIMNet) Initiative. This initiative is led by the CNSC and ECCC to improve information sharing and documentation regarding the environmental effects of past, existing and proposed nuclear facilities in the Ottawa River Watershed Basin. RIMNet aims to improve understanding of environmental effects, including cumulative effects of past, existing and proposed nuclear facilities.

The AOPFN, Kebaowek First Nation (KFN), KZA and Ottawa Riverkeepers have been engaging with CNSC and ECCC to share knowledge, perspectives and priorities in relation to the RIMNet initiative. Participants met with CNSC and ECCC quarterly to receive updates on data collection and analysis, review the draft table of contents for the State of the Environment report, which included identifying sections of the report where they may have interest in contributing to, as well as share resources and/or Indigenous Knowledge, as appropriate. CNSC and ECCC are engaging with participants at all stages of Phase 1 of RIMNet to ensure a collaborative process and look forward to further collaboration in future phases of the initiative.

CNSC Terms of Reference for Long-Term Engagement with Indigenous Nations and communities

CNSC staff have formalized long-term engagement relationships with interested Indigenous Nations and communities through ToRs collaboratively developed with each Nation or community. The ToRs and associated work plans, include regular meetings, an accountability and governance structure, specific collaborative activities, as well as topics, facilities, sites and projects of interest. In 2022, the CNSC developed and finalized ToRs for long-term engagement with the following Indigenous Nations and communities with an interest in CNL sites and activities:

- AOPFN
- Mississaugas of Scugog Island First Nation
- KFN

This is in addition to existing ToRs with CLFN, the SON, the MNO and the HSM. In total, CNSC staff have signed 8 ToRs for long-term engagement to date and are working on developing a number of others in the coming years with interested Indigenous Nations and communities. CNSC staff remain open to developing ToRs for long-term engagement with other interested Nations and communities with nuclear facilities in their territories upon request. A summary of the engagement activities that occurred in 2022 in relation to each of the existing ToRs for long-term engagement with these Nations and communities which was collaboratively drafted between CNSC staff and each respective Indigenous Nation or community can be found in Appendix L.

5.2 CNL Engagement Activities

CNSC staff confirms that CNL has a dedicated Indigenous Engagement program that covers CNL's operations and activities. CNL met and shared information with interested Indigenous Nations and communities throughout 2022. CNL staff also participated in cultural awareness activities, provided capacity funding to support engagement activities, and invited Indigenous community members to CNL events.

CNL engagement with respect to CRL, NPDWF, DPWF, G1WF, PHAI and WL in 2022 generally focused on project-specific environmental assessments and licensing processes. However, discussions and activities have also addressed concerns and interest in the broader sites and ongoing licensing activities.

Chalk River Laboratories and Nuclear Power Demonstration Waste Facility Sites

For the CRL site, CNL continued to work on long-term relationship agreements in 2022. CNL has a Memorandum of Understanding (MOU) with the Algonquins of Ontario as well as an MOU with the MNO Regions 5 and 6. CNL is also in the process of working on an MOU and Contribution Agreement with KFN, as well as with KZA. CNL is working to amend a Contribution Agreement with CLFN to go until 2024 and is working to establish a Contribution Agreement with Hiawatha First Nation. CNL continued discussions with AOPFN on establishing a Guardian Program and a long-term relationship agreement. The MNO, AOPFN, KZA and KFN are also involved in CNL's public Environmental Stewardship Council. CNL continued engagement with KZA and KFN to continue to build their relationships and continued monthly meetings with the Williams Treaties First Nations (WTFN) (including CLFN). CNL has noted that Indigenous Nations and communities expressed interest in biodiversity and cultural heritage studies, as well as future site use at CRL. In response, CNL invited interested Indigenous community members to participate in archaeological assessment field studies at CRL.

Douglas Point Waste Facility

For the DPWF, CNL continued to focus on long-term engagement in 2022. CNL participated in the annual SON Tradeshow, as well the SON Environmental Office community event, provided regular project updates, provided a facility tour, and worked towards signing a ToR for long-term engagement. CNL conducted regular quarterly meetings with HSM to discuss project updates on the DPWF. CNL also met with the MNO staff and MNO Georgian Bay Traditional Territory Consultation Committee to provide project updates and discuss a relationship agreement.

Whiteshell Laboratories

In 2021, CNL shifted its approach to engaging with interested First Nations and the Red River Métis (represented by the MMF) in the vicinity of the WL site to be more relationship-based than solely project-focused. This work carried on into 2022. CNL continued to work to establish an Indigenous Advisory Committee for the WL site, as well as relationship agreements with key Indigenous Nations and communities. In 2022, CNL worked with Sagkeeng Anicinabe First Nation to establish a community liaison officer position, met with Chief and Council, provided site tours, renewed the Technical Working Group and supported the development of an independent Community Environmental Monitoring Program. In 2022, MMF participated in or observed many CNL environmental monitoring and other site activities, received updates on ongoing WL decommissioning activities, hosted CNL at a MMF Community Consultation Meeting, discussed potential collaborative initiatives, and continued negotiating a relationship agreement with CNL. In 2022, Black River First Nation and Hollow Water First Nation participated in a site tour, berry picking and mushroom collection, medicinal plant walk, environmental monitoring and extended the existing relationship agreement with CNL.

Gentilly-1

No specific engagement activities with Indigenous Nations and communities were carried out for G1WF in 2022. However, CNL has indicated its intention to share information with and seek feedback from interested Indigenous communities with respect to G1WF and has noted that planning activities for Indigenous engagement and relationship building with Indigenous Nations and communities with an interest in the G1WF site were initiated by CNL in 2022 and 2023.

Port Hope Area Initiative

In 2022 for the PHAI, CNL continued engaging with the WTFN regarding the PHAI, which is located in their shared traditional and treaty territory, as well as approximate Indigenous communities with potential interests in the area around PHAI. CNL's Indigenous engagement staff met monthly with representatives from the Mississauga First Nations, as well as the Chippewa communities (Beausoleil, Georgina Island and Rama First Nations). In April 2022, CNL staff met with representatives of the Mississaugas of Scugog Island First Nation and their business partners to discuss potential procurement opportunities. In May 2022, CNL hosted senior representatives of Anishinabek Nation for an in-person meeting in Port Hope that included an update on PHAI activities and tour of the PHP sites.

The WTFN monthly meeting for June 2022 took place in-person in Port Hope and included a PHAI project update, information on the 10-year licence renewal application and revisions to the cleanup criteria amendment application proposal. The meeting was followed by a tour of the PHP and PGP sites. In July 2022, CNL staff met with representatives of the MNO Regions 6 and 8 to provide an update on the status of the PHAI project, an update on environmental monitoring and to discuss details of a proposed site tour with MNO representatives in the fall of 2022. Preparations for the PHP 10-year licence renewal hearing were also discussed. CNL continues to hold an active Contribution Agreement with CLFN and remains open to similar PHAI-related agreements with other Indigenous communities if desired.

Feedback received by Indigenous Nations and communities on engagement with CNL in 2022

In response to concerns raised by Indigenous Nations and communities in their interventions in relation to the 2021 CNL ROR that their input was not being incorporated into CNSC's assessment of licensees, CNSC staff sought formal feedback from Indigenous Nations and communities with regards to their perspectives and feedback on CNL's engagement with them in 2022 to be included in the 2022 CNL ROR. This input was sought outside of regular meetings from all interested Nations and communities who had raised issues, concerns and recommendations in the 2021 CNL ROR. Of the Nations CNSC requested feedback from relevant to this ROR, the HSM, CLFN and the AOPFN have provided feedback. Their submissions are as follows:

1. Feedback on CNL's Engagement from the Historic Saugeen Metis:

HSM Council and staff informed CNSC staff that they appreciated the informative project updates and discussions with CNL in 2022, which also included a project site tour.

2. Feedback on CNL's Engagement from Curve Lake First Nation:

CLFN informed CNSC staff that in 2022, CNL and the WTFN continued the practice of conducting routine meetings for the WTFN communities that have shown an interest and are able to attend. Reoccurring meetings allow CLFN to stay up to date on the different CNL projects and maintain predictability of interactions based on a schedule. During meetings, CNL has asked the representatives from WTFN about what could be improved during meetings and to continue building the relationship. CLFN had the opportunity to talk about the need to improve communication tools, like having infographics instead of meeting minutes. Representatives from WTFN also suggested having more interactions and less updates, more leadership meetings, more in-person meetings, concrete actions and deliverables, as well as allowing space to learn and digest the information. At these meetings, CNL has made the effort to share public disclosures.

3. Feedback on CNL's Engagement from the Algonquins of Pikwakanagan:

In April 2023, AOPFN provided CNSC staff with a performance review of CNL's engagement activities with their community in 2022. AOPFN has developed their own Aboriginal Rights SCA Criteria to assess the quality of engagement of licensees and the CNSC, which was first discussed in AOPFN's 2021 CNL ROR submission to the Commission. AOPFN's assessment is based on AOPFN's experience with CNL in relation to their participation in engagement and outreach initiatives and activities. CNSC staff and AOPFN have collaborated on summarizing AOPFN's key findings with regards to CNL's engagement activities with them in 2022 and the summary is included below. AOPFN's full assessment will be included in their submission to the Commission in relation to the 2022 CNL ROR.

Summary of AOPFN's Assessment of CNL's Engagement Activities and Performance in 2022

AOPFN's key findings from their assessment of CNL's engagement activities and performance in 2022 include the need for CNL to provide more inclusive and accessible communications with AOPFN, the need for meaningful commitments to be made by CNL to address AOPFN's concerns and priorities, as well as the full implementation of existing commitments between AOPFN and CNL. Other findings include AOPFN's desire for CNL to recognize AOPFN as a partner with a joint decision-making role on CRL site planning activities, as well as monitoring and management activities that are not restricted due to security concerns. AOPFN notes no commitments have been made to date in relation to measures at the NPDWF site to protect or promote AOPFN rights. Neither AECL, CNL or CNSC have indicated that they will respect and adhere to AOPFN United Nation Declaration on the Rights of Indigenous People (UNDRIP), Free, Prior and Informed Consent decisions, including in relation to projects that fit under the "positive consent requirements" for hazardous waste disposal facilities outlined in UNDRIP Article 29.2.

AOPFN has determined that from their perspective, CNL was overall operating below expectations in most of their Aboriginal Rights and engagement assessment categories for 2022. These categories include the integration of Indigenous Knowledge into site monitoring and management, engagement of Indigenous Peoples in site planning, monitoring and management, and contributions to reconciliation with Indigenous Peoples. However, AOPFN notes that they are seeing some improvement as CNL invests more in its relationship with AOPFN, including the ongoing efforts to develop a long-term relationship agreement (LTRA). This has contributed to a slight upward trend in the quality of CNL's engagement and the CNL-AOPFN relationship over the past year. AOPFN did not include the LTRA in their assessment of CNL's operations as no such agreement has been finalized to date.

AOPFN has developed and shared a list of proposed commitments that they would like CNL to implement to further improve the relationship between the two parties. AOPFN has shared these commitments with CNSC and CNL. Examples of the commitments include greater CRL site access provisions for AOPFN members and Guardians (including confirmed long-term funding and initial application of the Neya Wabun Guardian Program); recognition of past impacts on traditional use, culture and well-being; long-term funding for full implementation of AOPFN-led risk communication program agreement on a procurement and employment benefits program at CNL sites in their territory; greater communication and information sharing including but not limited to reportable incidents as well as plans for importing radioactive waste; among others.

AOPFN notes that CNL has made some progress towards improving the relationship and collaborating with AOPFN with respect to CNL sites in their traditional territory. For example, AOPFN appreciates that CNL is prioritizing having regular meetings with AOPFN at both the leadership and staff levels. However, AOPFN is of the view that CNL must make greater efforts to respect AOPFN rights and interests with regards to their operations and projects.

AOPFN reaffirms their responsibility to care for their unceded territory, and to preserve and protect the lands, waters, and wildlife. As such, AOPFN maintains that they must be recognized as a rightful, respected, and principled steward of the environment and have a greater role with regards to oversight, monitoring and management of the CRL site and other CNL operations and projects in their territory.

CNSC staff are encouraged that AOPFN and CNL are making progress towards enhancing their relationship and collaboration and encourage both parties to continue to make efforts to ensure the relationship and engagement continues to progress in a positive trend. CNSC staff will continue to monitor CNL's engagement and communication activities and support the relationship and work towards addressing AOPFN's concerns and comments as appropriate.

CNSC Indigenous Consultation and Engagement Findings

CNSC staff are overall satisfied with the level and quality of Indigenous engagement conducted by CNL with regards to its operations and proposed projects at its different sites in 2022. CNSC staff encourages CNL to continue to remain flexible and responsive to the requests and needs of the Indigenous Nations and communities that have an interest in its sites, facilities and proposed projects.

6 EVENTS AND OTHER MATTERS OF REGULATORY INTEREST

This section of the ROR provides information on other matters of regulatory interest, including reportable events, the separate efforts of CNSC staff and CNL regarding public engagement, environmental protection reviews, the Independent Environmental Monitoring Program (IEMP) and nuclear liability insurance at CNL sites.

6.1 Reportable Events

Detailed requirements for reporting unplanned situations or events at CNL licensed sites to the CNSC are referenced in the applicable LCHs. CNSC's REGDOC- 3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [11] was implemented for applicable CNL sites with the exception of PHP and PGP. CNSC's REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices* [37] was implemented for PHP and PGP. Over the period covered by this report, CNL has complied with the requirements for submission of these reports.

Appendix E provides a list and a brief description of the reportable events which occurred in 2022. These events are of low safety significance and CNSC staff are satisfied with CNL's corrective actions to prevent recurrence.

Events which CNSC staff assess as meeting specific risk criteria are the subject of "Event Initial Reports" from CNSC staff to the Commission. In 2022, there was one Event Initial Report, which was presented to the Commission on June 28, 2022:

- Exceedance of copper discharge criteria in plant effluent for the week ending on June 1, 2022 at the PHP waste water treatment plant (WWTP), presented to the Commission in CMD 22-M38 [20]. On June 6, 2022, CNL reported that during routine compliance sampling at the PHP WWTP the composite effluent sample for the week ending June 1, 2022, exceeded the weekly release limit for copper and the action level for zinc. CNL determined that the evaporator cooling loop was the source of the abnormal copper and zinc concentrations. CNL redirected the evaporator cooling loops to the plant process drain for water treatment until brass components could be modified and then tested to confirm the absence of copper and zinc concentrations in excess of the applicable licence limits and action levels. CNL also conducted an extent of condition evaluation on all systems potentially impacting the facility's final effluent to identify and address future sources of copper (both brass and bronze). CNSC staff took confirmatory influent and effluent water samples from the PHP WWTP and had them assessed by the CNSC lab and CNSC subject matter experts. The results were below applicable licence limits and action levels. CNSC staff are satisfied with the corrective actions taken by CNL and the event is now closed. The event had no adverse environmental or health effects.

6.2 Public Engagement

6.2.1 CNSC

Public engagement consists of activities carried out directly by CNSC staff, and those activities carried out by CNL. The *Nuclear Safety and Control Act* [1] mandates the CNSC to disseminate objective scientific, technical and regulatory information to the public concerning its activities and the activities it regulates. CNSC staff fulfill this mandate in a variety of ways, including hosting in-person and virtual information sessions and through annual regulatory reports. CNSC staff also participate in local community events as well as CNL-led public meetings. CNSC staff also seek out other opportunities to engage with the public and Indigenous Nations and communities, often participating in meetings or events in communities with interest in nuclear sites. These allow CNSC staff to answer questions about the CNSC's mandate and role in regulating the nuclear industry, including CNL's sites. Additionally, CNSC staff have responded to or provided CNSC staff's path forward to meaningfully address and close out specific requests, concerns and comments raised by Indigenous Nations or communities and intervenors who raised issues or concerns in relation to the 2021 CNL ROR. More details can be found in Table A in Appendix M of this report.

CNSC staff carried out several targeted outreach activities in 2022. Some of these activities were linked to specific regulatory review and licensing processes underway, including the NSDF, the Global First Power Small Modular Reactor (SMR) EA and licensing proposals, and the PHAI licence renewal. Other activities were more generic in nature including the outreach related to the CNL ROR. Outreach related to the ROR focused on Indigenous Nations and communities that have traditional and/or treaty territories in proximity to CNL sites.

CNSC awarded $72,828.76 in participant funding to assist Indigenous Nations and communities, members of the public and stakeholders in reviewing this ROR and submitting comments to the Commission, as detailed in Appendix K.

6.2.2 CNL

The CNSC requires licensees to maintain and implement public information and disclosure programs, in accordance with CNSC's REGDOC-3.2.1, *Public Information and Disclosure* [38]. These programs are supported by disclosure protocols that outline the type of facility's information to be shared with the public as well as details on how that information is to be disseminated. This ensures that timely information about the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities, is effectively communicated to the public.

CNSC staff monitor CNL's implementation of its public information and disclosure program to verify that it communicates regularly with its audiences in a way that is open, transparent and meaningful to them. CNSC staff also review yearly program updates to verify CNL is taking communities feedback into consideration and taking steps to implement program adjustments to meet the evolving needs of the various communities.

With the lingering impact of the COVID-19 pandemic, all licensees continued to face challenges and make ongoing adjustments to their public information programs. CNL successfully maintained and adapted its public information and disclosure program to engage their many stakeholders while adapting to the evolving restrictions and respecting all necessary protocols. CNL was able to reintroduce a number of in-person activities in 2022 and continued to deliver a hybrid approach to meetings and events, offer webinars and increase digital communications whenever possible.

Communications activities conducted by CNL included:

- maintaining a current, easy to navigate, public facing website
- regularly updating its website with information on each facility/site/project and posting its public disclosure protocol and reportable events
- extensive posting on social media with information on each facility/site/project, as well as engaging with audiences on social media; this included a total of more than 290 posts across the main platforms (Twitter/ LinkedIn/Facebook/YouTube) resulting in a 56% increase in impressions and a notable increase of followers (13% increase of followers on Twitter, 35% increase of followers on LinkedIn, 9% increase of followers on Facebook) and over 1.6 million impressions in total
- advertising on social media, local and national media including Maclean and the Toronto Star
- sending out information externally to local communities and interested stakeholders via newsletters (mailout and online), as well as internally to CNL employees via staff meetings, intranet and internal newsletters (online). CNL produces general newsletters as well as facility-, site- and project-specific newsletters for specific communities [CRL (fall edition) ~55,000 households, WR-1 (winter 2021/2022 edition) ~8,000 households]. The Kids CONTACT newsletter (winter and summer edition) was expanded to include the CRL, WL and Port Hope catchment areas in 2022 (~72,000 households).
- developing and publishing the 2022 CNL Sustainability Report on the website
- hosting and participating in several in-person events including open houses, community events, national and international conferences and tradeshows, including events to acknowledge and celebrate Indigenous Peoples, and encourage and promote youth and women in STEM. A CNL Science Camp was launched in 2022. All initiatives increased participants' awareness and understanding of CNL.
- hosting and participating in virtual events such as webinars, online conferences, career fairs and school presentations

- conducting sitewide tours at various facilities/sites for local communities, school groups, interested stakeholders and media as requested
- supporting local communities through various initiatives including an employee crowdfunding initiative
- providing mechanisms for audience feedback and responding to public inquiries including:
  - 327 website visitors who used the “Contact Us” function (down approx. 500 visitors from 2021)
  - a toll-free information line
  - breakfast briefings, technical meetings and focus groups and other community events
- consistent engagement with local and national media, both proactively and in response to requests. In 2022, CNL produced 35 news releases. By taking a more proactive approach to media relations, coverage was more accurate overall.
- conducting a Nanos research public attitude survey of more than 500 residents within Renfrew and Pontiac counties
- maintaining the community advisory panel which began in 2021 and posting meeting summaries to the CNL website

In 2022, CNL demonstrated a strong commitment to disseminating appropriate and timely health and safety information to the public and community members through the use of their website, social media, in-person and virtual events, engagement activities, and newsletters. CNL has a diverse educational program for youth. CNSC staff found that all CNL sites and facilities were in compliance with applicable public information program requirements.

6.3 Environmental Protection Reviews

CNSC staff conduct environmental protection reviews (EPRs) for all licence applications with potential environmental interactions, in accordance with CNSC’s mandate under the *Nuclear Safety and Control Act* [1] and associated regulations. An EPR is a science-based environmental technical assessment conducted by CNSC staff. The fulfillment of other aspects of the CNSC’s mandate, such as regulating safety and security, are met through other oversight activities.

Starting in 2021, the CNSC began a new approach for publishing stand-alone EPR reports online based on the scale and complexity of the environmental risk of the facility. These reports are separate from a specific licensing decision to allow interested Indigenous Nations and communities and members of the public additional time to review information related to environmental protection and engage with CNSC staff on any information in the reports. All available EPR reports can be found on the CNSC website. EPR reports are typically timed to align with the facility’s ERA cycle, which is at minimum every 5 years or sooner if there is a major change to the facility. Currently, there is only one EPR report available for CNL sites and facilities, and it is for the Port Hope Area Initiative. CNSC staff will be publishing EPR reports for the other CNL sites and facilities in the future.

- Environmental Protection Review Report: Port Hope Area Initiative [39]

The information in EPR reports support staff's recommendations to the Commission in future licensing and regulatory decisions on whether the proposal provides adequate protection of the environment and the health of people.

6.4 Independent Environmental Monitoring Program

The CNSC requires that each nuclear facility licensee develops, implements and maintains an environmental monitoring program as appropriate to demonstrate that the public and the environment are protected from any releases to the environment related to the facility's nuclear activities. CNSC staff evaluate and assess the results of these monitoring programs to determine compliance with the applicable requirements and limits, as set out in the regulations that govern Canada's nuclear industry.

The Independent Environmental Monitoring Program (IEMP) is an independent from licensee, technical environmental sampling program that is carried out by CNSC staff in publicly accessible areas around nuclear facilities. The CNSC continues to strive to build Indigenous and public trust in the CNSC's regulation of the nuclear industry; and thus implements an IEMP to confirm the effectiveness of a licensee's monitoring program and to promote more awareness and information sharing of CNSC's work in the protection of people and the environment. The IEMP is a regulatory tool that complements and informs the CNSC's ongoing compliance verification program. The IEMP does not rely on licensees to provide samples. CNSC staff or independent contractors obtain samples from publicly accessible areas around nuclear facilities, then measure and report the amounts of radiological and hazardous substances present in these samples to the Commission, Indigenous Nations and communities, and the public.

In 2022, CNSC staff conducted independent environmental monitoring around the CRL, Bruce Power (DPWF) and WL sites. There were no results of concern. In addition, these results are consistent with the results submitted by CNL. The IEMP results add to the body of evidence and supports CNSC staff's assessment that the public and the environment in the vicinity of the CRL, DPWF and WL sites are protected and that CNL's environmental protection programs are effective.

Results from all IEMP sampling campaigns are available on the CNSC's Web page.

6.5 Nuclear Liability Insurance

Pursuant to section 7 of the *Nuclear Liability and Compensation Act* [40], which came into force on January 1, 2017, and previously under the *Nuclear Liability Act* [41], CNL is required to maintain nuclear liability insurance for designated nuclear installations. The 5 nuclear installations operated by CNL that require nuclear liability insurance, as designated in the Schedule (section 2) of the *Nuclear Liability and Compensation Regulations* [42], are: CRL, WL, DPWF, G1WF and NPDWF.

The insured facilities at CRL are a single-unit reactor of over 7 megawatts, nuclear fuel waste processing facilities, retired nuclear reactor structures, facilities for nuclear fuel production and nuclear substance processing, and radioactive waste processing and storage facilities. CNL's prescribed limit of liability for this installation is $180 million, in accordance with paragraph 5(a) of the *Nuclear Liability and Compensation Regulations* [42].

The insured facilities at WL, DPWF, and G1WF have each a prescribed limit of liability of $13 million.

CNL's prescribed limit of liability for the installation at NPDWF is $1 million.

Natural Resources Canada, which is the federal department responsible for the administration of the *Nuclear Liability and Compensation Act* [40], confirms that CNL is in compliance with its obligation under the *Nuclear Liability and Compensation Act* [40] for nuclear liability insurance for all 5 designated nuclear installations.

6.6 Overall Conclusions

CNSC staff conclude that the CRL, WL, PHP, PGP, DPWF, G1WF and NPDWF sites operated safely in 2022. This conclusion is based on CNSC staff's assessments of CNL's activities which included site inspections, reviews of reports submitted by CNL, and event and incident reviews, supported by follow-up and general communication with CNL.

For 2022, the performance in all SCAs was rated as satisfactory with the exception of the emergency management and fire protection SCA at WL and security SCA at CRL, which were rated as below expectations. Despite these below expectation SCAs, overall:

CNSC staff's compliance activities confirmed that:

- Radiation protection programs at all CNL sites adequately controlled radiation exposures, keeping doses ALARA
- Conventional health and safety programs at all CNL sites continue to protect workers; and
- Environmental protection programs at all CNL sites were effective in protecting people and the environment.

CNSC staff will continue to provide regulatory oversight at all CNL sites, to ensure that CNL makes adequate provision to protect the health, safety and security of workers, Canadians, and the environment, and continues to implement Canada's international obligations on the peaceful use of nuclear energy.

REFERENCES

[1] *Nuclear Safety and Control Act*, S.C. 1997, c. 9

[2] *Regulatory review status for the Near Surface Disposal Facility (NSDF) – Canadian Nuclear Safety Commission*

[3] *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52

[4] Outcome of Federal-Provincial Review Team Review of Final Environmental Impact Statement for the Near Surface Disposal Facility Project CNSC to CNL, July 2, 2021

[5] Letter from Kebaowek First Nation

[6] Letter from Kitigan Zibi Anishinabeg

[7] *Regulatory review status for the decommissioning of the Whiteshell Reactor #1 – Canadian Nuclear Safety Commission*

[8] DEC 22-H13, Record of Decision, *Application to Renew the Waste Nuclear Substance Licence for the Port Hope Project as a Single Licence for the Port Hope Area Initiative*

[9] DEC 20-H4, Record of Decision, *Application to amend the Waste Facility Decommissioning Licence for the Douglas Point Waste Facility to include phase 3 decommissioning activities*

[10] Regulatory review status of Nuclear Power Demonstration Closure Project – Canadian Nuclear Safety Commission

[11] CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*

[12] CNSC REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue*

[13] CNSC REGDOC-2.2.2: *Personnel Training*

[14] CNSC REGDOC-2.4.3, *Nuclear Criticality Safety*

[15] CNSC REGDOC-2.6.3, *Aging Management*

[16] *Radiation Protection Regulations*, SOR/2000-203

[17] *Canada Labour Code*, R.S.C., 1985, c L-2

[18] *Occupational Health and Safety Regulations*, SOR/86-304

[19] 2022 Workplace Safety and Insurance Board Statistical Report

[20] CMD 22-M38 Event Initial Report, *Canadian Nuclear Laboratories Port Hope Waste Water Treatment Plant – Exceedance of Copper discharge in plant effluent*

[21] CSA Group, CSA N288.4, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*

[22] CSA Group, CSA N288.7, *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*

[23] ISO Standard 14001:2015, *Environmental Management Systems*

[24] CNSC REGDOC 2.9.1, *Environmental Protection: Environmental Principles, Assessments and Protection Measures*

[25] CSA Group, CSA N288.6-12, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills*

[26] CSA Group, CSA N393-13, *Fire protection for facilities that process, handle or store nuclear substances*

[27] *General Nuclear Safety and Control Regulations*, SOR/2000-202

[28] CMD 23-M25 Event Initial Report, *Safety stand-down at Canadian Nuclear Laboratories' Whiteshell Site following the discovery of non-compliances in the fire protection program*

[29] *Canadian National Report for the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (October 2020)*

[30] CNSC REGDOC-2.11.2, *Decommissioning*

[31] CSA Group, CSA N294-19, *Decommissioning of facilities containing nuclear substances*

[32] CNSC REGDOC-3.3.1, *Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*

[33] *Nuclear Security Regulations*, SOR/2000-209

[34] United Nations, *Treaty on the Non-Proliferation of Nuclear Weapons*

[35] *Packaging and Transport of Nuclear Substances Regulations*, *2015*, SOR/2015-145

[36] *Transportation of Dangerous Goods Regulations*, SOR/2001-286

[37] CNSC REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices*

[38] CNSC REGDOC 3.2.1 *Public Information and Disclosure*

[39] Environmental Protection Review Report: Port Hope Area Initiative

[40] *Nuclear Liability and Compensation Act*, S.C. 2015, c. 4, s. 120

[41] *Nuclear Liability Act*, R.S.C. 1985, c. N-28

[42] *Nuclear Liability and Compensation Regulations*, SOR/2016-88

[43] CNSC REGDOC-3.6, *Glossary of CNSC Terminology*

[44] *CMD 23-M31, Regulatory Oversight Report on the Use of Nuclear Substances in Canada: 2022*, (e-Doc 6945639)

GLOSSARY AND ACRONYMS

For definitions of terms and acronyms used in this document, except for those listed below, see REGDOC-3.6, *Glossary of CNSC Terminology* [43].

ACMR	Annual Compliance Monitoring Report
AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable
AL	Action Level
ANMRC	Advanced Nuclear Materials Research Centre
AOPFN	Algonquins of Pikwakanagan First Nation
APM	Adaptive Phase Management
BE	Below Expectation
BNGS	Bruce Nuclear Generating Station
Bq	Becquerel
CAM	Continuous Air Monitor
CANDU	Canada Deuterium Uranium
CAP	Corrective Action Plan
CEAA	Canadian Environmental Assessment Act
CECEUD	Combined Electrolysis and Catalytic Exchange Upgrading and Detritiation
CED	Committed Effective Dose
CLFN	Curve Lake First Nation
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CMD	Commission Member Document
CRL	Chalk River Laboratories
CVC	Compliance Verification Criteria
CWMP	Coastal Waters Monitoring Program
DCP	Dose Control Points
DIF	Dedicated Isotope Facility
DRL	Derived Release Limits
DPWF	Douglas Point Waste Facility
EA	Environmental Assessment

EAFS	Exhaust Air Filtration System
ECCC	Environment and Climate Change Canada
EOC	Emergency Operations Centre
EPR	Environmental Protection Review
ERA	Environmental Risk Assessment
FA	Facility Authorization
G1WF	Gentilly-1 Waste Facility
HEPA	High Efficiency Particulate Air
HSM	Historic Saugeen Métis
IAEA	International Atomic Energy Agency
IEMP	Independent Environmental Monitoring Program
ISO	International Organization for Standardization
KFN	Kebaowek First Nation
KZA	Kitigan Zibi Anihsinabeg
LCH	Licence Conditions Handbook
LLRW	Low Level Radioactive Waste
LTRA	Long-Term Relationship Agreement
LTWMF	Long-Term Waste Management Facility
MCP	Management Control Procedure
MMF	Manitoba Métis Federation
MNO	Métis Nation of Ontario
MOU	Memorandum of Understanding
MPF	Molybdenum-99 Production Facility
MSIFN	Mississaugas of Scugog Island First Nation
mSv	Millisievert
MWe	Megawatt Electric
MWth	Megawatt Thermal
NCCA	Nuclear Criticality Controlled Area
NCCO	Nuclear Criticality Control Officer
NEW	Nuclear Energy Worker
NFFF	Nuclear Fuel Fabrication Facility
NNC	Notice of Non-compliance

NPDWF	Nuclear Power Demonstration Waste Facility
NRF	Nuclear Response Force
NRU	National Research Universal
NRTEOL	Nuclear Research and Test Establishment Operating Licence
NRTEDL	Nuclear Research and Test Establishment Decommissioning Licence
NSDF	Near Surface Disposal Facility
NWMO	Nuclear Waste Management Organization
OPEX	Operating Experience
PFP	Participant Funding Program
PHAI	Port Hope Area Initiative
PGP	Port Granby Project
PHP	Port Hope Project
REGDOC	Regulatory Document
RFFL	Recycle Fuel Fabrication Laboratories
RIMNet	Regional Information and Monitoring Network
RLTI	Recordable Lost-Time Injury
ROR	Regulatory Oversight Report
RP	Radiation Protection
RSSSA	Recoverable Surface Storage and Staging Area
SA	Satisfactory
SAT	Systematic Approach to Training
SCA	Safety and Control Areas
SFM	Special Fissionable Material
SMR	Small Modular Reactor
SON	Saugeen Ojibway Nation
SPOP	Security Program Oversight Plan
SSC	Structures, Systems and Components
SWS	Storage with Surveillance
ToR	Terms of Reference
TRP	Tactical Response Plan
UA	Unacceptable
UNDRIP	United Nation Declaration on the Rights of Indigenous People

WFDL	Waste Facility Decommissioning Licence
WL	Whiteshell Laboratories
WMA	Waste Management Area
WNSL	Waste Nuclear Substance Licence
WR-1	Whiteshell Reactor No. 1
WTFN	Williams Treaties First Nations
WWTP	Waste Water Treatment Plant

A. INDIGENOUS NATIONS AND COMMUNITIES THAT HAVE TRADITIONAL AND/OR TREATY TERRITORIES WITHIN PROXIMITY TO CNL SITES

Chalk River Laboratories and Nuclear Power Demonstration

- Algonquin Anishinabeg Nation Tribal Council
- Algonquin Nation Secretariat
- Algonquins of Barriere Lake
- Algonquins of Ontario
- Algonquins of Pikwàkanagàn First Nation
- Conseil de la Nation Anishnabe de Lac Simon
- Conseil de la Première Nation Abitibiwinni
- Kebaowek First Nation
- Kitcisakik First Nation
- Kitigan Zibi Anishinabeg First Nation
- Long Point First Nation
- Métis Nation of Ontario
- Mitchikanibikok Inik (Algonquins of Barriere Lake)
- Timiskaming First Nation
- Wahgoshig First Nation
- Williams Treaties First Nations:
  - Alderville First Nation
  - Beausoleil First Nation
  - Chippewas of Georgina Island First Nation
  - Chippewas of Rama First Nation
  - Curve Lake First Nation
  - Hiawatha First Nation
  - Mississaugas of Scugog Island First Nation
- Wolf Lake First Nation

Douglas Point Waste Facility

- Saugeen Ojibway Nation, comprised of:
  - Chippewas of Nawash Unceded First Nation
  - Saugeen First Nation

- Historic Saugeen Métis
- Métis Nation of Ontario

Gentilly-1 Waste Facility

- Abénakis of Wôlinak and Odanak, represented by the Grand Conseil de la Nation Waban-Aki
- Nation huronne-wendat

Whiteshell Laboratories

- Sagkeeng Anicinabe First Nation
- Black River First Nation
- Brokenhead Ojibway Nation
- Grand Council of Treaty 3
- Hollow Water First Nation
- Iskatewizaagegan #39 Independent First Nation
- Red River Métis (represented by Manitoba Métis Federation)
- Northwest Angle #33 First Nation
- Shoal Lake #40 First Nation
- Wabaseemoong Independent Nations

Port Hope Area Initiative

- Mohawks of the Bay of Quinte
- Métis Nation of Ontario
- Williams Treaty First Nations:
    - Alderville First Nation
    - Beausoleil First Nation
    - the Chippewas of Georgina Island First Nation
    - Chippewas of Rama First Nation
    - Curve Lake First Nation
    - Mnjikaming (Chippewas of Rama First Nation)
    - Hiawatha First Nation
    - Mississaugas of Scugog Island First Nation

B. LICENCES AND LICENSING ACTIVITIES

Site/ Facility/ Project	Licence Number	Previous Commission Hearing	Licensing Changes in 2022
Chalk River Laboratories	NRTEOL-01.00/2028	CMD 18-H2, January 23-25, 2018	None
Whiteshell Laboratories	NRTEDL-W5-8.00/2024	CMD 19-H4, October 2-3, 2019	
Port Hope Long-Term Low-Level Radioactive Waste Management Project	WNSL-W1-2310.02/2022	CMD 17-H101 November 29, 2017	Licensing work to renew the Port Hope Project licence and consolidate with the other PHAI licences occurred in 2022, with the new licence being valid starting January 1, 2023 (CMD 22-H13, November 22, 2022).
Port Granby Long-Term Low-Level Radioactive Waste Management Project	WNSL-W1-2311.00/2022	CMD 21-H102, Hearing in Writing, December 13, 2021	
Pine Street Extension Temporary Storage Site	WNSL-W1-182.0/2022	DNCFR-CNLRPD-DOD-21-002, December 16, 2021	
Port Hope Radioactive Waste Management Facility	WNSL-W1-344-1.8/ind	DNCFR-NPFD-DOD-16-004, September 26, 2016	
Douglas Point Waste Facility	WFDL-W4-332.03/2030	CMD 20-H4, November 25-26, 2020	None
Gentilly-1 Waste Facility	WFDL-W4-331.00/2034	CMD 18-H107, Hearing in Writing, February 8, 2019	
Nuclear Power Demonstration Waste Facility	WFDL-W4-342.00/2034		
Waste Nuclear Substance Licence (WNSL) for Low-Level Radioactive Waste Management Office (Historic Waste)	WNSL-W2-2202.0/2026	WDD-DOD-16-004, November 28, 2016	

Site/ Facility/ Project	Licence Number	Previous Commission Hearing	Licensing Changes in 2022
Canadian Nuclear Laboratories Import Licence	IL-01.00/2031	DNCFR-CNLRPD-DOD-21-001, July 7, 2021	
Canadian Nuclear Laboratories Export Licence	EL-01.00/2031		
La Prade Nuclear Substances and Radiation Devices Licence*	15193-4-26.0	N/A	
Low-Level Waste Programs Nuclear Substances and Radiation Devices Licence*	15193-5-23.0		
Dosimetry Service Licence	15193-1-26.2		
**These Nuclear Substances and Radiation Devices Licences are discussed in CMD 23-M31, Regulatory Oversight Report on the Use of Nuclear Substances in Canada: 2022 [44] and are not included as part of the content of this ROR.*			

C. REGULATORY DOCUMENT IMPLEMENTATION

Regulatory documents are a key part of the CNSC's regulatory framework for nuclear activities in Canada. They explain to licensees and applicants what they must achieve in order to meet the requirements set out in the *Nuclear Safety and Control Act* [1] and the regulations made under the *Nuclear Safety and Control Act* [1].

In 2022, the CNSC published several updated regulatory documents that impacted CNL sites, including REGDOC-3.2.2, *Indigenous Engagement, Version 1.2*, REGDOC-2.4.4, *Safety Analysis for Class 1B Nuclear Facilities*, REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills*, Version 1.1.

When a new regulatory document or revision is published, CNSC staff will formally request CNL conduct a gap analysis and provide an implementation plan. The CNSC will review the plan. The dates provided in the implementation plan are considered the date that the regulatory document becomes effective at the site, at which point it becomes compliance verification criteria.

Table C-1: CNSC REGDOC Implementation dates

REGDOC number	Publication year	Effective date						
		CRL	WL	DPWF	G1WF	NPDWF	PGP	PHP
REGDOC-2.1.1 Management system	2019	Guidance						
REGDOC-2.1.2 Safety Culture	2018	2019	2020	2019	Guidance	Guidance	Guidance	Guidance
REGDOC-2.2.1 Human Factors	2019	Guidance						
REGDOC-2.2.2 Personnel Training	2016	2018	2020	2020	2020	2020	2021	2021
REGDOC-2.2.4 Fitness for Duty: Managing Worker Fatigue	2017	2019	2020	2019				
REGDOC-2.2.4 Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3	2021	2022*	2022*	2022*				
REGDOC-2.2.4 Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	2018	2019	2020	2020				
REGDOC-2.2.5 Minimum Staff Complement	2019	Guidance	Guidance	Guidance				

REGDOC number	Publication year	Effective date						
		CRL	WL	DPWF	G1WF	NPDWF	PGP	PHP
REGDOC-2.3.1, Conduct of Licensed Activities: Construction and Commissioning Programs	2016	2018						
REGDOC-2.3.2, Accident Management, Version 2	2015							
REGDOC-2.3.3, Periodic Safety Reviews	2015							
REGDOC-2.4.1, Deterministic Safety Analysis	2014	2018						
REGDOC-2.4.3, Nuclear Criticality Safety, Version 1.1	2020	2020	2021					
REGDOC-2.4.4 Safety Analysis for Class 1B Nuclear Facilities	2022	Guidance	Guidance					
REGDOC-2.5.1, General Design Considerations: Human Factors	2019	Guidance	Guidance	Guidance				
REGDOC-2.5.2 Design of Reactor Facilities: Nuclear Power Plants	2014	Guidance						
REGDOC-2.5.7 Design, Testing and Performance of Exposure Devices	2017	2018						
REGDOC-2.6.1 Reliability Programs for Nuclear Power Plants	2017	Guidance						
REGDOC-2.6.3, Aging Management	2014	2018	Guidance	2018	2019	2019		
REGDOC-2.7.1, Radiation Protection	2021	Guidance	Guidance					
REGDOC-2.7.2, Dosimetry, Volume I: Ascertaining Occupational Dose	2021	Guidance	Guidance				Guidance	Guidance
REGDOC-2.7.2, Dosimetry, Volume II: Technical and Management System Requirements for Dosimetry Services	2020							

REGDOC number	Publication year	Effective date						
		CRL	WL	DPWF	G1WF	NPDWF	PGP	PHP
REGDOC-2.8.1, Conventional Health and Safety	2019	Guidance					Guidance	Guidance
REGDOC-2.9.1, Environmental Principles, Assessments and Protection Measures, Version 1.2	2020	2021	2020 (v. 1.1.)	2021	2021	2021	2020	2020
REGDOC-2.10.1, Nuclear Emergency Preparedness and Response, Version 2	2016	2018	2020	2020	2020	2020		
REGDOC-2.11 Framework for Radioactive Waste Management and Decommissioning in Canada, Version 2	2021	Guidance	Guidance	Guidance	Guidance	Guidance	Guidance	Guidance
REGDOC-2.11.1, Waste Management, Volume I: Management of Radioactive Waste	2021	2022	2022	2022	2022	2022	2023	2023
REGDOC-2.11.1 Waste Management, Volume III: Safety Case for the Disposal of Radioactive Waste, Version 2	2021	2021	2022	Guidance	Guidance	2022	Guidance	Guidance
REGDOC-2.11.2, Decommissioning	2021	2025**	2025	2024	2023	2025	2024	2024
REGDOC-2.12.1, High Security Facilities, Volume I: Nuclear Response Force, Version 2	2018	2019	2020	V 2012 effective 2015				
REGDOC-2.12.1, High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	2018	2018	2020	Guidance				
REGDOC-2.12.2, Site Access Security Clearance	2013	2018	2020	Guidance	Guidance	2022		
REGDOC-2.12.3 Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1	2020	2020	2021	V 2013 TBD	Guidance	2022	Guidance	Guidance

REGDOC number	Publication year	Effective date						
		CRL	WL	DPWF	G1WF	NPDWF	PGP	PHP
REGDOC-2.13.1, Safeguards and Nuclear Material Accountancy	2018	2018	2020	2019	2019	2018 (section 6 only)		2018
REGDOC-2.13.2, Import and Export, Version 2	2018							
REGDOC-2.14.1 Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015, Volume I, Version 2	2021	Guidance	Guidance					
REGDOC-3.1.2, Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills, Version 1.1	2022 2018	2019	2020	2019	2019	2019		
REGDOC-3.1.3, Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices	2020						2020	2020
REGDOC-3.2.1, Public Information and Disclosure	2018	2020	2020	2020		2020	Guidance	Guidance
REGDOC-3.2.2, Indigenous Engagement, Version 1.2	2022	Guidance						
REGDOC-3.3.1 Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities	2021	2022	2022			2022	2023	2023

Shaded cells indicate the REGDOC is not applicable for those facilities.

*Fully implemented with the exception of random alcohol and drug testing of workers in safety-critical positions

**All requirements in REGDOC-2.11.2, are effective March 1, 2023 with the exception of the requirements in section 6.1.1 (content of preliminary decommissioning plan) and section 7.1.1 (content of detailed decommissioning plan)

D. LIST OF INSPECTIONS AT CNL SITES

Table D-1: List of CNSC-led inspections at CRL

Inspection	Dates	SCAs Covered	Number of Notices of Non-Compliance (NNCs)
CNL-CRL-2022-01 General Inspection of Class II Nuclear Facilities at Chalk River Laboratories	March 1 – 2, 2022	• Fitness for Service • Operating Performance • Radiation Protection • Conventional Health and Safety	4 NNCs
CNL-CRL-2022-02 General Inspection of the Molybdenum 99 Production Facility, Target Residue Material Retrieval and Transfer and FISST – Building 225, 229 and 229A	March 14 – 15, 2022	• Fitness for Service • Operating Performance • Human Performance Management • Radiation Protection • Conventional Health and Safety • Emergency Management and Fire Protection • Waste Management	2 NNCs
CNL-CRL-2022-03 Focused Human Performance Management Inspection at Chalk River Laboratories	March 9 – 11, 2022	• Human Performance Management	6 NNCs
CNL-CRL-2022-04 General Inspection of Building 250, Facilities Decommissioning Project	March 22 – 23, 2022	• Operating Performance • Radiation Protection • Conventional Health and Safety • Waste Management	6 NNCs
CNL-CRL-2022-05 General Inspection of Universal Cells at Chalk River Laboratories	May 4 – 5, 2022	• Fitness for Service • Operating Performance • Safety Analysis • Radiation Protection • Conventional Health and Safety • Emergency Management and Fire Protection	7 NNCs

Inspection	Dates	SCAs Covered	Number of Notices of Non-Compliance (NNCs)
CNL-CRL-2022-06 General Inspection of the Waste Management Area B	June 1 – 2, 2022	• Operating Performance • Environmental Protection • Radiation Protection • Conventional Health and Safety • Emergency Management and Fire Protection • Waste Management	12 NNCs
CNL-CRL-2022-07 General Inspection of the Chalk River Laboratories Tritium Laboratory	June 7 – 8, 2022	• Operating Performance • Fitness for Service • Emergency Management and Fire Protection • Environmental Protection • Radiation Protection • Conventional Health and Safety	2 NNCs
CNL-CRL-2022-08 General Inspection of the Chalk River Laboratories Nuclear Fuel Fabrication Facility	October 3 – 4, 2022	• Fitness for Service • Operating Performance • Safety Analysis • Conventional Health and Safety • Radiation Protection • Human Performance Management • Emergency Management and Fire Protection	4 NNCs
CNL-CRL-2022-09 General Inspection of Building 429, Facilities and Decommissioning Project	November 7 – 8, 2022	• Operating Performance • Safety Analysis • Environmental Protection • Conventional Health and Safety • Radiation Protection • Emergency Management and Fire Protection • Waste Management	6 NNCs
CNL-CRL-2022-10 General Inspection of the Chalk River Laboratories Recycle Fuel Fabrication Laboratory	December 5 – 6, 2022	• Operating Performance • Safety Analysis • Conventional Health and Safety • Radiation Protection • Emergency Management and Fire Protection	2 NNCs
CNL-CRL-PTP-2022-01	N/A	• Security	N/A

Table D-2: List of CNSC-led inspections at WL

Inspection	Dates	SCAs Covered	Number of Notice of Non-Compliance (NNCs)
CNL-WL-2022-01 Baseline Radiation Protection Inspection at Whiteshell Laboratories	May 10 – 11, 2022	• Radiation Protection	0 NNCs
CNL-WL-2022-03 Inspection of Whiteshell Laboratories Waste Management Area	October 24 – 26, 2022	• Management System • Operating Performance • Radiation Protection • Conventional Health and Safety • Emergency Management and Fire Protection • Waste Management • Fitness for Service	5 NNCs
CNL-WL-NSD-T2-2022-001	N/A	• Security	N/A

Table D-3: List of CNSC-led inspections at PHP

Inspection	Dates	SCAs Covered	Number of Notice of Non-Compliance (NNCs)
CNL-PHAI-PHP-2022-01 General Inspection of the Port Hope Waste Water Treatment Plant and Long-Term Waste Management Facility	March 28 – April 8, 2022	• Environmental Protection • Radiation Protection • Conventional Health and Safety	3 NNCs
CNL-PHAI-PHP-2022-02 Baseline Inspection of Human Performance Management at the Port Hope Project	December 14 -16, 2022	• Human Performance Management	6 NNCs

Table D-4: List of CNSC-led inspections at PGP

Inspection	Dates	SCAs Covered	Number of Notice of Non-Compliance (NNCs)
CNL-PHAI-PGP-2022-01 General Inspection of the Port Granby Waste Water Treatment Plant and Long-Term Waste Management Facility	March 28 – April 8, 2022	• Environmental Protection • Radiation Protection • Conventional Health and Safety	0 NNCs
CNL-PHAI-PGP-2022-02 Remediation Verification of the Port Granby Former Waste Management Area	March 28 – April 8, 2022	• Environmental Protection • Physical Design	1 NNC

Table D-5: List of CNSC-led inspections at DPWF, G1WF and NPDWF*

Inspection	Dates	SCAs Covered	Number of Notice of Non-Compliance (NNCs)
CNL-DP-2022-01 General Inspection at Douglas Point Waste Facility	February 15 – 16, 2022	• Waste Management • Management System • Fitness for Service	3 NNCs
CNL-DP-2022-02 General Inspection at Douglas Point Waste Facility	July 25 – 27, 2022	• Environmental Protection • Radiation Protection • Conventional Health and Safety • Waste Management • Operating Performance	4 NNCs
G1WMF-NSD-T2-2022-001	N/A	• Security	N/A
**No inspections were performed at NPDWF in 2022.*			

Table D-6: List of IAEA-led inspections at CNL Sites

SITE/ Facility/ Project	IAEA inspections (CNSC Escort)
CRL	51 (9) (9 others supported remotely)
WL	3 (1) (2 others supported remotely)
PHP	2 (0) (2 supported remotely)
PGP	1 (1)
DPWF	2 (0) (2 supported remotely)
G1WF	2 (0) (2 supported remotely)
NPDWF	0
TOTAL	**61 (11)**

E. REPORTABLE EVENTS

This appendix contains information on the number of reportable events at the CNL sites covered by this ROR, in the 2022 calendar year. CNL is required to report events as per the *General Nuclear Safety and Control Regulations* [27], and, if applicable to the site, the criteria outlined in CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [11] or CNSC REGDOC-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices* [37]. A total of 59 events were reported to and assessed by CNSC staff in 2022. CNSC staff, determined that there was no risk to the environment, nor the public associated with these events.

Table E-1: Number of reportable events at each CNL site in 2022

Site/Facility/Project	Number of events
Chalk River Laboratories	39
Whiteshell Laboratories	3
Port Hope Project	14
Port Granby Project	3
Douglas Point Waste Facility	0
Gentilly-1 Waste Facility	0
Nuclear Power Demonstration Waste Facility	0
TOTAL	59

Table E-2: Reportable events at CRL in 2022

Event Number	Title	CRL Event summary	SCA
1 HSSE-22-2889	Expanded 5 Gallon Secondary Container Found	A 5-gallon container was discovered to be bulging at the bottom of the pail presenting a pressure hazard and possible contamination. The building was evacuated. An Incident Action Plan was executed by moving the container to a ventilated and isolation room with effluent monitoring where the container was safely relieved of pressure. CNL staff took corrective action to prevent recurrence of the event and performed a full investigation. CNSC staff are satisfied with the actions completed.	Conventional Health and Safety
2 HSSE-22-1551	CNL Employee Trip and Fall Injury	A CNL employee was walking away from their workstation when their toe caught the floor and caused them to stumble, lose balance, and fall to the floor hitting their face and shoulder. The employee’s colleagues provided initial care and activated emergency response where CNL’s security, fire protection and health centre responded followed by Renfrew County Paramedics. An investigation of the accident area revealed no workplace factors which would contribute to the employee’s fall. It was determined that the cause was an unprovoked stumble. CNSC staff are satisfied with CNL’s response to the event and conclusion.	Conventional Health and Safety

Event Number	Title	CRL Event summary	SCA
3 HSSE-22-0089	Underground Fire Water Impairment South Loop	The CRL Fire Department was notified of a service water leak from fire water piping caused by repeated freezing and thawing of the ground. The CRL Fire Department implemented an impairment plan to compensate for the impaired hydrants due to the damaged fire water piping. Repairs to the firewater line were completed. CNSC staff are satisfied with the corrective measures taken by CNL.	Emergency Management and Fire Protection
4 HSSE-22-0108	Unplanned Sprinkler Impairment	A damaged building sprinkler head was discovered caused by ice buildup in the sprinkler pipe due to a defective heater in that area of the building. CNL implemented an impairment plan to compensate for the out of service sprinkler until repairs were completed for the sprinkler and heater. CNSC staff are satisfied with the corrective measures taken by CNL.	Emergency Management and Fire Protection
5 ERM-22-0386	Unplanned Level Increase in Liquid Storage Tank	A ruptured fire water line resulted in an unplanned level increase in a liquid storage tank. CNL staff transferred contents from tank 4 to other holding tanks within the Active Drainage system to restore the tank level to its previous volume. Abandoned piping to the liquid storage tank were cut and capped to prevent any recurrence. There were no effects on health, safety and security of persons,	Emergency Management and Fire Protection

Event Number	Title	CRL Event summary	SCA
		or the environment resulting from this event. CNSC staff are satisfied with the corrective measures taken by CNL.	
6 HSSE-22-0317	Chalk River Laboratories Emergency Operations Centre Activation Due to a Fire Water Line Break	A fire water line break was identified and isolated by the CRL Fire Department. No water or other anomalies were discovered in any of the surrounding buildings and areas, except for water entering a liquid storage tank. The breach of the Fire Water Service line has been attributed to repeated freezing and thawing cycles. There were no effects on health, safety and security of persons, or the environment resulting from this event. CNSC staff are satisfied with the actions taken by CNL.	Emergency Management and Fire Protection
7 HSSE-22-0772	External Fire Water Main Break	A fire water break was identified in the CRL Controlled Area and was isolated by the CRL Fire Systems Team Fire Department. An underground fire water line had a break due to ground movement from frost build-up and heavy equipment traffic. The CRL Fire Department was immediately dispatched and the fire service water was isolated by closing valves. Water samples were collected and all sample analysis test results indicated there was no contamination present above the exemption limits. CNSC staff are satisfied with CNL's	Emergency Management and Fire Protection

Event Number	Title	CRL Event summary	SCA
		actions.	
8 CTA-22-1074	Active Materials stored without a required Fire Hazard Analysis	Radium-226 material was found to be stored in a CRL building during a fire assessment walkdown. The material was moved to a concrete structure within the building with ventilation, heating, and radiation detection equipment, and contained within Special Form Capsules in a Type A Shipping Package. A Fire Hazard Assessment has been completed and submitted after the Radium-226 was moved under Fire Protection supervision. CNSC staff are satisfied with CNL's actions.	Emergency Management and Fire Protection
9 HSSE-22-1499	CRL Site-Wide Loss of Class IV Power	Power was lost at the CRL site due to a severe storm damaging electrical infrastructure off-site. Emergency backup power immediately came online and was confirmed to be operating as intended. Although the storm itself did not damage the CRL site, the off-site electrical infrastructure was significantly damaged resulting in loss of Class IV Power. CNSC staff were contacted by CNL and reported of the event. There were no effects on the health, safety and security of persons or the environment. CNSC staff are satisfied with CNL's response.	Emergency Management and Fire Protection

Event Number	Title	CRL Event summary	SCA
10 HSSE-22-1714	CRL Building Fire Alarm Panel Battery Failure	A CRL building fire alarm panel battery failed during the planned annual site-wide electrical outage. Due to the need for replacement of fire alarm panel batteries at set intervals, the Fire Protection Program had Fire Systems Staff on-site throughout the outage to rapidly perform battery replacements as required. Staff identified and replaced the battery which re-established fire panel monitoring. The fire panel, which reports fire alarms for several buildings, was impaired for 15.5 hours. CNSC staff are satisfied with the actions completed.	Emergency Management and Fire Protection
11 HSSE-22-2051	CRL Building Linear Heat Detector Impairment	CRL Fire Operations responded to a Linear Heat Detector activation alarm at a CRL building tunnel. There was no evidence of any hazards and the detector was determined to be in a fault due to nearby leaking steam in the tunnel. The detector was repaired during a steam shutdown. CNSC staff are satisfied with the corrective measures taken by CNL.	Emergency Management and Fire Protection
12 HSSE-22-2619	Lightning Strike on CRL Building Radio Tower Resulted in Loss of Fire Alarm Monitoring	During a thunderstorm, the radio tower at a CRL building was struck by lightning. This resulted in loss of fire detection, alarms and monitoring in several CRL buildings on the same fire-alarm loop. CNL implemented compensatory measures and fire alarm system components	Emergency Management and Fire Protection

Event Number	Title	CRL Event summary	SCA
		were inspected and replaced as required, followed by the restoration of fire detection, and monitoring to buildings. CNSC staff are satisfied with the corrective measures taken by CNL.	
13 S&T-22-2951	Digital Thermocouple Caught Fire in CRL Building	A fire occurred on top of an operating furnace at a CRL building shortly after initiating the heating up process for the unit and CNL staff activated the fire alarm. The fire was extinguished immediately by the staff using a portable ABC extinguisher. CNL conducted a follow up investigation and implemented corrective actions to prevent a similar recurrence. CNSC staff are satisfied with the actions completed.	Emergency Management and Fire Protection
14 HSSE-22-3198	Thermostat Failure Results in Portable Heater Fire in CRL Building	CNL staff were investigating a malfunctioning 600 V barrel heater and observed it igniting into flames. The fire did not spread beyond the heater and there were no combustibles in the area. CNL staff extinguished the fire and disconnected the electrical supply to the heater. A fire investigation was initiated, and the use of barrel heaters was paused across the site. CNL implemented corrective and compensatory actions as a result. CNSC staff are satisfied with the corrective measures taken by CNL.	Emergency Management and Fire Protection

Event Number	Title	CRL Event summary	SCA
15 HSSE-22-3810	Underground Fire Water Line Break Near CRL Building	CRL Fire Operations responded to a fire water break near the CRL Powerhouse. The water break was isolated by the fire department within one hour of the issue being identified and CNL proceeded to isolate the storm-water management pond. The EOC was activated to manage the impacts of the high volume of water at the site, to ensure the water had not entered any nuclear facilities, and to coordinate the collection of water samples at various locations for analysis. All water sample analysis results confirmed that the water was not contaminated. CNSC staff are satisfied with the actions completed.	Emergency Management and Fire Protection
16 ERM-22-1151	Non-Radiological Liquid Effluent Monthly Licence Condition Handbook Reference Limit Exceedance at the Waste Treatment Center for Mercury	The monthly average for mercury released for the final effluent of the Waste Treatment Center Liquid Waste Evaporator was measured at 0.00155 mg/L, exceeding the Action Level of 0.001 mg/L. There was no impact to human health or the environment from the release of the impacted batches due to dilution at the Process Outfall. Additional administrative controls were implemented to prevent recurrence while the investigation continued. CNL identified and resolved the root causes of the exceedances and has resumed normal operations. CNSC staff are	Environmental Protection

Event Number	Title	CRL Event summary	SCA
		satisfied with the corrective measures taken by CNL	
17 ERM-22-0575	Small Pipe Rupture Resulting in Release of Contaminated Groundwater	The re-circulation pump and heat tracing simultaneously failed, resulting in a line rupture. Between 10 L and 40 L of contaminated groundwater at 1500 Bq/L was released to the ground. CNL committed to cleaning the soil. CNSC staff concluded the event had a low safety significance and did not result in an increased risk to the environment due to the low volume, and that the water leaked in the same area where the groundwater originated. CNSC staff will follow up on the cleanup and repair activities during future compliance inspection activities.	Environmental Protection
18 ERM-22-1620	Severe heavy rainfall overfills secondary containment	Due to a severe rainfall event, secondary containment surrounding 2 shipping containers holding radiologically contaminated waste overfilled and discharged onto the surrounding soil. Samples of the water were collected and analyzed. Soil around the containers was monitored and no radioactive levels were detected. There was no impact on health, safety and security of persons. CNSC staff are satisfied with the CNL's actions.	Environmental Protection

Event Number	Title	CRL Event summary	SCA
19 HSSE-22-2658	Tritium Sample Inadvertently Released Down Sanitary Drain	A 125 mL urine sample that was intentionally spiked with tritium as part of a performance test required by CNL's Dosimetry Services was inadvertently disposed into a sanitary drain. The effect on the health, safety, and security of persons is low due to the small quantity of radioactivity released. The sample was not properly segregated due to lack of written instructions and insufficient communication during task hand-over. CNL ensured that all samples in the bioassay laboratory with high measurements were stored properly with instructions. Operating experience was communicated to CNL staff on the segregation of samples. In addition, a procedure describing the receipt of bioassay samples in the laboratory was updated to include written instructions relating to the segregation of samples. CNSC staff are satisfied with CNL’s actions.	Environmental Protection
20 ERM-22-1798	Damaged Conduit Discovered in CRL Building Main Stairwell	CNL Workers attempted to push a loose conduit bracket back into place and caused an electrical short circuit which tripped the circuit breaker. CNL implemented corrective actions to prevent a similar recurrence. CNSC site inspectors conducted a walkdown of the area where the event occurred and	Human Performance Management

Event Number	Title	CRL Event summary	SCA
		discussed the event with CNL staff. CNSC staff are satisfied with CNL's actions.	
21 ERM-22-0645	Vehicle Driven Over Snow Covered Tile Holes at Waste Management Area	A Radiation Surveyor Trainee drove over the tile holes in the waste management area while performing routine surveys due to limited visibility caused by a significant snowfall. Following the event, contamination checks of the area were done as well as visual inspections of structures and no issues were noted. To prevent these types of events from occurring in the future, when there is significant snowfall, the Radiation Surveyor will accompany the snowplow operator, and at all other times there will be two individuals in the surveying vehicle. CNSC staff are satisfied with the corrective measures taken by CNL	Human Performance Management
22 S&T-22-1226	Ac-225 Product Shipments Delivered to Incorrect Customers	Two product shipments of Ac-225 were sent to separate customers. Upon review of the documentation for the shipments, it was determined that the 2 product vials were swapped in error. Radiobiology and Health began an investigation into the event and Actinium shipments were halted until the cause of the error could be identified. It was determined that there were no effects on the health, safety and security of persons or the environment as the packaging used was	Human Performance Management

Event Number	Title	CRL Event summary	SCA
		appropriate for both shipments. CNL took corrective action to prevent future recurrence and CNSC staff are satisfied with the corrective measures taken by CNL.	
23 CTA-22-1423	Non-compliance with reporting requirements for CNL Program Description Document	The Training and Development Program Description Document was submitted to the CNSC 6 days after it was implemented rather than at the time of implementation. CNL performed an extent of condition of management system document submissions and reported this to the CNSC and updated their regulatory reporting process steps within the Information Management implementation documents to prevent recurrences. CNSC staff are satisfied with the corrective measures taken by CNL.	Management System
24 S&T-22-1768	Unauthorized access and usage of gamma cell irradiation facility	A CNL employee, without proper authorization, was permitted to access the gamma cell irradiation facility and operate the gamma cell without proper oversight. The safety and security issues associated with this event were discussed with both employees and their facility access was revoked. To prevent recurrences, both employees received gamma cell training followed by a 6-month probationary period, and a site-wide OPEX was issued. CNSC staff are	Management System

Event Number	Title	CRL Event summary	SCA
		satisfied with the corrective measures taken by CNL.	
25 ERM-22-1457	Missing Record of Visual Inspection for Waste Management Area B	In preparation for a CNSC Inspection of WMA B (CNL-CRL-2022-06), CNSC staff requested records of routine safety inspections conducted by CNL. CNL stated that the inspection took place as required, but no record of this first-quarter inspection was available. CNL provided a new revision of the Routine Inspection, Radiological Monitoring and Surveillance procedure for the waste management areas, which was updated to include a summary table of all inspections conducted, the inspection frequency and the inspection form reference. CNSC staff verified that visual inspections are now recorded in the form as per CNL's revised procedure. CNSC staff are satisfied with the corrective measures taken by CNL.	Management System
26 ERM-22-0165	Temporary Loss of Power to NRU Emergency Air Filtration System Fans	Electrical power was lost to the Dedicated Isotope Facility (DIF) causing the operating NRU reactor Exhaust Air Filtration System (EAFS) Fans to shutdown unexpectedly. It is required that a minimum fan configuration of 1 EAFS fan shall be maintained in operation. Power was restored to the DIF and the NRU EAFS Fans restarted to the normal operating	Operating Performance

Event Number	Title	CRL Event summary	SCA
		configuration. CNSC site inspectors conducted a walkdown of the area where the event occurred and discussed the event with CNL staff. CNSC staff are satisfied with the corrective measures taken by CNL.	
27 ERM-22-0866	Incoming Dangerous Goods Package Labels Obscured by Other Packing Labels	A consignment of radioactive standards was received at CRL including an incoming package containing standards of low radioactivity. The package was received but the required label identifying the package as a dangerous good was not visible and had been obscured by other labels used while shipping. As the package was expected to be radioactive, all normal operating procedures were taken to receive the package safely with the proper surveying. There was no damage to the packaging and CNL took corrective actions to prevent recurrence of the event. There were no impacts on health, safety and security of persons or the environment. CNSC staff are satisfied with the corrective measures taken by CNL.	Packaging and Transport
28 S&T-22-0209	Area Radiation Monitor discovered past due calibration	A radiation monitor remained in service past its calibration due date. CNL replaced the monitor, verified the calibration dates of other radiation monitors, and evaluated calibration strategies used across CNL to ensure routine calibrations are	Radiation Protection

Event Number	Title	CRL Event summary	SCA
		performed on time. CNSC staff are satisfied with the corrective measures taken by CNL.	
29 S&T-22-1120	Skin contamination following an undesired chemical reaction in fume hood	A bottle containing consolidated waste solutions ruptured in a laboratory fume hood. A technologist received contamination in their hair and on their hand. The technologist notified their supervisor and contacted Radiation Protection and the Health Physicist. The technologist was instructed to shower, and Radiation Protection confirmed that the contamination was removed, and the worker was cleared to return to work. The committed effective dose was determined to be less than 1 mSv for the technologist. CNL issued a stop work order and performed an extent of condition to ensure work scope and work control practices are in place for all S&T laboratories. CNSC staff are satisfied with the corrective measures taken by CNL.	Radiation Protection
30 S&T-22-1271	Accessible Dose Rates Above 2.5 mrem/h Discovered Outside CRL Building	A radiation surveyor detected unposted radiation fields in an accessible area outside of a miscellaneous storage building at CRL. The field was due to the storage inside the building of drums containing radium needles. CNL put appropriate barriers and signage in place. CNSC staff are satisfied with the	Radiation Protection

Event Number	Title	CRL Event summary	SCA
		corrective measures taken by CNL.	
31 HSSE-22-3741	Instrument found in use beyond its calibration date	The calibration date for swipe castle E4133 expired on November 11, 2022. The instrument remained in service and utilized in the facility until December 2, 2022 during which the equipment functioned as intended and passed its weekly source checks. CNL Radiation Protection (RP) performed an extent of condition on all RP instrumentation to confirm that they are all within their calibration due dates. Coaching from RP Management to RP staff was done on the importance of calibration due date checks. CNL provided an update on the corrective actions during a RP focused meeting held on March 9, 2023 and CNSC staff are satisfied with the corrective actions taken by CNL.	Radiation Protection
32 ERM-22-1763	IAEA Measuring Equipment Damaged	Four spent driver fuel were being loaded into a sealed Rod Storage Can for transport to CRL WMAs. An IAEA inspector and CNL staff were performing fuel composition measurements using a detector tool when the detector accidentally contacted a component of the Rod Bay purification system. The measurement tool was damaged rendering it inoperable. A spare detector	Safeguards and Non-proliferation

Event Number	Title	CRL Event summary	SCA
		was used to complete measurements. CNL took corrective actions to prevent recurrence of the event. There were no impacts on health, safety and security of persons or the environment. CNSC staff are satisfied with the corrective actions taken by CNL.	
33 BUS-MGMT-22-2253	Unclear Wording in Import Licence Leads to an Exceedance in Maximum Uranium Content in Samples	The CNL-CRL site received an import of samples from the IAEA for a forensic exercise. The samples contained 5.5 g of uranium enriched with 0.19 g of uranium-235. The import licence indicated that 1 g of enriched uranium could be imported. CNSC staff requested clarification on the amount of enriched uranium imported. CNL mistook the wording to mean 1 g of uranium-235 and not 1 gram of total uranium. CNL reviewed all current import and export licences with enriched uranium to ensure there were no other issues. There were no impacts on health, safety and security of persons or the environment. CNSC staff are satisfied with the corrective actions taken by CNL.	Safeguards and Non-proliferation

Event Number	Title	CRL Event summary	SCA
34 ERM-22-2680	IAEA Seal Cable Found Damaged	Work was in progress in the NRU Rod Bays involving receipt of a pressure tube and end fitting components from Building 234 Universal Cells using a fuel flask subject to IAEA safeguards controls. During transit activities, a CNL operator discovered that the seal on the top of the flask was damaged from accidental contact between the hoist cable. CNL performed an investigation and took corrective actions to prevent future recurrence of the event. There were no impacts on health, safety and security of persons or the environment. CNSC staff are satisfied with the corrective actions taken by CNL.	Safeguards and Non-proliferation
35 ERM-22-2366	Waste Management Area D and H Recoverable Surface Storage Area Non-Nuclear Criticality Controlled Area Exceedance	During a review of the inventory for CRL WMA D and H above ground waste storage areas, CNL identified that the non-nuclear criticality-controlled area limit (100 g) of fissile nuclides in special fissionable materials (SFM) had been exceeded. CNL halted acceptance of waste containing FM/SFM within WMA D and H until a criticality safety analysis is completed along with 8 remedial and corrective actions (with a final completion due date by August 31, 2023) to prevent recurrence of similar events. CNSC staff’s review of the event's full report raised	Safety Analysis

Event Number	Title	CRL Event summary	SCA
		several questions and comments for CNL's disposition. CNL proposed to arrange a meeting to answer and clarify CNSC staff questions, which was held in March 2023. CNSC staff will continue to perform compliance oversight until satisfied with CNL’s corrective action plan.	
36 HSSE-22-2660	Unauthorized Site Access	The details of this event are Classified-Confidential.	Security
37 HSSE-22-2779	Unauthorized Site Access	The details of this event are Classified-Confidential.	Security
38 HSSE-22-3486	Unauthorized Site Access	The details of this event are Classified-Confidential.	Security
39 HSSE-22-3023	Security Equipment Failure	The details of this event are Classified-Confidential.	Security

Table E-3: Reportable events at WL in 2022

Event Number	Title	WL Event summary	SCA
1 ERM-22-1559	Worker Received Electrical Shock from Non-isolated Electrical Source	CNL workers were performing planned maintenance on a pump when a worker experienced an electrical shock to both hands. The worker was assessed by First Aid Responders, and they deemed the worker fit to return to normal duties with no further medical attention needed. It was determined that an electrical circuit related to the pump motor was not isolated via lock out tag out procedures to remove the hazard to workers. CNL has proposed a corrective action plan and implemented compensatory measures to ensure planning and work control documents are reviewed in detail and approved in signature by a member of WL management before work can proceed. CNSC staff will be performing compliance and implementation oversight of CNL’s action plan.	Conventional Health and Safety
2 ERM-22-3469	Annual 3rd Party Inspection of Fire Devices Overdue	An annual fire devices inspection was delayed due to contractor workers' security clearances being outstanding. Discussions between CNL and the contractor took place to rectify the situation; however, the deadline for inspection completion was not met. The inspection was completed at the next opportunity. There has been no safety consequence because of the non-conformance. Due to the other fire device tests that are performed there, this is a low-level risk. CNSC staff are satisfied with the actions taken by CNL.	Emergency Management and Fire Protection

Event Number	Title	WL Event summary	SCA
3 HSSE-22-3025	Continuous Air Monitor in Whiteshell Laboratories Shielded Facility Waste Compactor Area Operated Past Calibration Due Date	A beta and gamma continuous air monitor (CAM) in the WL Shielded Facility waste compactor area was identified to be operating 12 days past its annual calibration due date, CNL staff had identified the CAM to be due for removal and replacement within the WL instrument calibration database, however the CAM was missed because of a temporary change in personnel assignments. There was no safety consequence because of the non-conformance. There was no waste processing during this period. The monitor was removed out of service and replaced with a calibrated instrument. An extent of condition was performed and confirmed there were no other in-service radiation protection instruments past their calibration due date on the WL site. CNSC staff are satisfied with the corrective measures taken by CNL.	Operating Performance

Table E-4: Reportable events PHP in 2022

Event Number	Title	PHP Event summary	SCA
1 ERM-22-3304	Fire Alarm Call to 228 Cavan Street, Port Hope (Pine Street Extension Site)	A building fire alarm sounded due to low voltage battery alarm. The building was provided the all clear by Fire Services and the alarm was cleared by CNL's monitoring service. The low voltage battery alarm was serviced**.** CNSC staff are satisfied with the corrective actions taken by CNL.	Emergency Management and Fire Protection

Event Number	Title	PHP Event summary	SCA
2 ERM-22-2149	39 Hayward Street – False Fire Alarm Event	A fire alarm indication was activated on the upper floor of the 39 Hayward Street field office. Fire and Emergency Services personnel determined that there was no fire in the field office and the site was secured. CNSC staff are satisfied with the corrective measures taken by CNL to prevent a similar event in the future.	Emergency Management and Fire Protection
3 ERM-22-2126	Port Hope Waste Water Treatment Plant Toxicity test failure of effluent	Final effluent sampling done in the low storage pond resulted in 100% mortality to Daphnia magna zooplankton, where a result of < 50% mortality is considered non-toxic. This resulted in a halt to releases to the environment. CNL has reviewed the factors that may have contributed to this toxicity failure and has concluded that the 100%-mortality test result was due to a lab error. Following 7 consecutive days of toxicity sampling where all toxicity tests were passed with zero mortality, CNL resumed normal plant operations. CNSC staff are satisfied with the actions taken by CNL.	Environmental Protection
4 ERM-22-3601	Gasoline Spill into Port Hope Harbour	A spill of less than 1 L of gasoline occurred from a boat at the Port Hope Harbour. There was no effect on the health, safety or security of persons or the environment. The visible gasoline was remediated from the water body. The affected boat and motor have been removed from service until an assessment and repair or replacement is completed. Site staff were	Environmental Protection

Event Number	Title	PHP Event summary	SCA
		reminded to continue to conduct equipment inspections prior to each operation. CNSC staff are satisfied with the corrective actions taken by CNL.	
5 ERM-22-1705	Arsenic Action Concentration Exceedance	During routine compliance sampling at the Port Hope waste water treatment plant (WWTP), it was determined that arsenic concentration in the final effluent from the plant for the week ending on June 7, 2022 was 41.5 ppb and thus exceeded the regulated weekly composite action concentration limit of 41 ppb. CNL took immediate corrective action and split the flow of effluent to the old Port Hope WWTP which lowered arsenic concentrations to below the action level. CNL posted a public disclosure to the PHAI website. CNSC staff are satisfied with the corrective actions taken by CNL.	Environmental Protection
6 ERM-22-1841	Environmentally Safe Vegetable Oil-Based Rock Drill Lubricant Spill	An environmentally safe vegetable oil-based rock drill lubricant spill from a drill head occurred on a drill barge. An estimated 0.6 L of oil was released to the inner harbour. Work stopped immediately when the spill was identified, and spill containment was installed. CNL took corrective action through spill contingency and equipment maintenance. There was no risk	Environmental Protection

Event Number	Title	PHP Event summary	SCA
		to human health or the environment because of this spill. CNSC staff are satisfied with the corrective measures taken by CNL.	
7 ERM-22-1698	Waste Water Treatment Plant Exceedance Of Discharge Criteria In Plant Effluent (Copper And Zinc)	CNL determined that the final effluent produced by the WWTP for the week ending on June 1, 2022 exceeded the weekly composite release limit for copper and the action level for zinc. The source of the elevated copper and zinc concentrations was due to corroding brass components on the treated effluent side of the WWTP, therefore was not related to water influent requiring treatment. CNL isolated the brass components in the cooling loop and the copper and zinc levels returned to normal operating levels. Corrective measures were put in place until the brass components could be replaced. CNSC staff are satisfied with the information provided and corrective measures taken by CNL to prevent a similar event in the future.	Environmental Protection
8 ERM-22-2612	Boiler Condensate Tank Overflow	During a routine walkdown, CNL operations staff observed water leaking from a treated water boiler steam vent piping at the Port Hope WWTP. An automatic valve failed to open and caused the tank to overflow. The spilled water entered a storm sewer drain and was contained within the system. CNL immediately shut down the boiler and drained the tank. The faulty valve was replaced. No water was observed to be released off site with the	Fitness for Service

Event Number	Title	PHP Event summary	SCA
		single discharge location noted to be free of standing water. CNSC staff are satisfied with the corrective actions taken by CNL.	
9 ERM-22-1960	Port Hope Pine Street Extension Temporary Storage Site - Delayed Submission of Annual Compliance Monitoring Report (ACMR)	CNL staff did not meet the deadline to submit the 2021 ACMR for the Pine Street Extension Temporary Storage Site Waste Nuclear Substance Licence, WNSL-W1-182.0/2022, by March 15 as required by the licence conditions handbook and was instead submitted March 31. CNL staff have taken corrective action to review, communicate, and track ACMR deadlines on an annual basis. CNSC staff are satisfied with the corrective measures taken by CNL to prevent a similar event in the future.	Operating Performance
10 ERM-22-3086	Misclassification of LSA-I Material	A shipment consisting of 50 bags of personal protective equipment was misclassified by a CNL sub-contractor. The shipment was travelling from the PHAI Harbour Center Pier Site to the Long-Term Waste Management Facility (LTWMF) in Port Hope in a covered and secured dump-truck box. The misclassification did not change the way the material was required to be	Packaging and Transport

Event Number	Title	PHP Event summary	SCA
		handled and there was no risk to workers, the public and the environment. CNSC staff are satisfied with CNL's corrective actions to ensure its contractors' packaging and transport procedures and CNL's supplier operating procedure are revised to ensure it is compliant with the *Packaging and Transport of Nuclear Substances Regulations, 2015*.	
11 ERM-22-1033	Failure to Provide CNSC Written Notification Of Licence Document Revision (Wooden Pallet Placement)	During a CNSC inspection, a CNSC inspector observed wooden pallets supporting supersacks of Cameco waste being placed into the Port Hope LTWMF, which is a deviation from one of CNL's detailed design description report documents that was previously accepted by CNSC staff. CNL failed to provide written notification to CNSC of this change to this licensing basis document as required by the PHP licence WNSL-W1-2310.02/2022. As a result of this finding, CNL submitted an event report on its failure to provide written notification. CNL is compiling a fulsome extent-of-condition report to identify if other licensing basis documents require revision and if any licensing documents have been revised and not provided to CNSC staff as required.	Physical Design
12 ERM-22-2507	Sub-Contractor Hand Scrape in Radiological (RP) Zone 3	A sub-contractor at a small scale site was holding a vacuum for dust control, while another worker was using a drill with a wire wheel to remove	Radiation Protection

Event Number	Title	PHP Event summary	SCA
		contamination from the foundation of a concrete block. During the decontamination process, the wire wheel slipped causing a fracture to the hand of the worker holding the vacuum. This resulted in a lost-time injury. CNL took corrective action and requested the contractor to determine appropriate tools and personal protective equipment to prevent a similar event from occurring again. CNL confirmed that the contractor took significant corrective actions to prevent the recurrence, which included adding an extension to the vacuum hose to keep the worker's hand further away from the drill's wire wheel and adding a second grip to the drill to give the operator better control of the drill. CNL also released an operating experience bulletin to all CNL sites and contractors with a summary of the event, causes and lessons learned. CNSC staff are satisfied with the corrective actions taken by CNL.	
13 ERM-22-3994	PHAI perimeter fences down at various project sites due to winter storm	Due to a severe winter storm, PHAI perimeter fences were temporarily down across several worksites. The severity of the storm prevented immediate safe restoration of the fencing. Contractor security providers were stationed near where the fences were down at the Harbour and the Viaduct sites excavations and radiation zones to mitigate unauthorized access. CNL has repaired the perimeter fencing and is working to improve the	Security

Event Number	Title	PHP Event summary	SCA
		robustness of the fencing. There were no adverse effects on the health, safety and security of persons or the environment. There was no evidence of public access to any of the sites. CNSC staff are satisfied with the corrective actions taken by CNL.	
14 ERM-22-2209	Attempted Trespassing	An individual known to PHAI staff and Port Hope police attempted to gain access to the Port Hope Harbour and Centre Pier site. The individual was stopped from gaining entry by the front gate attendant and turned away by a site security guard. Port Hope Police were notified of the incident and were able to track down and speak with the individual. There was no loss or breach of security at the Harbour Centre Pier. CNSC staff are satisfied with the actions taken by CNL.	Security

Table E-5: Reportable events PGP in 2022

Event Number	Title	PGP Event summary	SCA
1 ERM-20-3094	Water Collection Line Struck and Severed During Excavation	During excavation near the PGP mound a leachate pipe was damaged. Pumps were used to pump water away and divert it into the EQ pond. There were no injuries or contamination events to personnel because of this event. Following the repair of the line, the area was checked for contamination and all impacted material was removed. Following this removal, soil samples were taken and analyzed by a third-party laboratory to confirm the area was clean. CNSC staff are satisfied with the corrective actions taken by CNL.	Operating Performance
2 HSSE-22-0145	Shipment of Unclassified Material	A shipment containing process residual waste from the PGP LTWMF was shipped to the PHP LTWMF, as part of the ongoing effort to demobilize the equipment from the PGP LTWMF site. It was revealed during the paperwork consolidation that 7 of the 14 totes on the shipment had not been classified in accordance with the Off-site Transportation of Dangerous Goods Standard (900-508520-STD-001). The 7 waste packages were correctly packaged in Industrial Packaging 2; however, the associated shipping documentation did not identify them as contents of the consignment. CNL took corrective action to investigate the event to verify package contents and the adequacy of packaging and documentation. CNL also introduced a handler verification system to ensure correct packages	Packaging and Transport

Event Number	Title	PGP Event summary	SCA
		are loaded. CNSC staff are satisfied with the corrective actions taken by CNL to prevent a similar event in the future.	
3 ERM-22-2811	Port Granby Long-Term Waste Management Facility Security Breach	Overnight, a security event occurred at the PGP LTWMF that involved an unidentified male gaining access to the site. Contracting staff arriving at the site the morning after discovered that the contractor’s lunchroom trailer doors were locked, which was not typical. It was noticed that the far door to the trailer was open and upon inspection, it was noted that bottled water had been consumed. Nothing else appeared disturbed, missing or stolen. There were no adverse effects on the health, safety and security of persons or the environment because of this event. CNSC staff are satisfied with the corrective actions taken by CNL to prevent a similar event in the future.	Security

Table E-6: Reportable events at DPWF in 2022

There were no reportable events for DPWF in 2022.

Table E-7: Reportable events at G1WF in 2022

There were no reportable events for G1WF in 2022.

Table E-8: Reportable events at NPDWF in 2022

There were no reportable events for NPDWF in 2022.

F. RATING DEFINITIONS

The CNSC applies rating levels as follows:

Satisfactory (SA): The licensee meets all of the following criteria:

- Performance meets CNSC staff expectations.
- Licensee non-compliances or performance issues, if any, are not risk-significant.
- Any non-compliances or performance issues have been, or are being, adequately corrected.

Below expectations (BE): One or more of the following criteria apply:

- Performance does not meet CNSC staff expectations.
- The licensee has risk-significant non-compliance(s) or performance issue(s).
- Non-compliances or performance issues are not being adequately corrected.

Unacceptable (UA): One or both of the following criteria apply:

- The risk associated with a non-compliance or performance issue is unreasonable.
- At least one significant non-compliance or performance issue exists with no associated corrective action.

G. SAFETY AND CONTROL AREA RATINGS

Note that the following acronyms are used in this appendix:

SA = satisfactory

BE = below expectations

UA = unacceptable

Table G-1: Safety and control area summary, CRL, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	BE	**BE**
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table G-2: Safety and control area summary, WL, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	**BE**
Waste management	SA	SA	SA	SA	SA
Security	BE	BE	SA	BE	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table G-3: Safety and control area summary, PHP, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis*	N/A	N/A	N/A	N/A	N/A
Physical design	SA	SA	SA	SA	SA
Fitness for service*	N/A	N/A	N/A	N/A	N/A
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

*As per the LCH for the PHP, due to the scope of work under the licence, the safety analysis and fitness for service SCAs do not apply to the PHP.

Table G-4: Safety and control area summary, PGP, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis*	N/A	N/A	N/A	N/A	N/A
Physical design	SA	SA	SA	SA	SA
Fitness for service*	N/A	N/A	N/A	N/A	N/A
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation*	N/A	N/A	N/A	N/A	N/A
Packaging and transport	SA	SA	SA	SA	SA

*As per the LCH for the PGP, due to the scope of work under the licence, the safety analysis, fitness for service, and safeguards and non-proliferation SCAs do not apply to the PGP.

Table G-5: Safety and control area summary, DPWF, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table G-6: Safety and control area summary, G1WF, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

Table G-7: Safety and control area summary, NPDWF, 2018-2022

Safety and control areas	2018	2019	2020	2021	2022
Management system	SA	SA	SA	SA	SA
Human performance management	SA	SA	SA	SA	SA
Operating performance	SA	SA	SA	SA	SA
Safety analysis	SA	SA	SA	SA	SA
Physical design	SA	SA	SA	SA	SA
Fitness for service	SA	SA	SA	SA	SA
Radiation protection	SA	SA	SA	SA	SA
Conventional health and safety	SA	SA	SA	SA	SA
Environmental protection	SA	SA	SA	SA	SA
Emergency management and fire protection	SA	SA	SA	SA	SA
Waste management	SA	SA	SA	SA	SA
Security	SA	SA	SA	SA	SA
Safeguards and non-proliferation	SA	SA	SA	SA	SA
Packaging and transport	SA	SA	SA	SA	SA

H. DOSES TO NUCLEAR ENERGY WORKERS AND NON-NUCLEAR ENERGY WORKERS AT CNL SITES

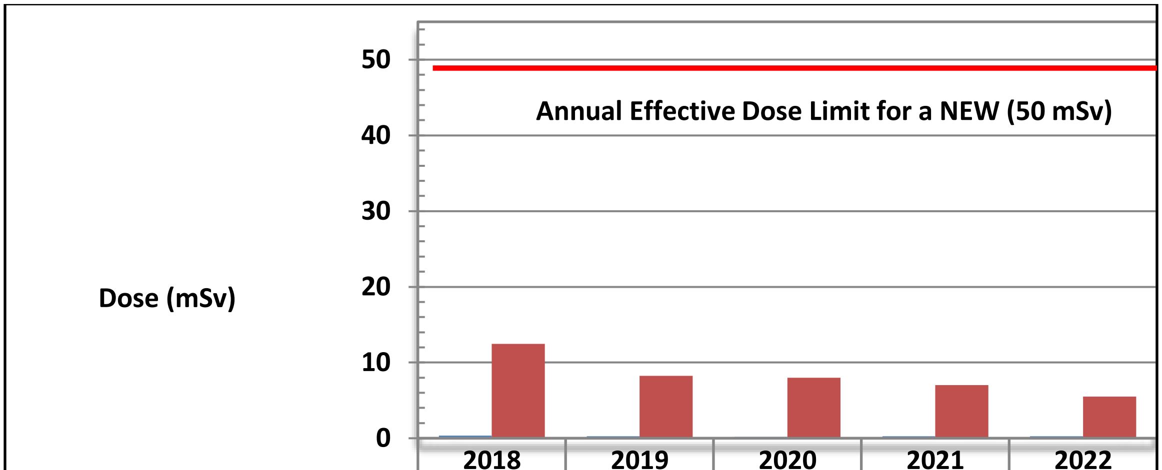
This appendix presents information on doses to Nuclear Energy Workers (NEWs) and non-NEWs at CNL sites.

Chalk River Laboratories

Radiation exposures of workers at the CRL site are ascertained, recorded and monitored to ensure compliance with CNSC's regulatory dose limits and to maintain radiation doses ALARA. External and internal dosimetry are provided by CNL's licensed dosimetry service.

At CRL, workers, including employees and contractors, conducting work activities which present a reasonable probability of receiving an occupational dose greater than 1 mSv/year are identified as NEWs. In 2022, the maximum effective dose received by a NEW was 5.48 mSv, well below the CNSC's regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period. Figure H-1 provides the average and maximum effective doses received by NEWs at CRL from 2018 to 2022.

Figure H-1: Effective doses to NEWs at CRL from 2018 – 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.34	0.27	0.16	0.27	0.26
Maximum Effective Dose (mSv)	12.48	8.23	7.97	7.01	5.48
Number of NEWs Monitored	4227	4071	3679	3957	4134

The dose fluctuations from year to year are attributed to the scope and duration of the radiological work conducted, along with the dose rates associated with the work. No adverse trends were identified in 2022.

Annual average and maximum equivalent doses to the skin and extremities (hands) for NEWs at CRL from 2018 to 2022 are provided in tables H-1a and H-1b. In 2022, the maximum skin dose received by a NEW at CRL was 32 mSv, and the maximum extremity dose received by a NEW at CRL was 11.50 mSv. Doses to the skin and extremities at CRL were well below the CNSC's regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-1a: Equivalent (skin) doses to NEWs at CRL from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.40	0.29	0.19	0.31	0.28	N/A
Maximum skin dose (mSv)	15.84	9.65	9.37	7.43	32	500 mSv/year

Table H-1b: Equivalent (extremity) doses to NEWs at CRL from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average extremity dose (mSv)	4.85	2.21	1.70	2.02	0.98	N/A
Maximum extremity dose (mSv)	44.83	21.38	11.86	28.30	11.50	500 mSv/year

Non-NEWs at CRL

In 2022, the maximum effective and equivalent (skin) doses received by a person not considered as a NEW was 0.44 mSv and 0.52 mSv, respectively, which is well below the CNSC's regulatory effective and equivalent dose limits for persons who are not NEWs of 1 mSv and 50 mSv, respectively, in one calendar year.

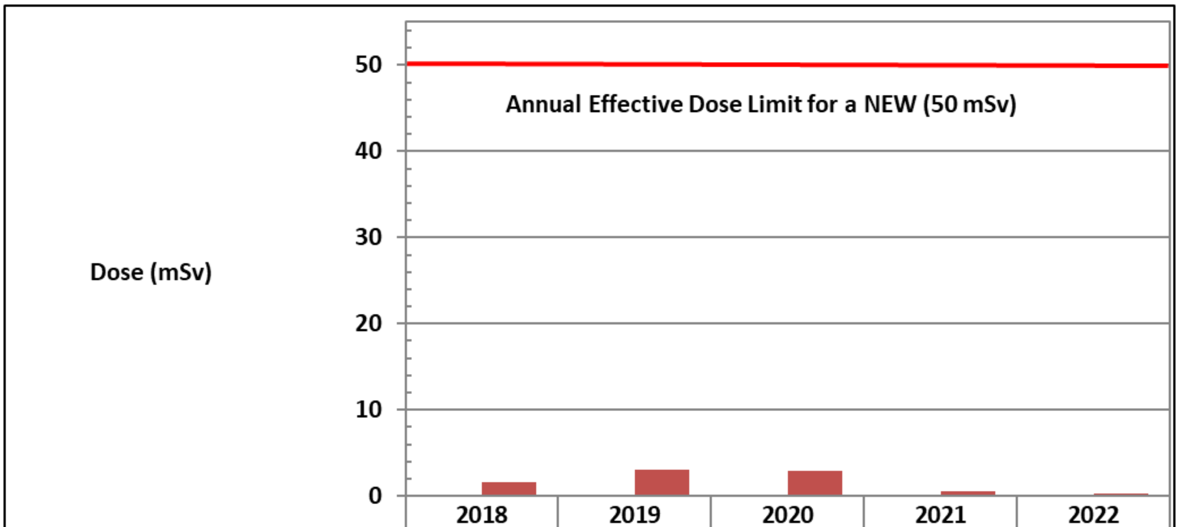
Whiteshell Laboratories

Radiation exposures of workers at WL are ascertained, recorded and monitored to ensure compliance with CNSC's regulatory dose limits to maintain radiation doses ALARA. WL uses CNL's licensed dosimetry services for external and internal dosimetry for site/facility staff and contractors.

At WL, workers, including employees and contractors, conducting work activities which present a reasonable probability of receiving an occupational dose greater than 1 mSv/year are identified as NEWs. In 2022, the maximum effective dose received by a NEW was 0.31 mSv, well below the CNSC's regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-2 provides the average and maximum effective doses received by NEWs at WL from 2018 to 2022.

Figure H-2: Effective doses to NEWs at WL from 2018 – 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.07	0.10	0.10	0.02	0.01
Maximum Effective Dose (mSv)	1.65	3.09	2.97	0.57	0.31
Number of NEWs Monitored	595	489	376	472	570

The dose fluctuations from year to year are attributed to the scope and duration of the radiological work conducted. Worker doses decreased in 2022 with the site safety pause instituted in June. The main contribution to radiation doses to NEWs in 2022 was the replacement of hot cell roughing filters. There was continued waste handling with low level waste package removal and characterization activities; however, these activities had only a small contribution to NEW's doses.

Annual average and maximum equivalent doses to the skin and extremities (hands) for NEWs at WL from 2018 to 2022 are provided in Table H-2a and H-2b. In 2022, the maximum skin dose received by a NEW at WL was 0.66 mSv, and the maximum extremity dose received by a NEW at WL was 1.38 mSv. Doses to the skin and extremities at WL were well below the CNSC's regulatory equivalent dose limits for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-2a: Equivalent (skin) doses to NEWs at WL from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.12	0.20	0.16	0.02	0.02	N/A
Maximum skin dose (mSv)	3.72	7.47	6.80	0.94	0.66	500 mSv/year

Table H-2b: Equivalent (extremity) doses to NEWs at WL from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average extremity dose (mSv)	5.02	4.80	1.43	0.45	0.27	N/A
Maximum extremity dose (mSv)	36.71	37.77	6.46	1.86	1.38	500 mSv/year

Non-NEWs at WL

In 2022, the maximum individual effective to a non-NEW at WL was 0.01 mSv, which was well below the CNSC's regulatory effective dose limit for persons who are not NEWs of 1 mSv, in one calendar year.

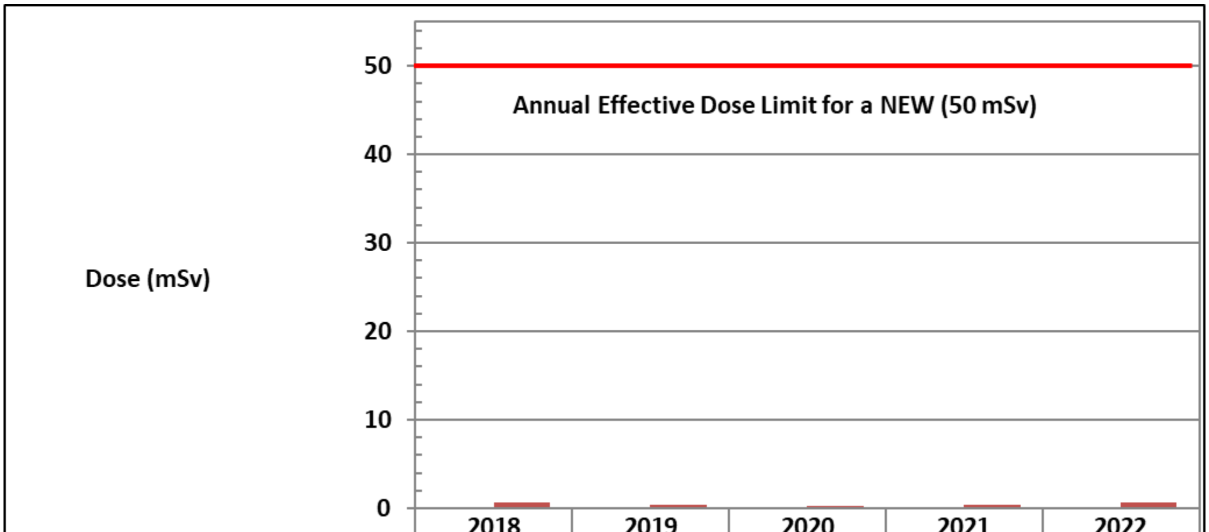
Port Hope Area Initiative

Port Hope

Radiation exposures of NEWs at the PHP are ascertained, recorded and monitored to ensure compliance with the CNSC’s regulatory dose limits and to maintain radiation doses ALARA. Dosimeters are used for measuring external doses (whole body and skin) of PHP workers. Internal doses for PHP workers, resulting from exposure to radon progeny and long-lived alpha, are determined by indirect methods using concentration levels in air and time spent in work areas, or through the use of Personal Alpha Dosimeters. In 2022, no NEW received a radiation dose in excess of the CNSC’s regulatory dose limits.

Figure H-3 provides the average effective doses and the maximum effective doses for NEWs from 2018 to 2022. In 2022, the maximum effective dose received by a NEW at the PHP was 0.59 mSv, which is well below the CNSC’s regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-3: Effective doses to NEWs at PHP from 2018 – 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.04	0.03	0.03	0.02	0.01
Maximum Effective Dose (mSv)	0.59	0.38	0.27	0.43	0.59
Number of NEWs Monitored	656	935	595	919	1474

As the project continues, effective doses are expected to remain low and comparable to previous years.

Annual average and maximum equivalent doses to the skin for NEWs at the PHP from 2018 to 2022 are provided in Table H-3. In 2022, the maximum skin dose received by a NEW at the PHP was 0.49 mSv, which is well below the CNSC’s regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-3: Equivalent (skin) doses to NEWs at PHP from 2018 – 2022

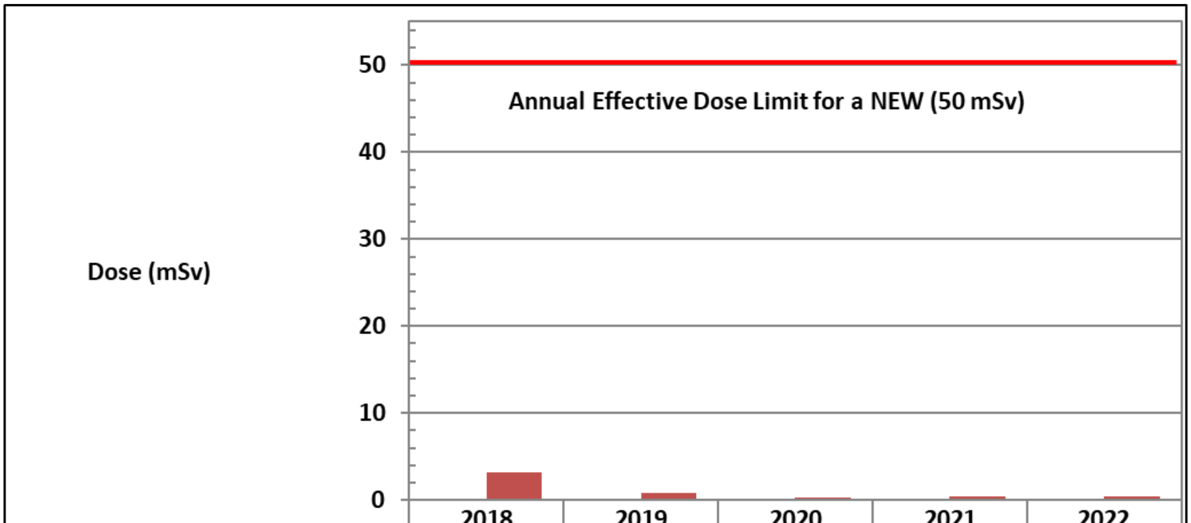
Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.04	0.04	0.03	0.01	0.02	N/A
Maximum skin dose (mSv)	0.33	0.60	0.27	0.45	0.49	500 mSv/year

Port Granby Project

Radiation exposures of NEWs at the PGP are ascertained, recorded, and monitored to ensure compliance with the CNSC's regulatory dose limits and to maintain radiation doses ALARA. Dosimeters are used for measuring external doses (whole body and skin) of PGP workers. Internal doses for PGP workers, resulting from exposure to radon progeny and long-lived alpha, are determined by indirect methods using concentration levels in air and time spent in work areas. In 2022, no NEW received a radiation dose in excess of the CNSC's regulatory dose limits.

Figure H-4 provides the average effective doses and the maximum effective doses for NEWs from 2018 to 2022. In 2022, the maximum effective dose received by a NEW at the PGP was 0.42 mSv, which is well below the CNSC's regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-4: Effective doses to NEWs at PGP from 2018 - 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.06	0.05	0.03	0.03	0.02
Maximum Effective Dose (mSv)	3.13	0.79	0.27	0.38	0.42
Number of NEWs Monitored	489	563	514	537	657

Effective doses of NEWs continue to be very low as expected, as capping and site closure activities are completed at the PGP.

Annual average and maximum equivalent doses to the skin for NEWs at the PGP from 2018 to 2022 are provided in Table H-4. In 2022, the maximum skin dose received by a NEW at the PGP was 0.49 mSv, which is well below the CNSC's regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-4: Equivalent (skin) doses to NEWs at PGP from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.05	0.05	0.03	0.01	0.03	N/A
Maximum skin dose (mSv)	2.44	0.79	0.27	0.45	0.49	500 mSv/year

Non-NEWs at Port Hope Area Initiative

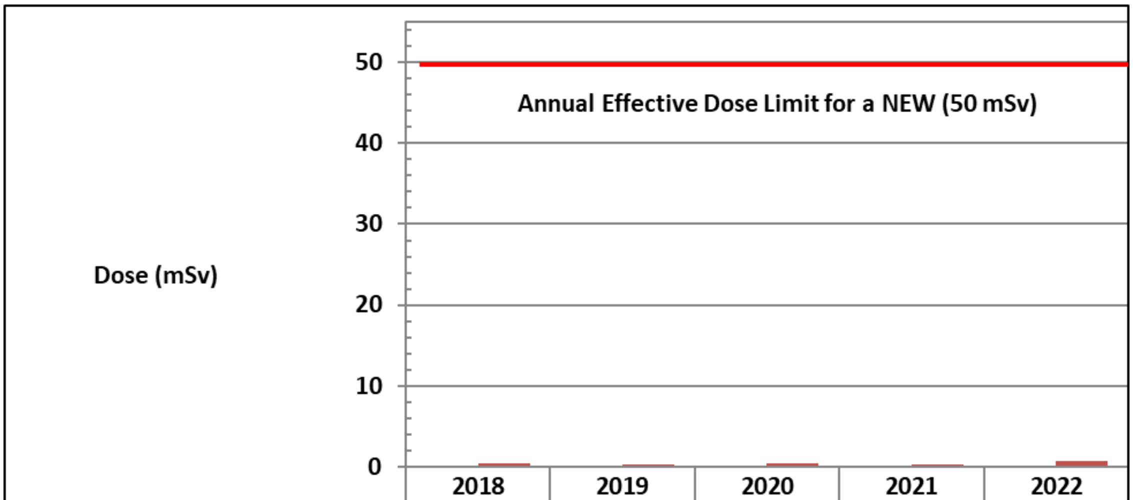
In 2022, there were no measurable doses recorded for visitors and contractors that were not considered as NEWs at the PHP and PGP.

Douglas Point Waste Facility

Radiation exposures of NEWs at the DPWF are ascertained, recorded, and monitored to ensure compliance with the CNSC's regulatory dose limits and to maintain radiation doses ALARA. In 2022, no NEW received a radiation dose in excess of the CNSC's regulatory dose limits.

Figure H-5 provides the average effective doses and the maximum effective doses for NEWs from 2018 to 2022. In 2022, the maximum effective dose received by a NEW at the DPWF was 0.69 mSv, which is well below the CNSC's regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-5: Effective doses to NEWs at DPWF from 2018 – 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.01	0.02	0.02	0.01	0.01
Maximum Effective Dose (mSv)	0.43	0.24	0.45	0.36	0.69
Number of NEWs monitored	123	74	76	142	168

Over 2018 to 2022, hazard reduction work activities occurred at the DPWF site. In 2018, most of the maximum individual effective dose was attributed to the Spent Resin Removal Project. In 2019 and 2020, the hazard reduction work continued in the Reactor Building, including the dry active waste removal campaigns. In 2021, work focused outside of the reactor building, in low dose rate areas. In 2022, work focused on the installation and energization of the new Class IV power system, Service Building characterization and hazard abatement, Reactor Segmentation characterization work, walk downs for the Detailed Decommissioning Plans development, and preparation work for non-nuclear building demolition activities.

Annual average and maximum equivalent doses to the skin for NEWs at the DPWF from 2018 to 2022 are provided in Table H-5. In 2022, the maximum skin dose received by a NEW at the DPWF was 0.74 mSv, which is well below the CNSC's regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-5: Equivalent (skin) doses to NEWs at DPWF from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.01	0.02	0.03	0.01	0.01	N/A
Maximum skin dose (mSv)	0.43	0.24	0.51	0.45	0.74	500 mSv/year

Non-NEWs at DPWF

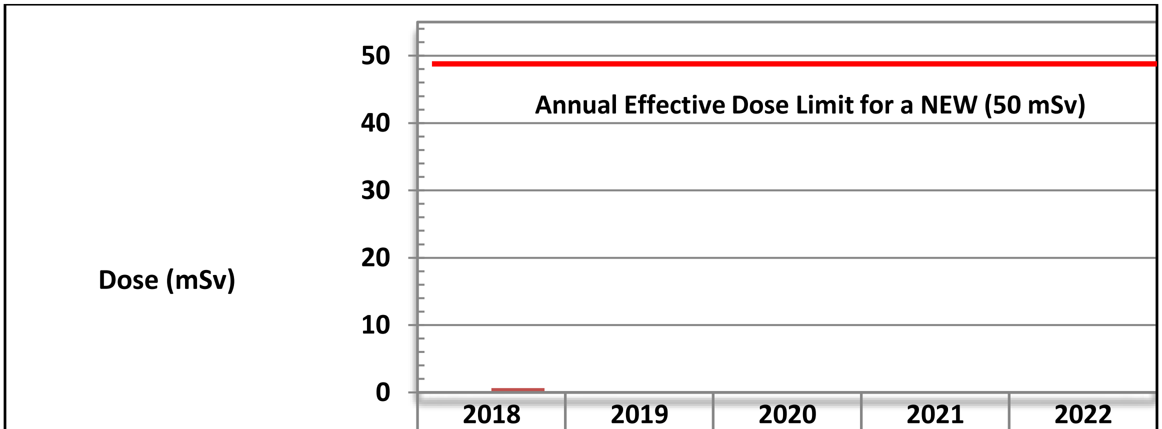
In 2022, there were no visitors or contractors not considered as NEWs at the DPWF, and therefore no corresponding dose information.

Gentilly-1 Waste Facility

Radiation exposures of NEWs at the G1WF are ascertained, recorded, and monitored to ensure compliance with the CNSC's regulatory dose limits and to maintain radiation doses ALARA. External and internal dosimetry are provided by CNL's licensed dosimetry service. In 2022, no NEW received a radiation dose in excess of the CNSC's regulatory dose limits.

Figure H-6 provides the average effective doses and the maximum effective doses for NEWs from 2018 to 2022. In 2022, the maximum effective dose received by a NEW at the G1WF was 0.07 mSv, which is well below the CNSC's regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-6: Effective doses to NEWs at G1WF from 2018 - 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.03	0.01	0.00	0.01	0.00
Maximum Effective Dose (mSv)	0.62	0.10	0.01	0.12	0.07
Number of NEWs Monitored	101	57	43	132	202

In 2018, most of the maximum individual effective dose was attributed to the Spent Resin Removal Project. From 2019 to 2021, the hazard reduction work continued, including asbestos abatement and dry active waste removal. This work had a low potential for worker exposures and resulted in low effective doses observed as compared to 2018. In 2022, hazard reduction work at the site continued; however, this work resulted in low effective doses to workers.

Annual average and maximum equivalent doses to the skin for NEWs at the G1WF from 2018 to 2022 are provided in Table H-6. In 2022, the maximum skin dose received by a NEW at the G1WF was 0.07 mSv, which is well below the CNSC's regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-6: Equivalent (skin) doses to NEWs at G1WF from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.03	0.01	0.00	0.01	0.00	N/A
Maximum skin dose (mSv)	0.62	0.16	0.01	0.12	0.07	500 mSv/year

Several extremity doses were recorded at G1WF during 2022 for the inspections of the spent fuel canisters. The maximum extremity dose received by a NEW at the G1WF was 0.15 mSv, which is well below the CNSC's regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Non-NEWs at Gentilly-1

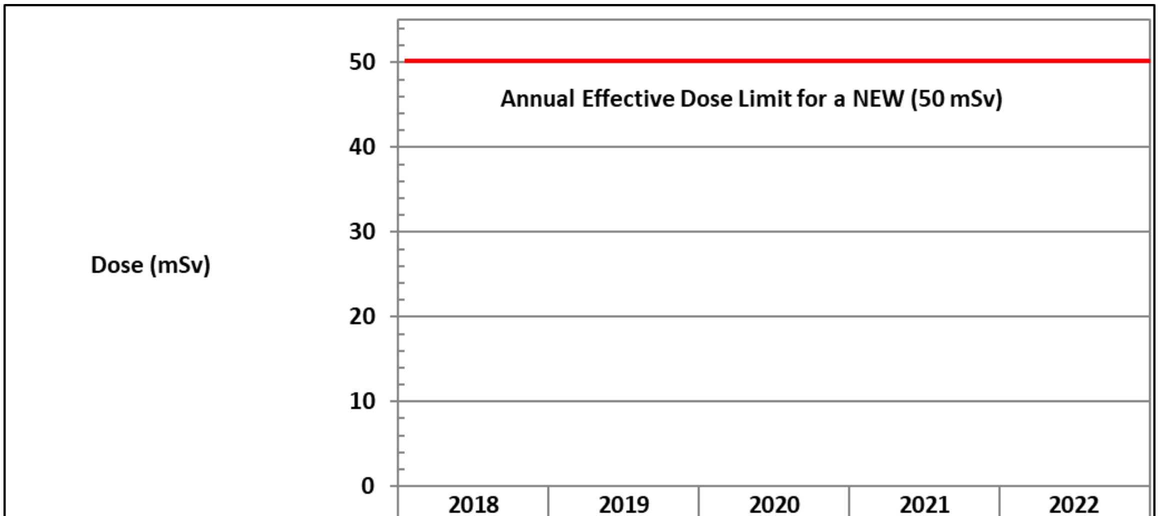
In 2022, there were no visitors or contractors not considered as NEWs at the G1WF, and therefore no corresponding dose information.

Nuclear Power Demonstration Waste Facility

Radiation exposures of NEWs at the NPDWF are ascertained, recorded, and monitored to ensure compliance with the CNSC’s regulatory dose limits and to maintain radiation doses ALARA. External and internal dosimetry are provided by CNL’s licensed dosimetry service. In 2022, no NEW received a radiation dose in excess of the CNSC’s regulatory dose limits.

Figure H-7 provides the average effective doses and the maximum effective doses for NEWs from 2018 to 2022. In 2022, the maximum effective dose received by a NEW at the NPDWF was 0.02 mSv, which is well below the CNSC’s regulatory effective dose limit for NEWs of 50 mSv in a 1-year dosimetry period.

Figure H-7: Effective doses to NEWs at NPDWF from 2018 – 2022



	2018	2019	2020	2021	2022
Average Effective Dose (mSv)	0.00	0.02	0.00	0.00	0.00
Maximum Effective Dose (mSv)	0.09	0.05	0.05	0.01	0.02
Number of NEWs Monitored	186	167	125	179	249

Effective doses over these years are consistently low and reflect storage with surveillance activities such as routine inspection and maintenance, as well as some hazard reduction activities.

Annual average and maximum equivalent doses to the skin for NEWs at the NPDWF from 2018 to 2022 are provided in Table H-7. In 2022, the maximum skin dose received by a NEW at the NPDWF was 0.02 mSv, which is well below the CNSC’s regulatory equivalent dose limit for NEWs of 500 mSv in a 1-year dosimetry period.

Table H-7: Equivalent (skin) doses to NEWs at NPDWF from 2018 – 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Average skin dose (mSv)	0.00	0.02	0.00	0.00	0.00	N/A
Maximum skin dose (mSv)	0.09	0.05	0.05	0.01	0.02	500 mSv/year

Non-NEWs at NPDWF

In 2022, there were no visitors or contractors not considered as NEWs at the NPDWF and therefore no corresponding dose information.

I. LOST-TIME INJURY INFORMATION

This appendix contains information on the number, frequency and severity of recordable lost time injuries (RLTIs) at the CNL sites covered by this ROR, with information presented separately for CNL employees and contractors.

CNL Employees

Frequency and severity are calculated per 100 full-time workers (equivalent to 200,000 worker-hours per year) using the following formulas:

Frequency rate =

(# of Lost-Time Injuries) x (200 000 hrs of exposure) / (person hours worked)

Severity rate =

(# of Working Days Lost) x (200 000 hrs of exposure) / (person hours worked)

Table I-1: Summary of CRL's Employee RLTIs, frequency and severity *(Source: CNL)*

Year	2018	2019	2020	2021	2022
Person Hours Worked	5,396,450	5,729,010	5,346,690	5,358,630	5,709,410
Lost-Time Injuries	5	1	4	3	2
Working Days Lost	69	75	78	4	3
Frequency	0.19	0.03	0.15	0.11	0.07
Severity	2.56	2.62	2.92	0.15	0.15

Table I-2: Summary of WL's Employee RLTIs, frequency and severity *(Source: CNL)*

Year	2018	2019	2020	2021	2022
Person Hours Worked	688,000	642,000	584,030	684,000	812,000
Lost-Time Injuries	1	0	1	0	0
Working Days Lost	5	0	2	0	0
Frequency	0.28	0	0.34	0	0
Severity	1.45	0	0.68	0	0

Table I-3: Summary of PHP's RLTIs, frequency and severity *(Source: CNL)*

Year	2018	2019	2020	2021	2022
Person Hours Worked	-	298,377	391,875	389,016	397,443
Lost-Time Injuries	0	1	0	2	0
Working Days Lost	0	33	0	12	0
Frequency	0	0.68	0	1.03	0
Severity	0	22.57	0	6.17	0
Note that prior to 2019, CNL did not provide data on person-hours worked on the PHP site.					

Table I-4: Summary of PGP's RLTIs, frequency and severity *(Source: CNL)*

Year	2018	2019	2020	2021	2022
Person Hours Worked	-	41,622	30,000	19,614	10,513
Lost-Time Injuries	0	1	0	0	0
Working Days Lost	0	1	0	0	0
Frequency	0	4.81	0	0	0
Severity	0	4.81	0	0	0
Note that prior to 2019, CNL did not provide data on person-hours worked on the PGP site.					

Table I-5: Summary of DPWF, G1WF, and NPDWF Employee RLTIs, frequency and severity *(Source: CNL)*

Year	2018	2019	2020	2021	2022
CNL staff at the DPWF, G1WF, and NPDWF sites have not recorded a lost-time injury since 2016.					

Contractors at CNL sites

The number of contractor recordable lost-time incidents reported to CNL in 2022 is shown in Table I-6.

CNL records the number of lost-time injuries reported to CNL by their contractors. However, contractor employee hours worked is considered sensitive information and the contractors do not divulge the specific number of hours worked to CNL as their client. Therefore, CNL does not provide frequency and severity rates for contractors since these calculations require hours worked.

Table I-6: Contractor lost-time injuries in 2022 *(Source: CNL)*

Site	CRL	WL	PHP	PGP	DP	G-1	NPD
Lost-Time Injuries (Change from 2021)	1(-1)	0	1(+1)	0	0	0	0

J. ESTIMATED DOSE TO THE PUBLIC

This appendix contains information on the estimated dose to the public around CNL sites. Regulatory release limits known as Derived Release Limits (DRLs) are site-specific calculated release levels that could, if exceeded, expose a member of the public of the most highly exposed group to a committed dose equal to the regulatory annual dose limit of 1 mSv/year. DRLs are calculated using CSA standard N288.1-14, *Guidelines for calculating derived release limits for radioactive materials in airborne and liquid effluents for normal operation of nuclear facilities* [32].

As per the *Radiation Protection Regulations* [16] subsection 1(3), and considering the fact that the radiological releases from all the sites covered by this ROR have remained small fractions of the DRLs applicable to those sites, the contribution to the dose to the public from these releases remains a very small fraction of the prescribed limit for the general public.

Chalk River Laboratories

The maximum dose in each year since 2018 has been well below the dose limit of 1 mSv/year.

Table J-1: CRL maximum effective dose to a member of the public from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Maximum Effective Dose (mSv)	0.0360	0.0036	0.0072	0.0037	0.0026	1 mSv/year

Whiteshell Laboratories

The dose to critical groups from releases from CNL-WL in 2022 was well below the regulatory dose limit of 1 mSv/year.

Table J-2: WL maximum effective dose to a member of the public from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Maximum effective dose (mSv)	0.00004	0.00009	0.000005	0.00001	0.00002	1 mSv/year

Port Hope Area Initiative

A modified approach for calculating estimated dose to the public was performed by CNL for PHAI sites beginning in 2019 and includes both radon monitoring and fence line dosimeter measurements at both PHP and PGP sites.

The annual estimated doses to the public in 2022 at PHP and PGP were well below the annual regulatory dose limit of 1 mSv.

Table J-3: PHP maximum effective dose to a member of the public from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Maximum effective dose (mSv)	0.0275	0.0350	0.033	0.023	0.028	1 mSv/year

Table J-4: PGP maximum effective dose to a member of the public from 2018 - 2022

Dose Data	2018	2019	2020	2021	2022	Regulatory Limit
Maximum effective dose (mSv)	0.0200	0.0396	0.020	0.041	0.033	1 mSv/year

DPWF

The gap analysis against CSA standard N288.1-14 conducted in 2021 by CNL determined that given the very low levels of contaminants in airborne and waterborne effluents, there is no need for an environmental monitoring program at DPWF. CNSC staff reviewed and accepted this gap analysis. All releases of radioactive material in DPWF effluents are a small fraction of their respective regulatory limits which indicate the potential of minimal impact on the public or the environment. In addition, as DPWF is located within the Bruce Nuclear Site, the Bruce Power environmental monitoring program potentially captures any environmental impacts emanating from the small contribution of DPWF. The dose to the public from the Bruce Nuclear Site, (potentially including contributions from the DPWF), remain below 2.4µSv/year (0.0024 mSv/year).

G1WF

The effluent monitoring plan assessment conducted in 2021 by CNL determined that there is minimal or no source of airborne radioactivity from routine operations at G1WF. In addition, all liquid releases were discharged through the Gentilly-2 effluent system, operated by Hydro-Québec, and represent a small fraction of the total releases from the larger Gentilly site. Hydro-Québec's Gentilly-2 environmental monitoring program captures any environmental impacts from the small contribution from G1WF. The dose to the public from the Gentilly-2 nuclear site, including contributions from G1WF, remain below 0.01 mSv/year.

NPDWF

NPDWF is no longer discharging liquid effluents from the facility sumps to the Ottawa River, and there were no such releases during the 2022 reporting period. All other releases of radioactive material in NPDWF effluents are a small fraction of their respective DRLs and thus, continue to indicate minimal impact on the public or the environment. CNL's environmental monitoring at CRL will regionally overlap with the NPDWF, so information from CRL's off-site environmental monitoring program could also be considered. CNSC staff have determined that the public dose from NPDWF remains at a very small fraction of the public dose limit.

K. PARTICIPANT FUNDING AWARDED FOR THE 2022 REGULATORY OVERSIGHT REPORT

CNSC staff provided interested communities with notice of the opportunity for funding through the CNSC's Participant Funding Program to review and comment on this report and the opportunity to submit a written intervention and/or appear before the Commission as part of the Commission meeting.

CNSC awarded approximately $72,828.76 in participant funding to assist the following Indigenous Nations and communities, members of the public and stakeholders in reviewing this ROR and submitting comments to the Commission.

Recipient
Algonquins of Pikwanagan First Nation
Manitoba Métis Federation
Hiawatha First Nation
Nuclear Transparency Project
Chippewas of Kettle and Stony Point First Nation
Total: $72,828.76

Further information on the CNSC's Participant Funding Program can be found on the CNSC's website at: http://www.nuclearsafety.gc.ca/eng/the-commission/participant-funding-program/index.cfm

L. SUMMARY OF ENGAGEMENT IN RELATION TO CNSC'S TERMS OF REFERENCE FOR LONG-TERM ENGAGEMENT AND ASSOCIATED WORKPLANS IN 2022

These sections were drafted collaboratively between representatives of the represented Indigenous Nations and Communities below and CNSC staff.

L.1 CNSC- Historic Saugeen Métis Long-term Engagement Terms of Reference

As committed to with the Historic Saugeen Métis (HSM) as part of the Terms of Reference (ToR) for long-term engagement with the CNSC, the update below was prepared in collaboration with HSM representatives.

Following the licence renewal hearing for the Bruce Nuclear Generating Station (BNGS) in 2018, a ToR was agreed upon and signed April 12, 2019, between CNSC staff and the HSM, which ensures that HSM is provided with adequate and meaningful funding, support and capacity to participate in consultation and engagement activities required throughout the year.

Topics of discussion related to the facilities in this ROR included updates and discussions about Douglas Point such as CNSC inspections and HSM's interest in the project.

CNSC staff and HSM representatives collaborated on the IEMP sampling campaign that took place around BNGS in 2022. CNSC staff appreciated the HSM's involvement in the IEMP, through selection of samples and participating in sample collection. Their contributions have helped to strengthen the IEMP. HSM and CNSC staff also discussed how to best share results with HSM community members and committed to working collaboratively once results are available.

While the HSM did not have any outstanding concerns related to the nuclear activities on the Bruce site, they continued to actively participate and make informed contributions to address any potential impacts on HSM rights and interests. CNSC staff plan to continue to engage and update HSM on regulatory activities on a semi-annual basis as agreed upon in the ToR including updates on CNL's Douglas Point decommissioning project and communicating results from the IEMP sampling campaign in 2022.

L.2 Curve Lake First Nation and CNSC Long-term Engagement Terms of Reference

As committed to with Curve Lake First Nation (CLFN) as part of the ToR for long-term engagement with the CNSC, the update below was prepared in collaboration with CLFN representatives.

In 2020, CNSC staff started discussions with CLFN to establish a formal long-term relationship with the community, and a ToR for long-term engagement was signed between the CLFN and CNSC in February 2021. This ToR ensures that CLFN is provided with adequate and meaningful funding, support, and capacity to participate in consultation and engagement activities required throughout the year. As part of the ToR a yearly work plan is developed between the CNSC and CLFN, which provides information on the scope of work, detailed activities, and timelines associated with work items for collaboration and engagement.

In 2022 the work plan included:

- ToR maintenance and updates
- Participation in the CNSC's IEMP
- Updates and discussions on specific Projects and Ongoing Operations of Existing Nuclear Facilities of Interest
- Co-Jurisdictional Matters of Significance (i.e., Fisheries Act Authorization, Emergency preparedness and thermal emissions from Nuclear Generation Stations)
- Information, communication, and other topics (i.e., REGDOC updates, feedback on CNSC reporting and processes, PFP opportunities)
- Developing a plan for a CLFN Indigenous Knowledge Study

In 2022, due to capacity constraints and other priorities CLFN and CNSC were not able to initiate discussions on developing a plan for an Indigenous Knowledge study. However, it is CLFN and CNSC's commitment to develop a plan for a Curve Lake Indigenous Knowledge Study in 2023.

In 2022, CLFN and CNSC staff continued to meet monthly and work collaboratively to make progress on a number of the agreed upon initiatives in the work plan. Through routine monthly meetings and interactions, CLFN and CNSC have developed a good working level relationship; one that has been more conducive to open and direct communications.

Topics of discussion included updates and information sharing with regards to ongoing CNL projects and sites including NSDF, NPDWF and CRL. Discussions were also had regarding the PHAI licence renewal. CNSC staff and CLFN also met to discuss CLFN's involvement in the 2022 IEMP sampling campaign planned near the CRL site. In August 2022, CLFN observers participated in the IEMP sampling activities around the CRL site. Having CLFN representatives participate in the sampling promotes a better understanding of sampling methods and improves input into future sampling in terms of CLFN species of interest, valued components and potential sampling locations.

In 2022, CLFN and CNSC staff worked collaboratively on communication products (such as a KI Pill information sheet and pamphlet for the Cameco Fuel Manufacturing Environmental Protection Review Report) to improve how information is shared with CLFN community members.

In October 2022, CLFN hosted CNSC staff in their community for a lunch and meeting with their leadership. CLFN also shared their knowledge during a tour of the Petroglyphs Provincial Park. These activities were invaluable for building and strengthening the relationship, advancing project-specific discussions and enhancing CNSC staff cultural awareness and understanding. CNSC staff and CLFN are planning on organizing another in-person event in the CLFN community and territory in 2023.

In 2022, CLFN provided feedback through their intervention on the 2021 RORs and continue to do so through ongoing discussions. CNSC staff have made a number of improvements to reports and documentation based on the feedback, such as including land acknowledgements for each facility and creating a separate Indigenous consultation and engagement section. CNSC staff and CLFN are working together to discuss and address the common themes raised in CLFN's interventions.

CNSC staff and CLFN continue to be committed to strengthening the relationship through on-going respectful dialogue to share knowledge, information on culture, history and perspectives that help CNSC staff and CLFN learn from each other. CNSC staff will also continue to have discussions regarding areas of interest and issues or concerns related to existing CNSC-regulated nuclear activities of interest to CLFN.

In 2023, CLFN and CNSC staff are planning to initiate discussions on the scope and approach to a Territory wide study of Indigenous Knowledge and Land Use Study as it relates to CNSC-regulated facilities and activities. Discussions will include the specific funding and capacity needs in order for CLFN to be able to meaningfully participate and complete these important studies and research. CLFN and CNSC staff will also continue to foster and create a safe ethical space for Indigenous Knowledge to be collected and shared.

L.3 CNSC-Mississaugas of Scugog Island First Nation Long-term Engagement Terms of Reference

As committed to with the Mississaugas of Scugog Island First Nation (MSIFN) as part of the ToR for long-term engagement with the CNSC, the update below was prepared in collaboration with MSIFN representatives.

In September 2021, CNSC staff started discussions with MSIFN to establish a formal long-term relationship with the community, and ToR were signed between MSIFN and the CNSC in March 2022. The ToR ensures that MSIFN is provided with adequate and meaningful funding, support and capacity to participate in consultation and engagement activities required throughout the year. As part of the ToR, a yearly work plan is developed between the CNSC and MSIFN, which provides information on the scope of work, detailed activities, and timelines associated with work items for collaboration and engagement.

In 2022, the work plan included:

- Learning about and engaging in the CNSC's IEMP
- Collaborative annual reporting to the Commission and to MSIFN Chief and Council
- Updates and discussions on specific projects and ongoing operations of licensed nuclear facilities of interest
- Enhancing information sharing and communication between the CNSC and MSIFN members
- Emergency management and preparedness

In 2022, MSIFN and CNSC staff continued to meet monthly and work collaboratively to make progress on a number of the agreed upon initiatives in the work plan. In addition, in October 2022, MSIFN hosted CNSC staff in their community for a lunch and meeting with their leadership. The in-person meeting was an important step for building and strengthening the relationship, advancing project-specific discussions and enhancing CNSC staff's understanding of MSIFN priorities and areas of concern. CNSC staff and MSIFN are planning on organizing another in-person meeting and event in the MSIFN community and territory in 2023.

L.4 Algonquins of Pikwakanagan First Nation -CNSC terms of reference for long-term relationship

As committed to with Algonquins of Pikwakanagan First Nation (AOPFN) as part of the ToR for long-term engagement with the CNSC, the update below was prepared in collaboration with AOPFN representatives.

In 2022, CNSC staff and AOPFN representatives started discussions to establish a ToR for a long-term relationship. The ToR were signed on November 30, 2022, providing a formalized structure for ongoing dialogue on CNSC-regulated facilities and activities of interest in the AOPFN traditional territory. As part of the ToR, a yearly work plan was developed between the CNSC and AOPFN that provides information on the scope of work, detailed activities, and timelines associated with work items for collaboration and engagement. The work plan includes activities that CNSC staff and AOPFN will be working to implement throughout 2023 and beyond, including:

- participation in the CNSC's IEMP
- collaborative annual reporting to the Commission and to the AOPFN Chief and Council
- updates and discussions on specific projects and ongoing operations of licensed nuclear facilities of interest
- enhanced information sharing and communication between the CNSC and AOPFN members
- emergency management and preparedness

The following facilities covered in this ROR are of interest in the work plan:

- Chalk River Laboratories
- Nuclear Power Demonstration Closure Project

CNSC staff and AOPFN are committed to continuing to strengthen the relationship through ongoing, respectful dialogue to share knowledge, information on culture and history, and perspectives that help CNSC staff and AOPFN learn from each other. CNSC staff will also continue to have discussions on areas of interest and concern related to CNSC-regulated nuclear activities of interest to AOPFN.

L.5 Saugeen Ojibway Nation- CNSC Long-term Engagement Terms of Reference

As committed to with the Saugeen Ojibway Nation (SON) as part of the ToR for long-term engagement with the CNSC, the update below was prepared in collaboration with SON representatives.

The ToR were signed between the SON and the CNSC in 2019. The ToR ensures that the SON is provided with adequate and meaningful funding, support and capacity to participate in consultation and engagement activities required throughout the year. As part of the ToR, a yearly work plan is developed between the CNSC and SON, which provides information on the scope of work, detailed activities, and timelines associated with work items for collaboration and engagement.

In 2022, the work plan included:

- Joint review and analysis of licensee submissions, particularly around environmental protection
- Participation in the CNSC's IEMP
- Inclusion on the design and review of Bruce Power's study of available mitigation measures for environmental impacts
- SON community outreach
- Sharing the results of CNSC's environmental oversight, such as inspection reports
- Identifying federal, provincial, and municipal decision-making agencies, as needed
- Coordinating meetings with federal and provincial Crown agencies, as needed
- Sharing information on the Western Waste Management Facility, Douglas Point and Nuclear Waste Management Organization's (NWMO) Adaptive Phase Management (APM) initiative

The work plan sets out detailed tasks and timelines for each of these items.

Topics of discussion related to the facilities in this ROR included updates and discussions about Douglas Point.

In 2022, CNSC staff and the SON continued to meet and work collaboratively to complete a number of the agreed upon initiatives in the work plan. These activities included CNSC's funding support for a traditional land use and occupancy study to obtain a baseline inventory of mapped cultural sites in relation to the SON's Territory, including the Territory around the Bruce Power site. However, due to the pandemic and inability to meet with community members in person, this work has been delayed, however is expected to be completed in early 2023.

Work was completed on Bruce Power's mitigation measures study. The outcomes of this process have led to further collaboration between SON and CNSC staff on environmental monitoring as well as future updates to the CNSC's regulatory framework.

CNSC staff and members from the SON community participated in the IEMP sampling campaign for 2022. SON helped to select and provide samples (including fish) that would be meaningful to their community members. As part of IEMP sampling, CNSC staff also conducted outreach activities as well to explain the program as well as health impacts due to radiation.

CNSC staff participated in a number of outreach activities with the SON. Spring and Fall community information sessions were organized by the SON Environment Office staff and were well attended. This provided the opportunity for SON members to ask questions and learn more about how nuclear energy and radiation is regulated in Canada.

Additionally, SON Environment Office staff and CNSC staff provided a joint presentation at the 2022 CNS Conference on the participation by SON in regulatory inspections to share this experience with the nuclear industry.

In addition, the SON completed another year of the Coastal Waters Monitoring Program (CWMP), which is an initiative funded in cooperation with Bruce Power, but was designed, led and implemented by the SON to monitor environmental conditions in the nearshore areas of the Saugeen Peninsula. SON has recently shared with CNSC the 2022 Annual CWMP Report, as has been done in previous years. CNSC staff are interested in the results of the CWMP, as this will provide data that can be used in future environmental risk assessments in relation to the BNGS.

SON has on-going concerns regarding the storage of nuclear waste in their traditional territory. In 2022, CNSC staff provided information on the update to Natural Resources Canada's plans to update Canada's nuclear waste policy. In addition, work is on-going to provide information on how the SON can contribute to and participate in the processes around new nuclear projects in Ontario in which waste may be stored at the Western Waste Management Facility, or a potential deep geological repository sited in SON Territory.

CNSC staff and SON will continue to work collaboratively to address areas of concern, rights, and interests for the SON in relation to the Bruce site, including CNL's Douglas Point decommissioning project.

L.7 Métis Nation of Ontario-CNSC Long-term Engagement Terms of Reference

As committed to with the Métis Nation of Ontario (MNO) as part of the ToR for long-term engagement with the CNSC, the update below was prepared in collaboration with MNO representatives.

Following the licence renewal hearing for the BNGS in 2018, a ToR was agreed upon and signed on December 18, 2019, between CNSC staff and the MNO, which formally documents the engagement with their Nation. As the MNO is a province-wide organization, a specific engagement plan under the Terms of Reference was also signed in December 2019 with MNO Region 7, which is the consultation committee region that includes the Bruce site to address their areas of interest.

In 2022, the engagement plan included:

- Participation in the CNSC's IEMP
- Sharing information on NWMO's APM initiative

- Sharing information on SMRs
- CNSC to support MNO capacity building through professional development workshops
- Communication with MNO citizens

The following facilities covered in this ROR are of interest: Douglas Point.

As per the engagement plan, in 2022, CNSC staff continued to meet with MNO representatives semi-annually to discuss topics such as the Douglas Point decommissioning project, the Bruce Power Major Component Replacement project and the pressure tube findings, OPG's WWMF and NWMO's APM project. CNSC staff worked with MNO to update the work plan to identify areas of collaboration, including environmental monitoring through the IEMP and providing information related to Impact Assessments and Small Modular Reactors. In 2022, MNO representatives participated in the IEMP sample campaign that took place around BNGS. Representatives observed the air sampling station set up by Baie-du-Doré and helped with identifying vegetation in the area that is important to their citizens (e.g., plantains, cattails).

As discussed at Bruce Power's licence renewal hearing in 2018, MNO Region 7 would like to be more involved in environmental monitoring activities and addressing the concerns their citizens have regarding perceived environmental impacts related to the Bruce site. CNSC staff will continue to collaborate and engage with the MNO Region 7 on areas of interest with regards to the Bruce site including CNL's Douglas Point decommissioning project, including the upcoming midterm licence review, on a semi-annual basis as agreed upon in the Terms of Reference.

L.8 Kebaowek First Nation (KFN)-CNSC Long-term Engagement Terms of Reference

As committed to with Kebaowek First Nation (KFN) as part of the long-term relationship arrangement "the Arrangement" with the CNSC, the update below was prepared in collaboration with KFN representatives.

In 2022, CNSC staff and KFN representatives started discussions to establish an Arrangement for a long-term relationship. The Arrangement was signed on September 29, 2022, providing a formalized structure for ongoing dialogue on CNSC-regulated facilities and activities where KFN has identified concerns in relation to a project's construction or existing operations on their rights, interests, culture, current and traditional uses of their territory.

As part of the Arrangement, a yearly work plan is being developed between the CNSC and KFN that provides information on the scope of work, detailed activities, and timelines associated with work items for collaboration and engagement. The work plan includes activities that CNSC staff and KFN will be working to implement throughout 2023 and beyond, including:

- collaborative annual reporting to the Commission and to the KFN Chief and Council

- updates and discussions on specific projects and ongoing operations of licensed nuclear facilities of interest
- enhanced information sharing and communication between the CNSC and KFN members
- opportunities to comment and review policies and regulations including those related to nuclear safety, non-proliferation and Indigenous engagement.

The following facilities covered in this ROR are of interest in the to be developed work plan:

- Chalk River Laboratories
- Nuclear Power Demonstration Closure Project

CNSC staff and KFN are committed to continuing to strengthen the relationship through ongoing, respectful dialogue and the sharing of knowledge, information on culture and history, and perspectives that help CNSC staff learn from KFN. CNSC staff will also continue to have discussions on areas of interest and concern related to CNSC-regulated nuclear activities of interest to KFN.

M. SUMMARY TABLE OF THE STATUS OF ISSUES CONCERNS AND REQUESTS FROM INTERVENORS IN THE 2021 CNL ROR

In direct response to the Commission's action from the 2021 RORs, CNSC staff has established an internal CNSC issues, concerns, and comments tracking table for each intervening Indigenous Nation or Community in the 2021 CNL ROR. These tables also summarize and track CNSC's efforts to respond to and address intervenor requests concerns and comments, where feasible. In the 2021 CNL ROR meeting, the Commission noted the concerns raised by several intervenors that comments and recommendations made regarding past RORs had not been addressed directly by CNSC staff. As a result, the Commission expects to be updated on the status of CNSC staff's efforts to address and track intervenor recommendations across all RORs moving forward. The Commission has directed CNSC staff to provide an update on whether and how comments and recommendations made by Indigenous Nations and communities in particular have been, or will be, addressed, including where there are disagreements.

The purpose of this appendix is to provide a summary of information and data from the CNSC's issues tracking tables to the Commission. The tables below provide an overview of the issues raised in interventions in relation to the previous year's ROR, and the proposed path forward to address them. Table A outlines the number of specific issues and concerns raised by each intervenor and their related themes, as well as CNSC responses and proposed path forward. Table B provides an overview of the key thematic categories raised by each intervenor and the total number of times each theme or topic was raised by all intervenors in their interventions. Tracking this thematic information will provide a baseline to help direct CNSC staff to focus their efforts in future engagements and consultations to areas that generate the most concerns. This is a new ROR initiative and will continue taking shape moving forward as CNSC staff begin tracking trends in intervention topics and track progress with Indigenous Nations and Communities, as well as repeat public intervenors.

Table A: Issues and Concerns Raised in Interventions from Indigenous Nations and Communities from the 2021 CNL ROR Tracking and Response Table

The following table provides details regarding the number of specific issues and concerns raised in the interventions by Indigenous Nations and communities in relation to the 2021 CNL ROR, the number of thematic categories the issues and concerns are grouped by, and the status of the CNSC's approach to responding to and addressing each issue, concern or request raised in the interventions to date.

CNSC staff are committed to responding to and following up with the intervenors below with regards to their interventions and working collaboratively to identify options for a path forward to address the comments, where possible. For Indigenous Nations and communities that have a ToR for long-term engagement with the CNSC, requests, concerns and comments raised in relation to the ROR have been integrated into the engagement work plan and regular meetings with each Indigenous Nation or community, including sharing the specific issues and concerns tracking table with each Indigenous Nation and community in order to verify the data and discuss a path forward for meaningfully addressing their comments.

In addition, CNSC staff have also followed up with Indigenous Nations and communities who the CNSC does not currently have a ToR for long-term engagement with, in order to follow up on or set a path forward on their comments and issues.

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
Algonquins of Pikwàkanagàn First Nation (AOPFN)	9 (falling within 5 main subjects/categories)	9	The issues, concerns and recommendations raised by AOPFN in their intervention for the 2021 CNL ROR are being addressed and discussed with AOPFN through an issues tracking table and regular meetings and the associated workplan in relation to the CNSC-AOPFN ToR for long-term engagement. In addition, CNSC staff reached out to AOPFN to offer to have a specific meeting and discussions to address their concerns, comments, and recommendations from the 2021 CNL ROR. This meeting was held virtually on April 26, 2023. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and impacts on rights.
Manitoba Métis Federation (MMF)	8 (falling within 3 main subjects/ categories)	8	The issues, concerns and recommendations raised by MMF in their intervention for the 2021 CNL ROR are being addressed and discussed with MMF based on an issues tracking table developed by CNSC staff in 2021 designed to track the issues, concerns, and comments that MMF have raised in various interventions over the past few years. CNSC staff has shared the

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
			tracking table with MMF for review and offered to meet to discuss CNSC staff's responses and a path forward on addressing their comments, requests and concerns. CNSC is committed to working with MMF to address each topic to the greatest extent possible. CNSC staff reached out to offer to have a specific meeting and discussions to address MMF's concerns, comments and recommendations in relation to their interventions for the 2021 CNL ROR. This meeting was held virtually on May 1, 2023. In addition, CNSC has offered MMF a ToR for long-term engagement (offered in 2021) as well as funding and capacity support. CNSC staff look forward to hearing back from MMF with regards to working towards finalizing a ToR for long-term engagement, developing a workplan and prioritizing discussions on addressing their comments, concerns and recommendations. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and Environmental Monitoring.
Grand Council Treaty 3	29 (falling within 4	29	The issues, concerns and recommendations raised by Grand

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
	main subjects/categories)		Council Treaty 3 in their intervention for the 2021 CNL ROR are being addressed and discussed with Grand Council Treaty 3 based on an issues tracking table developed by CNSC staff. CNSC staff have reached out to offer to have a specific meeting and discussions to address their concerns, comments and recommendations in relation to the 2021 CNL ROR. CNSC has offered to provide Grand Council Treaty 3 funding and to establish regular meetings to support this work with the CNSC. CNSC staff look forward to hearing back from Grand Council Treaty 3 and making progress on developing the relationship and addressing their comments, concerns and recommendations. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and CNSC Oversight Activities.
Sagkeeng Anicinabe First Nation	9 (falling within 5 main subjects/categories)	9	The issues, concerns and recommendations raised by Sagkeeng Anicinabe First Nation in their intervention for the 2021 CNL ROR are being addressed and discussed with Sagkeeng Anicinabe First Nation based on an issues tracking table developed

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
			by CNSC staff designed to track the issues, concerns, and comments that Sagkeeng Anicinabe First Nation has raised. CNSC staff have reached out to Sagkeeng Anicinabe First Nation to offer to have a specific meeting and discussions to address their concerns, comments and recommendations. CNSC has offered to develop a ToR for long-term engagement and related work plan with Sagkeeng Anicinabe First Nation. CNSC has also offered funding support, should this be of interest to Sagkeeng Anicinabe First Nation in relation to the 2021 CNL ROR. CNSC staff look forward to hearing back from Sagkeeng Anicinabe First Nation and making progress on developing the relationship and addressing their comments, concerns and recommendations. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and impacts to rights.
Curve Lake First Nation (CLFN)	9 (falling within 2 main subjects/categories)	9	The issues, concerns and recommendations raised by Curve Lake First Nation in their intervention for the 2021 CNL ROR are being addressed and discussed with Curve Lake First Nation based on an issues

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
			tracking table designed by CNSC staff and regular meetings and the associated workplan in relation to the CNSC-Curve Lake First Nation ToR for long-term engagement. In addition, CNSC staff reached out to Curve Lake First Nation to offer to have a specific meeting and discussions to address their concerns, comments, and recommendations in relation to the 2021 CNL ROR. CNSC looks forward to working with CLFN to address their comments and recommendations. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and Other (some examples: Nation-specific concerns, comments relating to specific technologies).
Chippewas of Kettle and Stony Point First Nation	18 (falling within 7 main subjects/categories)	18	The issues, concerns and recommendations raised by the Chippewas of Kettle and Stony Point First Nation in their intervention for the 2021 CNL ROR are being addressed and discussed with the Chippewas of Kettle and Stony Point First Nation based on an issues tracking table designed by CNSC staff to track the issues, concerns, and comments that Chippewas of Kettle and Stony Point First Nation have raised.

2021 CNL ROR Interventions from Indigenous Nation and Communities	The number of Requests/ Concerns/ Comments Raised in 2021 ROR intervention	Requests/ Concerns/ Comments Responded to by CNSC staff*	Notes
			In addition, CNSC staff reached out to the Chippewas of Kettle and Stony Point to offer to have a specific meeting and discussions to address their concerns, comments and recommendations in relation to the 2021 CNL ROR. This meeting was held virtually on April 27, 2023. Examples of the themes and issues raised include CNSC's consultation and engagement activities (Indigenous and Stakeholder) and environmental monitoring.

** "Responded to" refers to the number of requests/concerns/comments that CNSC staff have provided dispositions to, responded to directly, or have made requests with intervenors to have a specific meeting and discussions to address their concerns, comments and recommendations. See notes column for more details.*

Engagement with Other Public Intervenors

CNSC staff are committed to engaging with the public and learning more about their values, issues and concerns. Repeat public intervenors, including individuals and civil society organizations, have been reached out to, to follow up on their issues, concerns, and recommendations. This is being facilitated through existing opportunities for engagement and individualized bilateral meetings.

Table B. Interventions by Thematic Category

The following table provides an overview of the key thematic categories raised in the interventions in relation to the 2021 CNL ROR and the number of times each theme or topic was raised in total across all interventions. In total for this ROR last year there were 10 intervenors. Some were positive and did not raise concerns, however, there were a number that raised concerns in the categories outlined below. The categories included in Table B have been ordered from most frequently raised to least. The thematic categories are derived from the review of the 2021 interventions and CNSC staff's analysis of the issues and topics raised.

CNSC staff are committed to continuing to follow up and work with each intervenor in Table A, as well as other repeat individuals and civil society organizations who intervened to continue discussions on how best to address these themes and areas of interest identified in their interventions.

Requests/Concerns/ Comments Category in the intervention for the 2021 CNL ROR	Number of times the topic category was raised across 2021 CNL ROR interventions	Number of Intervenors who raised the topic in intervention
CNSC's Consultation and Engagement activities (Indigenous and Stakeholder) (e.g., suggestions for improvements to the approach to consultation and engagement and request for meaningful responses to issues raised)	41	7
Improvements to ROR process and ROR content (e.g., requests related to: improving accessibility, providing additional information or clarification in specific sections of the report, providing information about the performance rating system and improving the format of the report)	30	2
CNSC Oversight Activities (e.g., suggestions for improvements to the approach to consultation and engagement and request for meaningful responses to issues raised)	25	4
Environmental Monitoring (e.g., requests to be included in the development of monitoring plans and for additional monitoring to occur)	18	6
Waste Management (e.g., concerns about impacts from increased amounts of waste)	5	4
Impacts to Indigenous or Treaty Rights (e.g., concerns about lack of consent from Indigenous Nations and communities in the initial establishment of nuclear operations on traditional territories)	4	2
Indigenous Knowledge (e.g., requests to clarify how Indigenous Knowledge has been considered and	4	3

Requests/Concerns/ Comments Category in the intervention for the 2021 CNL ROR	Number of times the topic category was raised across 2021 CNL ROR interventions	Number of Intervenors who raised the topic in intervention
incorporated)		
Other (some examples: Nation-specific concerns, comments relating to specific technologies)	3	1
Nuclear Emergency Management (e.g., concerns around potential nuclear emergencies and safety processes)	2	2
CNL activities and Engagement (e.g., suggestions for improving CNL's engagement with Indigenous Nations and communities)	2	2
Participant Funding Program (e.g., requests for more funding to support participation in regulatory activities)	1	1
Small Modular Reactors (e.g., concerns relating to the possibility of SMR development)	1	1
Economic Development (e.g., request for more economic opportunities resulting from the nuclear industry)	1	1
Long Term Relationship Development (e.g., requests for additional relationship development activities between the CNSC and Indigenous Nations and Communities)	1	1

Conclusion

CNSC staff take the issues and concerns raised by intervenors seriously and CNSC ROR Project officers with assistance from the Indigenous and Stakeholder Relations Division will continue to work with each intervenor identified in Table A who has raised issues and concerns on identifying approaches to addressing the different topic areas, requests and comments raised as appropriate. Furthermore, the CNSC is committed to continuously improving the quality of data included in RORs, and the ROR reporting process. CNSC acknowledges that the two main themes of issues raised in the 2021 CNL

ROR were “CNSC’s Consultation and Engagement activities” and “improvements to the ROR process and ROR content” and has made it a priority to further discuss and address these issues, where feasible. As part of this commitment, CNSC staff have included appendices in all 2022 RORs with information on the issues and concerns raised by intervenors and the status of the CNSC’s work to follow-up, respond to and address each intervention as appropriate, and are working towards the continued expansion and enhancement of reporting to the Commission on issues tracking and engagement efforts.

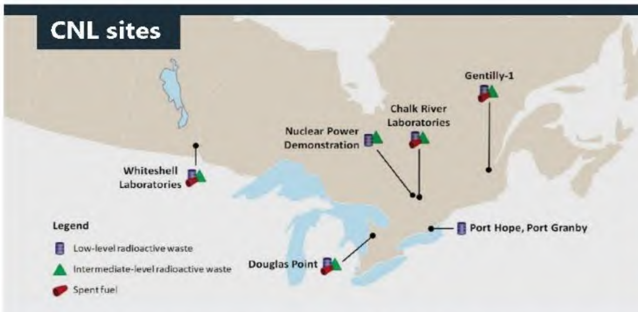
The CNSC is dedicated to continuous improvement, and actively works to identify meaningful ways and approaches for addressing the concerns, comments and recommendations made by intervenors identified in the RORs, where appropriate. In instances where issues and concerns are raised that the CNSC and the intervenor may disagree the CNSC is open to having dialogue and working towards finding solutions and building consensus around key issues within the CNSC’s mandate and authority.

N. ROR DASHBOARD

Regulatory Oversight Report (ROR) Dashboard of Canadian Nuclear Laboratories Sites: 2022

This dashboard gives an overview of the safety performance of Canadian Nuclear Laboratories (CNL) sites and the efforts of the Canadian Nuclear Safety Commission (CNSC) to ensure the safety and protection of the people and the environment around the sites in 2022.

CNL sites



8 CNSC inspectors dedicated to CNL sites

30–40 CNSC staff with regulatory effort at CNL sites

3 CNSC employees working at Chalk River Laboratories site

Safety and control areas (SCAs)

14 SCAs

Chalk River Laboratories and Whiteshell Laboratories were rated as below expectations for the SCAs of Security and Emergency Management and Fire Protection, respectively. Other SCAs for these sites were rated as satisfactory. All other sites were rated as satisfactory for all 14 SCAs.

3 SCAs of focus in the ROR

1. Environmental protection
2. Radiation protection
3. Conventional health and safety

CNSC staff concluded that all CNL sites operated safely in 2022

Activities

61 International Atomic Energy Agency-led safeguards inspections

21 CNSC inspections

73 CNSC notices of non-compliance (NNCs)

Events

59 reportable events

1 event reported to the Commission

All NNCs were of low safety significance and did not impact safety at CNL sites

Maximum doses

Regulatory limit

Estimated dose

Effective dose

The public

0.033 mSv/y — 1 mSv/y

The maximum estimated dose to the public from any CNL site in 2022 was at the Port Granby Project.

Nuclear energy workers (NEWs)

5.48 mSv/y — 50 mSv/y

The maximum effective dose received by a NEW in 2022 across CNL sites was at Chalk River Laboratories.

Public outreach

CNSC staff conducted and participated in more than 10 outreach activities with respect to CNL sites in 2022.

Independent Environmental Monitoring Program

In 2022, CNSC staff conducted independent environmental monitoring around Chalk River Laboratories, Douglas Point and Whiteshell Laboratories. There were no results of concern.

Licensing actions

In 2022, the Commission made the decision to renew the Port Hope Project licence and consolidate with the other Port Hope Area Initiative licences. This new licence was valid starting January 1, 2023.

O. SELECTED WEBSITES

Canadian Nuclear Laboratories - www.cnl.ca

Canadian Nuclear Safety Commission - www.nuclearsafety.gc.ca

CNL Annual Compliance Monitoring Reports via the CNL website - https://www.cnl.ca/environmental-stewardship/performance-reporting/

CNL Regulatory Oversight Reports via the CNSC website - http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/regulatory-oversight-reports/CNL-sites.cfm

Information on CRL via the CNSC website- http://nuclearsafety.gc.ca/eng/reactors/research-reactors/nuclear-facilities/chalk-river/index.cfm

CSA Group - www.csagroup.org/

CSA Group via the CNSC website - https://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/csa-standards.cfm

Information on WL via the CNSC website- http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/whiteshell-laboratories.cfm

Information on DPWF via the CNSC website- http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/douglas-point-waste-facility.cfm

Information on G1WF via the CNSC website- http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/gentilly-1-facility.cfm

Information on NPDWF via the CNSC website- http://nuclearsafety.gc.ca/eng/reactors/research-reactors/other-reactor-facilities/nuclear-power-demonstration.cfm

CNSC's SCA framework via the CNSC website-

1.http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/powerindustry/safety-and-control-areas.cfm

2. http://www.nuclearsafety.gc.ca/eng/resources/news-room/feature-articles/safety-and-control-areas.cfm

Action Levels (AL) via the CNSC website- http://www.nuclearsafety.gc.ca/eng/resources/news-room/feature-articles/radiation-dose-limits-release-limits-and-action-levels.cfm

2022 Annual radionuclides via CNSC Open Government Portal- https://open.canada.ca/data/en/dataset/6ed50cd9-0d8c-471b-a5f6-26088298870e

Independent Environmental Monitoring Program (IEMP) via CNSC website-
http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Plan

WL Environmental Monitoring Plan

Whiteshell Site Documentation

WL-509200-PLA-002
Revision 0

2019 May | mai 2019

UNRESTRICTED | ILLIMITÉE

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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Plan

WL Environmental Monitoring Plan

Whiteshell Site Documentation

WL-509200-PLA-002
Revision 0

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Environmental Management

Reviewed by
Examiné par

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2019 May | mai 2019

UNRESTRICTED | ILLIMITÉE

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Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

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APPENDICES

1. PURPOSE AND SCOPE

This monitoring plan documents details of the Environmental Monitoring Program (EMP) for Whiteshell Laboratories (WL) including the decision for the need and development of the program, and shows how the planned monitoring meets the objectives of the program. It also documents and provides justification for the monitoring activities that are part of the EMP.

The EMP was developed and is executed in such a way as to conform to the *Municipal/Industrial Strategy for Abatement (MISA)* program [1] and the effluent regulations for the Electric Power Generating Sector [2], and to comply with:

a) conditions in the WL Operating Licence [3] and Licence Conditions Handbook [4];
b) the WL framework document, Whiteshell *Laboratories Integrated Environmental Monitoring Program Framework* [5];
c) the Environmental Protection Program procedure, *Environmental Monitoring Program* [6];
d) Canadian Standards Association (CSA) N288.4-10 [7];
e) the WL Environmental Assessment Follow-up Program [8];
f) other applicable regulations and standards; and
g) Canadian Nuclear Laboratories (CNL) policies.

This plan addresses the monitoring of contaminants and meteorological parameters at the WL Site.

This monitoring plan does not address any Effluent Verification Monitoring or Operational Control Monitoring in place at WL as a result of the requirements outlined in the Environmental Protection Program procedure, *Management and Monitoring of Emissions* [9].

This document is primarily intended for use by groups or laboratories which are directly involved in the WL Environmental Monitoring Program.

Note that the EMP is dynamic in nature and is continually evolving. As a result, this plan is current as of its issuance but does not necessarily completely reflect the program after this date. The most current monitoring schedules should always be consulted [10].

2. DEFINITIONS

For terms not defined below, refer to Appendices A and B in 900-509200-PDD-001, *Environmental Protection Program Description Document* [11] and *Environmental Monitoring Program* [6] for definitions and acronyms pertaining to this document. For additional terms, refer to the Acronyms, Abbreviations, and Definitions of Terms web page on the CNL Intranet.

Environmental media	Refers to both biotic and abiotic components of the environment. Environmental media is also referred to as media (or a medium) [7].
Pathway	Route of pollutant from source to receptor through one or more environmental media or compartments [7].
Pathways monitoring	Monitoring contaminant levels in abiotic or biotic components in the environment [7].
Receptor	A biological entity that can be exposed to contaminants or physical stressors, and might be subject to associated effects [7].
Reference area	A sampling area that has no effluent exposure from the facility in question; and has natural habitat features that are similar to those of the exposure areas, including anthropogenic areas [7].
Uncertainty	A quantitative expression of error that results from incomplete knowledge of information about a parameter or value [7].

3. WL SITE OPERATIONS

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares as shown in Figure 3-1. The WL site is owned by AECL and operated by CNL under a licence [3] issued by the Canadian Nuclear Safety Commission (CNSC). The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the east bank of the Winnipeg River. It is downstream from the towns of Pinawa and Seven Sisters Falls, and upstream of the communities of Lac du Bonnet and Pine Falls.

The Whiteshell Reactor-1 (WR-1) organic-cooled experimental test reactor was shut down in 1985. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL.

In 2014, Canadian Nuclear Laboratories (CNL) Ltd. was created as a wholly owned subsidiary of AECL. Implementation of the Government-Owned, Contractor-Operated model was achieved with share transfer of CNL from AECL to Canadian National Energy Alliance (CNEA) in 2015 September.

Activities to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report (CSR) [12] supporting the approval of the Environmental Assessment of the WL Decommissioning Project have been underway since 2003 January.

The major operating facilities are the Shielded Facilities, and the Waste Management Area (WMA). The Shielded Facilities includes the Hot Cell Facility and the Immobilized Fuel Test Facility area which includes a decontamination center and waste processing/handling area. Areas undergoing sampling and characterization activities include WR-1 Reactor Building and Active Liquid Waste Treatment Center (ALWTC). The ALWTC was shut down near the end of 2017, and is now being decommissioned. In total, these facilities are the major sources of radiological airborne effluent releases from the site. The primary source of liquid effluent releases at WL is the process water outfall (Outfall), which discharges continuously to the Winnipeg River. The secondary source of liquid effluent is the sewage lagoon (Lagoon), which is normally discharged semi-annually to the Winnipeg River.

Finally, the site contains numerous smaller non-nuclear facilities, development and analytical laboratories and support facilities (Power House, various workshops, maintenance shops, etc.). Industrial boilers are operated at the Power House to provide steam heating to the majority of the site, while some facilities in the outer areas are heated with propane.

Waste management facilities designed for the storage or disposal of wastes are located in WMA. Radiological and non-radiological contaminants that appear in groundwater down gradient of the WL WMA and other monitoring sites are largely the result of early operations.

More detailed information regarding population, as well as topography, land use, hydrography, and meteorology pertaining to the site is available in the WL Derived Release Limits document [15].

Figure 3-1 Near Field Map of WL Site

4. NEED FOR AN ENVIRONMENTAL MONITORING PROGRAM

The criteria used to determine whether there was a need to establish an EMP for the Whiteshell site are outlined in *Environmental Monitoring Program* [6]. The criteria which were met, thereby requiring the need to establish the EMP, are identified below. Note that only one of the criteria need be met to warrant the establishment of a program.

a) *A governing statute, regulation, licence, or permit requires it;*

Clause 1.8 of the current site Licence [3] and Licence Conditions Handbook [4] states that the "licensee shall implement and report on the progress of the Environmental Assessment Follow-Up Program" which identifies the requirement for maintaining an environmental monitoring program. Clause 11.1 of these two documents also state "The licensee shall implement and maintain an environmental protection program".

b) *The results of an Environmental Risk Assessment (ERA) (or equivalent) indicate a likelihood that the concentration of a contaminant or the intensity of a physical stressor could exceed a Benchmark Value (BV);*
Based on the results of the assessment of the low-level waste trenches (Volume 2 Appendix C of [12]) performed as part of the Comprehensive Study Report for the Whiteshell Laboratories site, there is reasonable likelihood that the concentration of some hazardous substances and/or physical stressors in the soil, surface water and groundwater within the WMA could exceed benchmark values. This is also the case for abandoned active drain lines and previously impacted areas on the main campus of the WL site.

c) *The effective dose to members of an off-site critical group from all radioactive emissions from the site during normal operations and anticipated transients is estimated to exceed 5×10^{-5} Sv (or 0.05 mSv) per yea*r [7][1];

Based on public dose assessments for WL for the most recent five years of normal operation (including anticipated transients), the threshold in *(c)* of 0.05 mSv per year is not exceeded. The calculated effective dose to off-site members of the public (i.e. critical groups) from all radioactive emissions from WL ranged from 0.00004 mSv in 2015 to 0.0014 mSv in 2014.

d) *The potential effective dose to members of an off-site critical group from all radioactive emissions from the site in the event of an accident is estimated to exceed 1×10^{-3} Sv (or 1 mSv) per year* [13];

In the event of a deflagration event inside a standpipe if there were flammable mixtures of gas in the void space of a standpipe and an ignition source, and a pyrophoric fire if there were flammable material and an ignition source this has the potential to result in a

[1] From Annex B 1.6.5 Calculated doses will be compared to the 1 mSv/a public dose limit and the benchmark of 50 uSv/a, which is a trigger for ALARA assessment under CNSC Regulatory Guide G-129

significant airborne release of radioactivity that could result in a dose up to 17 mSv to members of an off-site critical group [14].

e) *There are uncertainties in environmental transfer parameters such that emissions from the site could potentially cause doses exceeding the levels in c) or d); or*

   Emissions from the site are not expected to cause doses exceeding the levels in *(c)* and *(d)*

f) *There are other business reasons, i.e., stakeholder concerns, due diligence, etc.* Stakeholders want assurance that CNL is managing the site in an environmentally responsible manner.

5. SYSTEMATIC INFORMED PLANNING PROCESS

The EMP for WL was developed following a systematic, informed planning process, defined in CSA N288.4-10 [7] as consisting of six iterative steps:

STEP 1: Define the objectives of the EMP (Section 5.1).

STEP 2: Identify the information required to meet the defined objectives (Section 5.2).

STEP 3: Define the boundaries of the EMP (Section 5.3).

STEP 4: Determine how the data collected will be used to achieve the defined objectives (Section 5.4).

STEP 5: Specify performance and acceptance criteria (Section 5.5).

STEP 6: Develop the detailed design of the program that will be implemented to obtain the required data (Section 5.6).

Sections 5.1 to 5.6 provide details on each of these six steps.

The same systematic, informed planning process is applied when making changes to the EMP.

5.1 Step 1: Objectives of the EMP

The objectives of the WL EMP are shared among all of CNL's EMPS and are therefore defined in *Environmental Monitoring Program* [6].

5.2 Step 2: Information Required to Meet the Defined Objectives

In order to identify the information required to meet the defined objectives of the program, a set of monitoring criteria was established and is documented in *Environmental Monitoring Program* [6]. These include criteria that are specific to the environmental media to be monitored, the locations to be monitored, and the parameters to be measured.

Detailed sampling design to address these criteria is described in Sections 5.2.1 to 5.3. Justification is provided, in the context of the criteria, for the locations to monitor, selection of environmental media to sample, and contaminants to monitor for. In addition, further details are provided on the frequency and duration of monitoring based on guidance provided in *Environmental Monitoring Program* [6].

There have been many environmental studies completed in addition to those in the routine monitoring program. This available monitoring information was taken into account in the development of the site's *Comprehensive Study Report* [12], from which its results feed back into the decision making process as to what should be monitored under the routine EMP.

The exercise of identifying information to be obtained was completed both during the initial setup of the program and again over time as the program develops.

5.2.1 Media to be Monitored

The environmental media chosen for monitoring in and around WL include all media that trigger the environmental monitoring criteria.

The environmental media in which radioactive contaminants are measured are those that could contribute to the estimated dose to both human and non-human receptors. The selection of appropriate media is based on an understanding of receptor exposure pathways. A description of the exposure pathways for human receptors living near WL can be found in *Derived Release Limits (DRLs) for AECL's Whiteshell Laboratories* [15] and a description of the exposure pathways for non-human receptors living on or near WL can be found in the CSR [12].

The following principles are considered in the selection of environmental media for pathways monitoring:

- Where practical, monitoring is done near the end of a pathway (i.e. closer to the receptor) to reduce the uncertainties that arise from inaccuracies in the exposure/pathway models and transfer coefficients.
- The fate and distribution of the radionuclides along the pathway linking the source to the receptor are considered when selecting the media to be sampled.
- The mobility of the receptor relative to the area of contamination is considered when selecting the media to be sampled.

The selection of environmental media to be sampled and of contaminants to be measured in each medium also considers the feasibility of sampling the medium, obtaining quantitative results distinguishable from natural background, and obtaining measurements when estimated concentrations have high uncertainty.

A matrix of the relevant environmental media and their relation to the environmental monitoring criteria is summarized in Table 5-1.

5.2.2 Frequency of Monitoring

Subject to the considerations noted in *Environmental Monitoring Program* [6] and N288.4 [7], default monitoring and sample collection frequencies are provided in Table 5-1.

Samples are analyzed at the same frequency as sample collection, except where frequent sub-samples are collected for the purpose of preparing a composite (e.g. drinking water). Concentrations in the environment may vary considerably from point-to-point and day-to-day (due to temperature variations, air and water currents, and other factors). Where variability is high or unknown, a representative sample can be obtained by collecting a composite sample. This sample has a better chance of being closer to the average representative sample than any of the small samples making it up.

Deviations from the default monitoring frequencies are discussed in Section 5.2.2.1 and are justified on a case-by-case basis.

Table 5-1
Criteria and Justification for Monitoring of Environmental Media and Default Frequencies

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	Environmental Media Criteria (q)	(r)	(s)	(t)	(u)	(v)	Justification
Air Quality and Noise	Ambient Air	Continuous measurement by TLDs	Annual change out[3]	×	×	×				(q) Monitoring, and recording of the gamma fields on contact with, and in the immediate vicinity of, each fuelled canister is required by the CCSF FA [26] and SAR [27] documents which are referenced in WL Site Licensing Handbook [4]. Perimeter TLD monitoring is performed as confirmatory monitoring for the CCSF, WMA [14]. Radiation surveys within B100 [25] and B300 [40] are also required. TLD monitoring is also conducted around B100 and B300 Shielded Facilities [43] to confirm background radiation levels. (r) External exposure to, and inhalation of contaminants in ambient air could contribute to the dose to non-human receptors. (s) TLD monitoring in the vicinity of the B200 ALWTC is conducted to monitor the radiation field from the facility. Of particular concern was the MLW storage tank (TK-816) which has been removed. Another area of concern is 7 meters southeast of the ALWTC near active drain line break that occurred in 1980 as stated in the AL [39]. Note: The annual ambient gamma radiation at WL and the surrounding area is monitored by means of thermoluminescent lithium fluoride dosimeters (TLDs).
	Ground Surfaces	Annual Land gamma surveys – must be performed before the first snowfall	Annual	×		×				(q) Contamination could be spread by vehicles that travel between the controlled area and the supervised areas (e.g. WMAs), and by vehicles leaving the WL site. This was described as a potential residual effect in the CSR [12] as per Table 5-2 release of airborne radioactivity. (s) Gamma dose rates are measured annually on and off the WL site. Of particular interest is east side of the AWLTC due to the nature of the activities conducted in the facility and historical spills. Land gamma surveys are also conducted around B100 [44] and B300 Shielded Facilities [43] to confirm background radiation levels. Note: Off-site road monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend

[2] Monitoring frequencies are in line with Environmental Protection Program requirements from 900-509200-STD-010 [6], unless otherwise indicated within this table, and as outlined in Section 5.2.2.1 of this document.

[3] These TLDs may be changed out more frequently at the request of the Facility Manager, or if there was an unexpected increase in activity indicated in the air effluent data, or failure of the air monitoring equipment.

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	(q)	(r)	(s)	(t)	(u)	(v)	Justification
										indicator since it represents an intermediate step in environmental exposure pathways. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed.
	Wet/Dry Deposition	Continuous - Monthly collection	Monthly							Note: Not triggered by any criteria. Monitoring of total wet and dry atmospheric deposits is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways. This monitoring serves to verify the predictions made by the DRL model (i.e. groundshine). It also serves as a baseline for emergency preparedness purposes and provides confirmation of the absence of significant quantities of radioactive particulate material in airborne emissions. This monitoring is part of the WL EAFP [8].
	Noise	Noise Monitoring	At time of activity			×				(s) As identified in the CSR [12] as per Table 5-2, noise during periods of demolition and site restoration could impact some sensitive receptors if conducted during times of wildlife breeding, migration or could negatively impact feeding patterns [12]. Work is to be planned such that these noisy activities are only sporadic, short in duration and limited to daytime.
	Airborne Releases			Airborne releases area monitored as part of the Effluent Verification Monitoring Program (EVMP), the details of which are documented in program specific documentation [16].						
Surface Water and Public Health	Winnipeg River Water	Monthly composite of daily samples, except for K-11 which is monthly composite of weekly samples	Monthly	×	×					(q) (shall) Sampling of river water is required as part of the WL EAFP [8] which is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (r) (shall consider) Immersion in (e.g. swimming, washing, etc.), and ingestion of contaminated river/lake water could potentially contribute to human dose [15]. (o) (may) River water has been identified as a Valued Component to the Sagkeeng Anicinabe [63] and to members of the MMF [64].
	Surface Water Run-off from WMA (Ditch Water)	Periods of Flow[4]		×		×	×			(q) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Surface drainage water shall be sampled and analysed for activity levels monthly during the months when surface

[4] When ditches have flowing water, usually after a rain event (>5 millimetre of rain in a 24-hour period, preceded by at least 48 hours of no precipitation) or snow melt and not more than weekly unless there is some operational concern that triggers additional sampling.

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	Environmental Media Criteria (q)	(r)	(s)	(t)	(u)	(v)	Justification
			At time of sampling							waters are present and not frozen". These two documents are referenced in the WL Site Licensing Handbook [4]. (s) (should) Ditch water is anticipated to contain contaminants/physical stressors of concern as identified in the CSR [12] as per Table 5-2 and should be included in the EMP. (t) (should) Ditch water in which contaminant BVs have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants CSR [12] as per Table 5-2.
	Dugouts	Annual Measurement	At time of sampling			×				(s) (should) These surface and ground waters have the potential for containing contaminants/physical stressors of concern identified in the CSR [12] as per Table 5-2 (leaks from existing facilities or contamination during remediation) and should be included in the EMP. Landfill dugout water is known to have elevated levels of tritium (not above BVs) [28].
	Misc catch trays, Sumps, Excavations, Manholes	Pre-discharge collection	At time of sampling			×	×			(s) (should) These surface and ground waters have the potential for containing contaminants/physical stressors of concern identified in the CSR [12] as per Table 5-2 (leaks from existing facilities or contamination during remediation) and should be included in the EMP. (t) (should) Any environmental media in which contaminant BVs have been exceeded or are predicted to be exceeded as per Table 5-2 should be considered for inclusion in the EMP for measurement of those same contaminants.
	WMA Catch/Containment Tray for Underground Amine Waste Tank[5]	Monthly (when accessible)	At time of sampling			×	×			(s) (should) The water in the catch/containment tray has the potential for containing contaminants/physical stressors of concern identified in the CSR [12] as per Table 5-2 (leaks around existing facilities) and should be included in the EMP. (t) (should) Any environmental media in which contaminant BVs have been exceeded or are predicted to be exceeded as per Table 5-2 should be considered for inclusion in the EMP for measurement of those same contaminants.
Aquatic Biota[6] and Public Health	Fish[7] (walleye, pike, common sucker and whitefish)	Annual Collection (four to six of each type)	At time of sampling	×	×					(q) (shall) Annual sampling is required as part of the WL EAFP [8] which is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (r) (shall consider) Ingestion of contaminated fish could contribute to human dose [15]. Although there were no predicted effects to aquatic

[5] At least quarterly monitoring of the high-level liquid waste tank tray is conducted to confirm there is no leakage from the residue remaining in the storage tanks. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty [28].

[6] Wild rice has been identified as a Valued Component to the Sagkeeng Anicinabe [63]. CNL is currently investigating the locations of harvesting areas down stream of WL site.

[7] Fish netting activities must be in compliance with the annual permit issued under the Fisheries Act (Manitoba). Report of these activities must also be completed as the conditions listed in the permit.

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	Environmental Media Criteria (q)	(r)	(s)	(t)	(u)	(v)	Justification
										biota identified in the CSR [12], annual sampling continues as part of the WL EAFP [8] to verify that prediction. (o) (may) Fish have been identified as a Valued Component to the Sagkeeng Anicinabe [63] and to members of the MMF [64].
	Winnipeg River Sediment (surface)	Annual Measurement	At time of sampling	×						(q) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], annual sampling continues as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations. Implementation of the WL EAFP is listed as WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4].
	Winnipeg River Sediment (depositional zones)	Every twenty years starting (2026)	At time of sampling	×						(q) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], sampling of depositional areas as part of the WL EAFP [8] is required to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations and to verify the predictions in the CSR.. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4]. Note: This frequency is a deviation from 900-509200-STD-010 [6] and follows the frequency defined in WLDP-03704-REPT-007 [36] and EAFP [8] and accepted by the CNSC [37].
	Sediment (Lagoon)	Every five years (starting 1999)	At time of sampling	×						(q) (shall) As part of the WL EAFP [8] " Sewage lagoon Primary and Secondary Discharge pathway soils are required to be collected every five years (starting in 1999)" as per WLDP-03704-ENA-005 [34]. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4].
	Sediment (Landfill Dugouts)	Every five years (starting 2007)	At time of sampling	×						(q) (shall) As part of the WL EAFP [8] "monitoring of the dugouts around the landfill should be continued every 5 years to determine if contamination levels have risen significantly. Enhanced monitoring of the Landfill area should be implemented to detect possible contamination of sub-surface drainage". Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4].
	Game, (Deer, Bear, Grouse, Rabbit) Livestock,	Annual Collection[9]	Analyzed as a sample	×	×					(q) (shall) If environmental monitoring of a media is required by any statute, regulation, licence, or permit that governs the operation of the

[9] Game are obtained by CNL staff through roadkills and/or from local trappers. Animal collection activities must be in compliance with the permit issued under the Wildlife Act. Reporting of these activities must also be completed as per the conditions listed in the permit. Species (normally deer, moose, bear, grouse or rabbit) sex and age should be report to the WL Environmental Specialist along with the radioactivity in Bq/kg, fresh weight for flesh (and bone - for deer/moose). Livestock are obtained by EnvP staff from local farmers/farmer's markets.

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	(q)	(r)	(s)	(t)	(u)	(v)	Justification
Terrestrial Biota and Human Health	(Beef/Pork/Lamb/Poultry)[8], Honey		set annually							nuclear facility, or otherwise directed by a regulator, then that media shall be included in the EMP. Annual sampling is required as part of the WL EAFP [8]. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4]. (r) (shall consider) Ingestion of contaminated game, beef, pork, poultry, eggs and/or honey could contribute to human dose [15]. Milk was analyzed for radioactivity in 2017 [46] and all parameters were at background levels. This media has been removed from the program. Although there were no predicted effects to terrestrial biota identified in the CSR [12], annual collection continues as part of the WL EAFP [8] to verify that prediction. (o) (may) Game and honey have been identified as Valued Components to the Sagkeeng Anicinabe [63] and to members of the MMF [64].
	Native Vegetation (mixed grasses, weeds and clover)	Annual Measurement	At time of sampling	×		×	×			(q) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Samples of vegetation shall be collected annually and analysed for any changes in activity from normal background levels." These documents are referenced in the WL Site Licensing Handbook [4]. (s) (should) Although no residual effects are expected, deer consumption of vegetation in and around the WMA is a concern identified in the CSR [12] and this monitoring should be included in the EMP to verify no effect. (t) (should) Native vegetation within the WMA is known to have contaminants that exceed, or are predicted to exceed, BVs and should be considered for inclusion in the EMP for measurement of those same contaminants [46].
	Garden Vegetables (fruit (including berries), root, leafy (include mushrooms)) and Canola	Annual Measurement	At time of sampling	×	×					(q) (shall) Although, no residual effects were identified for terrestrial biota, annual sampling is required as part of the WL EAFP [8] to confirm effects predictions. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4]. (r) (shall consider) Ingestion of contaminated vegetables or crops could contribute to human dose [15]. (o) mushrooms and berries have been identified as a Valued Components to the Sagkeeng Anicinabe [63] and to members of the MMF [64].
Soil (Geology)	Soil – WMA	Annual and periodic measurements	At time of sampling	×		×	×			(q) (shall) Impacted areas shall be characterized and remediated to clearance levels as per the WL EAFP.[8], and in accordance with the WL Closure Land-Use and End-State criteria [33]. The frequency of sampling

[8] Monitoring of milk was conducted in 2017 [46] and there is no indication of impact. This monitoring would be initiated if beef results indicate uptake. Eggs have not been monitored but would be if the results from poultry meat indicate uptake.

Environmental Component	Media	Monitoring Frequency	Analysis Frequency[2]	Environmental Media Criteria (q)	(r)	(s)	(t)	(u)	(v)	Justification
										and parameters to be tested for are included in this plan and also detailed in WLDP-03704-ENA-005 [34]. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4]. (s),(t) (should) Soil within the WMA is known to have contaminants [46] that exceed, or are predicted to exceed, BVs and should be considered for inclusion in the EMP for measurement of those same contaminants.
	Soil – Lagoon Discharge path	Every five years (starting 1999)	At time of sampling	x						(q) (shall) Impacted areas shall be characterized and remediated to clearance levels as per the WL EAFP.[8], and in accordance with the WL Closure Land-Use and End-State criteria [33] and as per WLDP-03704-ENA-005 [34]. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4].
	Soil – Main Campus	Continuous, as impacted areas are identified and remediated and pre-clearance	At time of sampling	x						(q) (shall) Impacted areas shall be characterized and remediated to clearance levels as per the WL EAFP.[8], and in accordance with the WL Closure Land-Use and End-State criteria [33]. Implementation of the WL EAFP is WL Site Licence condition 1.8 [3].and referenced in WL Site Licensing Handbook [4].
Groundwater	Groundwater is monitored as part of the Groundwater Monitoring Program (GWMP), the details of which are documented in program specific documentation [35].									

Criteria:

(q) (shall) If environmental monitoring of specific media is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that media shall be included in the EMP..

(r) (shall consider) Any environmental media that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the EMP.

(s) (should) Any environmental media for which contaminants/physical stressors of concern were identified in an ERA (or equivalent) should be included in the EMP.

(t) (should) Any environmental media in which contaminant benchmark concentrations have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants.

(u) (should) Selection of the environmental media to be monitored should be based on the following principles:

- i) Where practical, monitoring should be done near the end of a pathway (i.e., closer to the receptor) to give dose/exposure estimates with fewer uncertainties that arise from inaccuracies in the models and transfer coefficients;
- ii) The fate and distribution of contaminants along the pathway linking the source to the receptor should be considered when selecting the media to be sampled; and
- iii) The mobility of the receptor relative to the area of contamination should be considered when selecting the media to be sampled.

(v) (should) Final selection of environmental media to be sampled and of contaminants to be measured in each medium should consider the feasibility of

- i) Sampling the medium;
- ii) Obtaining quantitative results distinguishable from background; and
- iii) Obtaining measurements when estimated concentrations have high uncertainty.

(o) (may) The choice of contaminants to monitor in the environment may also be based on the following:

- iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc.

5.2.2.1 Deviation from the default monitoring frequency

In certain circumstances, the EMP deviates from the default monitoring frequencies provided in Table 5-1.

When setting the sample collection frequency, a reduced frequency is considered in cases where:

- expected temporal variability in concentrations and/or conditions is low;
- capital and operating costs are high;
- the default frequency may lead to significant losses or uncertainties;
- the half-life of the radionuclide(s) being monitored is much longer than the default monitoring or sample collection frequency;
- concentrations of the radionuclide(s) being monitored are very low (at or near detection levels); and
- the likelihood of concentrations approaching or exceeding a BV is negligible.

When setting the sample collection frequency, an increased frequency is considered in cases where:

- there is high variability in releases at the source;
- expected temporal variability in concentrations and/or conditions is high (more variable quality may require more frequent sampling to obtain sufficiently precise estimates of contaminants);
- capital and operating costs are low;
- the half-life of the radionuclide(s) being monitored is much less than the default monitoring or sample collection frequency – collection frequency should not normally exceed two half-lives in such cases; and
- concentrations of the radionuclide(s) being monitored are very high (at or near BVs) and the likelihood of concentrations approaching or exceeding a BV is high.

When setting the analysis frequency, a reduced frequency (i.e. less than the sample collection frequency) is considered in cases where:

- analysis costs are large relative to sampling costs;
- analysis is labour/time intensive; and
- the objective is to estimate the mean of a population. (Note: Composite samples can produce equally precise or more precise estimates, compared to non-composite samples, with fewer analyses.)

5.2.3 Duration of Monitoring

The routine monitoring outlined in this Plan is intended to continue indefinitely unless a change is justified. The process for making modifications to the EMP is described in Section 6.

5.2.4 Sampling and analysis

The collection of environmental samples is conducted by the WL Environmental Management field team. The analysis of the environmental thermoluminescent dosimeters (TLDs) is conducted by Dosimetry Services. Analysis of all other environmental samples is conducted by, or sent to a Contract Lab by, Environmental Management staff. Detailed sampling and analysis methods are described in laboratory specific procedures per [49]. Specific analysis methods used for each parameter are given in Table 5-12.

The Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. This is discussed further in Section 5.5.

5.2.5 Locations to be Monitored

Locations on the site which are in need of monitoring were determined by reviewing potential areas with the *Need for Monitoring Criteria – Location* as outlined in the *Environmental Monitoring Program* procedure [6]. The rationale used in the selection of locations to be monitored in the EMP is discussed below, and a matrix of the monitoring locations and their relation to the environmental monitoring criteria is presented in Table 5-3.

Areas identified in the Environmental Assessment (EA)

The locations monitored in the EMP represent the areas in which contaminants of concern were identified in the CSR [12] for WL. The CSR (WL EA) describes the stressors and possible residual effects arising from WL decommissioning and summarized in Table 5-2. The CSR further defines the areas subject to those stressors and possible effects, and identifies the receptors (both human and non-human) potentially affected. The stressors of potential concern that were identified, and the areas and receptors potentially affected are summarized below:

- Surface water contamination in the Project Study Area and potential migration to the Winnipeg River from the WMA, buried services and affected lands.
- Potential for groundwater contaminant migration to the Winnipeg River from the WMA, sewage lagoons and the inactive landfill.
- Winnipeg River and selected fish species (Sturgeon, Walleye, Pike and Mooneye).
- Winnipeg River Shoreline and Gullies and Ravines on site.
- Deer and moose - the risk is that these may graze in areas affected by groundwater contamination.
- Coniferous Forest on site.

- Loss of archaeological sites in the region.
- Noise
- During Decommissioning and Institutional Control period, the use of some lands will be restricted.

Table 5-2
Summary of Residual Effects from WL Decommissioning Activities

Category	Description of Residual Effect	Potential Spatial Effect	Facility/Source
Air Quality and Noise	Release of airborne radioactive particulates during disconnecting of services, decontamination retrieval and repackaging of materials and remediation	On-site	ALWTC, WR-1, B300, Decontamination Centre, B402 WMA, Buried Services, Affected Lands, North Ditch, River Sediments
	Release of airborne radioactive particulates during demolition of canisters	On-site	Concrete Canisters
	Nuisance dust and fine particulates from building demolition, and site restoration and rehabilitation	On-site	All Building Demolition
	Production of methane gases from landfill	On-site	Inactive Landfill
	Noise during demolition and site restoration	On-site	All Building Demolition
Surface Water (hydrology)	Surface water contamination associated with migration of decontamination process water, the removal of drains and other buried services and remediation	Off-site Winnipeg River	Buried Services, WMA, Affected Lands, North Ditch
	Discharge of treated water flows into Winnipeg River (active and inactive)	Off-site Winnipeg River	ALWTC, Sewage Lagoon
	Leaks into surface water from in-situ trenches	Off-site Winnipeg River	WMA
Soil and Groundwater (geology and hydrology)	Soil and Groundwater contamination during operations	Off-site Winnipeg River	WMA, Sewage Lagoons
	Contamination from leaks around existing facilities or contamination during remediation	Off-site Winnipeg River	Off-site Contaminated Lands, Sewage Lagoons, Buried Services, Affected Lands, North Ditch
	Leachate from in-situ trenches	Off-site Winnipeg River	WMA
	Leachate from remediated facilities	Off-site Winnipeg River	Inactive Landfill
Terrestrial Biota	No residual effects identified		
Aquatic Biota	No residual effects identified		
Worker Health and Safety	No residual effects identified		
Socio-economics	No residual effects identified		

Category	Description of Residual Effect	Potential Spatial Effect	Facility/Source
Public Health	No residual effects identified		
Physical and Cultural Heritage	Potential to disrupt traditional uses of the Winnipeg River	Off-site Winnipeg River Shoreline	Shoreline
Land and Resource Use	Land-use restriction associated with in-situ disposal of radioactive waste	On-site	WMA
	Land-use restrictions associated with in-situ disposal of non-radioactive waste	On-site	Inactive Landfill
Archaeology	Artifact loss during excavation near shorelines of the Winnipeg River	On-site Shoreline	Sewage Lagoon, Outfall shoreline
Aboriginal Interests	General interest in the project especially as it affects the Winnipeg River. Artifact loss during excavations near the shores of the Winnipeg River	On-site shoreline	Sewage Lagoon, Outfall shoreline

Monitoring near critical groups

A large portion of the off-site locations monitored in the EMP are representative of WL's critical groups. As part of the DRL calculations, doses were modelled for a number of potential critical groups (Figure 3-1) selected based on lifestyle and proximity to WL. Monitoring is done near all potential critical groups, with the focus being on the critical groups that are likely to receive the highest radiation doses as a result of WL operations.

While human exposures (i.e. doses to WL critical groups) do not approach regulatory dose limits, routine monitoring near critical group locations is required in order to meet the regulatory requirement for an annual public dose assessment. It also contributes to identification of the most-exposed group(s) and important exposure pathways, to ensure that these receptors and pathways are considered in calculating DRLs for WL according to CSA N288.1 [17] and Candu Owner's Group (COG) [18] guidance.

For the critical groups that are subject to annual dose assessments, it is necessary to measure radioactive contaminant concentrations in environmental media along applicable/critical exposure pathways. Not all environmental media identified in Table 5-1 represent exposure pathways to each critical group. The decision to monitor specific media are based on the environmental pathways models for WL described in *Derived Release Limits (DRLs) for AECL's Whiteshell Laboratories* [15], and the results of historic effluent and environmental monitoring.

Monitoring in nearby population centres

In cases where there is public concern regarding emissions, monitoring is established in nearby population centres other than locations of identified or potential critical groups, or identified in the CSR (WL EA) [12] and Sagkeeng Land Use and Occupancy Study [63] (Figure A-13).

Benchmark value exceedances

Certain on-site locations are included in the EMP because BVs have been exceeded or are predicted to be exceeded there. The surface water BVs for WL are listed in Table 5-11.

In order to identify locations where surface water BVs are predicted to be exceeded (e.g. WMA ditches) for the purpose of Table 5-3, surface water concentrations at all monitored locations (with the exception of those locations that have already been found to exceed the BVs) were compared to the BVs for WL Table 5-11. However, it is used as a conservative means to indicate where there is the potential for a BV to be exceeded.

Verifying the effectiveness of containment and effluent controls

Monitoring of surface water, ambient air, direct radiation, and deposition serves to verify the effectiveness of containment and effluent controls. Where monitoring is being done for this purpose, the basic design aspects of the monitoring locations (i.e. specific monitoring location, parameter(s) to be monitored, and the frequency of monitoring) take into consideration several principles, as described below;

Surface Water

Monitoring of surface water at locations downgradient of, and within reasonable proximity to, points of groundwater discharge are included in the EMP. Monitoring at these locations is intended to provide feedback to the Groundwater Monitoring Program (GWMP). The evaluation of the groundwater results together with the surface water results is done at the GWMP's annual Environmental Performance Review, and as part of the annual EMP Report. Locations that fall under this category include the WMA ditch locations and water that accumulates in excavations within the WMA as shown in Figures A-6 and A-7. Surface hydrology is taken into consideration in the selection of monitoring locations. There is only one main drainage basin identified for WL, the WL WMA Drainage Basin (Figure A-10).

Monitoring to evaluate the environmental performance of specific facilities that contain significant quantities of hazardous materials in dispersible form (i.e. monitoring for leak detection), where releases could escape detection by other monitoring means (e.g. facility-specific monitoring, groundwater monitoring), is included in the EMP where needed. Monitoring to meet this purpose is done in locations within reasonable proximity to the points of discharge and in the likely path of the discharges. Locations that fall under this category include WMA ditch locations, water that accumulates in sumps, excavations, Landfill dugouts and manholes. Figure A-12 shows the WL Site Conceptual Model indicating the Contaminant Transport from WL Waste Management Area, Landfill, Lagoon and Main Campus Affected Areas to the Winnipeg River.

Wet and dry deposition

Monitoring to verify wet and dry deposition rates and direct radiation resulting from WL airborne releases is achieved through a network of monitors (ARMS) located at the site boundary, and at strategic off-site locations. Monitoring locations established for this purpose, in most cases, are selected to be within the main upriver and downriver windrose sectors.

Direct radiation

Where monitoring of direct radiation (e.g., TLDs) is being undertaken in areas affected by airborne effluents from the WL site, monitoring at locations within reasonable proximity to the site and in the prevailing wind direction are included in the EMP. Monitoring at these locations is intended to provide feedback to the Effluent Verification Monitoring Program. Locations that fall under this category include: Controlled Area Fence, WMA Perimeter Fence, and Canister Area Perimeter Fence, and Land Gamma Survey of Roads.

Reference areas

In addition to the locations mentioned above, areas with similar environmental conditions but without the potential for facility-related effects are included in the EMP as reference locations to provide information on “normal” variations in natural background radiation and are included in Table 5-3.

Table 5-3
Need for Monitoring of Locations

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
Air Quality and Noise											
	Ambient Air										
On-site (Main Campus) TLDs (see Figure A-1): The annual ambient gamma radiation at WL and the surrounding area is monitored by means of thermoluminescent lithium fluoride dosimeters (TLDs). Six of these locations, labelled ARMS, have been monitored since 1966. The locations of the ARMS are indicated on Figure A-2. Five of the ARMS stations are situated within 4 km of the Building 100 stack and are arranged according to the prevailing wind direction. The sixth is located near Pinawa, about 11 km to the east-southeast. Starting in 1986, twelve TLD packages were mounted at various locations along the fence enclosing the WL site active area. Another series of twelve TLD packages were installed in 1987 along the WMA fence (see Figure A-3), and in 1994 a series of ten were installed along the Canister Area fence (see Figure A-4). The TLD package system (4 TLDs per package) was changed to a TLD holder assembly system (two TLDs per badge) in 2017.											
(a) Controlled (Active) Area Fence											(f) (should) TLD monitoring in the vicinity of the B200 ALWTC is conducted to monitor the radiation field from the facility. Of particular concern was the MLW storage tank (TK-816) which has been removed. Another area of concern is 7 meters southeast of the ALWTC near active drain line break that occurred in 1980 as stated in the AL [39]. Radiation surveys within B100 [25] and B300 [40] are also required. TLD monitoring is also conducted around B100 and B300 Shielded Facilities [43] to confirm background radiation levels.
AAF-001 to 003	AAF South Fence (3 locations)						×				
AAF-004 to 006	AAF East Fence (3 locations)						×				
AAF-007 to 009	AAF North Fence (3 locations)						×				
AAF-010 to 012	AAF West Fence (3 locations)						×				
(b) WMA Perimeter Fence							×				(f) (should) Perimeter TLD monitoring is performed as confirmatory monitoring for the WMA [14] and as per [31].
WMP-002 to 004	WMA West Fence (3 locations)						×				
WMP-005 to 007	WMA North Fence (3 locations)						×				
WMP-008 to 010	WMA East Fence (3 locations)						×				
WMP-011, 012, 001	WMA South Fence (3 locations)						×				
(c) Canister Area Perimeter Fence											(f) (should) Monitoring, and recording of the gamma fields on contact with, and in the immediate vicinity of, each fuelled canister is required by the CCSF FA [26] and SAR [27] documents. Perimeter TLD monitoring
CAP-NW, CAP-NE	CAP North Fence (2 locations)						×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
CAP-ENCAN, CAP-ENWMA, CAP-ESCAN, CAP-ESWMA	CAP East Fence (4 locations)						×				is performed as confirmatory monitoring for the CCSF,
CAP-SE, CAP-SW	CAP South Fence (2 locations)						×				(f) (should) Monitoring, and recording of the gamma fields on contact with, and in the immediate vicinity of, each fuelled canister is required by the CCSF FA [26] and SAR [27] documents. Perimeter TLD monitoring is performed as confirmatory monitoring for the CCSF,
CAP-WS, CAP-WN	CAP West Fence (2 locations)						×				
Site Boundary TLDs (see Figure A-2)											
Ambient Radiation Monitoring Stations											
ARMST1	WL Perimeter, 3.2 km North, ARMS1		×						×		b) (shall) Air Effluent Critical groups C, B and E [15] are within Ambient Radiation Monitoring stations (ARMS) and critical groups A, D and F are within a 5 km radius of the site. h) (should) This location serves as a background location for comparison to locations within the WMA [28].
ARMST2	WL Perimeter, 4.3 km ESE, ARMS2	Location is no longer accessible									
ARMST3	WL Perimeter, 3.4 km SSE, ARMS3		×						×		
ARMST4	WL Perimeter, 2.2 km W, ARMS4		×						×		
ARMST5	WL Perimeter, 2.4 km NW, ARMS5		×						×		
Off-Site TLDs (see Figure A-2)											
Pinawa											
006	Pinawa Town Yard, ARMS6 (TYARDT) (2 locations)		×						×	×	b) (shall) Air Effluent Critical groups C, B and E [15] are within Ambient Radiation Monitoring stations (ARMS) and critical groups A, D and F are within a 5 km radius of the site. h) (should) This location serves as a background location for comparison to locations within the WMA [28]. i) (should) Monitoring provides confirmation to the public that there has been no deposition of radioactivity of concern in these areas [15] [12].
007	Pinawa Hospital		×						×	×	
008	Pinawa Golf Course		×						×	×	
STACK TLDs											
HCF	HCF Stack	×									(a) (shall) These TLDs are in place as required by the B300 Shielded

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
IFTF	IFTF Stack	×									Facilities [43] SAR to confirm air effluent emissions and provide back-up monitoring should the air monitoring equipment fail.
	Ground Surfaces - Land Gamma Survey of Roads										Land gamma measurements within a ~20 kilometer radius of the WL site.
On-site Controlled (Active) Area Roads											
A01-WL	Building 401 into active area						×				(f) (should) Gamma dose rates are measured annually on and off the WL site. Of particular interest is east side of the AWLTC due to the nature of the activities conducted in the facility and historical spills. Land gamma surveys are also conducted around B100 [44] and B300 Shielded Facilities [43] to confirm background radiation levels. Note: This monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed.
A02-WL	South side Building 300						×				
A03-WL	West side of Building 300						×				
A05-WL	South side of Bldg. 200 & Bldg. 411						×				
A06-WL	East of Building 100						×				
A08-WL	East Gate to Building 401						×				
On-site Uncontrolled (Outer Area) Roads											
A09-WL	North Road at Lagoon Road						×				(f) (should) Gamma dose rates are measured annually on and off the WL site [46]. Note: This monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways [15]. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored
A12-WL	East Road at Canister Area						×				
A13-WL	East Road at WMA Gate						×				
A14-WL	East Road at Landfill Site						×				
A-15-WL	SMAGs						×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
											or processed.
Off-Site Roads (see Figure A-5)											
B01-WL	Road at ARMS #1									×	(i) (should) Monitoring provides confirmation to the public that there are no emissions of concern in these areas. Gamma dose rates are measured annually on and off the WL site [46]. Note: This monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways [15]. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed.
B02-WL	Riverland School									×	
B03-WL	Highway 520 at Old Pinawa									×	
B04-WL	Junction of Highway 313 and Highway 520									×	
B05-WL	Black Bear Golf Course									×	
B06-WL	Junction of Highway 433 and Lagsdin Way									×	
B07-WL	Junction of Wendigo Road and Lettonia Lane									×	
B08-WL	West Side of Lac du Bonnet Bridge									×	
B09-WL	Lac du Bonnet Circuit									×	
B10-WL	Natural Resources and Government of Lac du Bonnet									×	(f) (should) Gamma dose rates are measured annually on and off the WL site [46]. (i) (should) Monitoring provides confirmation to the public that there are no emissions of concern in these areas. Gamma dose rates are measured annually on and off the WL site [46]. Note: This monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways [15]. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed.
B12-WL	Plant Road and Highway 211						×				
B13-WL	Highway 211 and Rifle Range						×				
B14-WL	Pinawa Stage 1						×				
B15-WL	Pinawa Stage 2						×				
B16-WL	Plant Parking Lot						×				
B17-WL	Junction of Highway 11 and Highway 211						×				
B18-WL	Junction of Highway 11 and Highway 307						×				
B19-WL	Junction of Highway 11 and Highway 44						×				
B20-WL	Road Side Park Highway						×				(f) (should) Gamma dose rates are measured annually on and off the WL

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	44										site [46]. Note: This monitoring is not used directly in estimating dose to human receptors. It is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways [15]. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed.
B21-WL	Seddons Corner						×				
B22-WL	Highway 214 (transfer station) close to Seddons Corner						×				
B23-WL	Milner Ridge Correctional Center						×				
B24-WL	Milner Ridge						×				
B25-WL	Halfway between Milner Ridge and Junction of Highway 11 and Highway 214						×				
B26-WL	Junction of Highway 11 and Highway 214						×				
C01	Bridge to Seven Sisters						×				
C03	Town Circuit at Dam						×				
C04	River Hills						×				
C07	End of Lee River Road						×				
C21	Bilan Road Highway 317 (214)						×				
	Wet Dry Deposition										
006	Pinawa Town Yard										No criteria is triggered for this location. Note: Monitoring of total wet and dry atmospheric deposits is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways. This monitoring serves to verify the predictions made by the DRL model (i.e. groundshine). It also serves as a baseline for emergency preparedness purposes and provides confirmation of the absence of significant quantities of radioactive particulate material in airborne emissions. This monitoring is part of the WL EAFP [8].
Surface Water and Public Health											

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	Winnipeg River Water (see Figure A-2)										
Pinawa (SFD) Winnipeg River Upstream	Water Collected daily by Municipal staff at Pinawa Water Treatment Center								×		h) (should) This location serves as a background location for comparison to locations downstream of the WL processed outfall.
Winnipeg River Water Location (K-11)	Closest location to critical group (Farm A) [15] Collected weekly by EM staff Near shoreline		×	×		×	×				b) (shall) Closest location to liquid effluent critical group (Farms A and F) [15] (c) (should) This location is the closest downstream location, from the processed outfall, sampled. Potential effects to Winnipeg River water were identified in the CSR as per Table 5-2. (e) (may) The gradient in contaminant concentration is expected over a spatial extent, this monitoring locations is along the gradient [15]. (f) (should) This environmental monitoring is being done to verify the effectiveness of containment and effluent controls, this monitoring location is within reasonable proximity to the points of discharge and in the likely path of the discharges [15] of the processed outfall and lagoon discharge.
Lac du Bonnet (LDB)	Sample collected daily by Municipal staff at Water Treatment Center					×				×	(e) (may) The gradient in contaminant concentration is expected over a spatial extent, this monitoring location is along the gradient [15]. i) (should) This locations is at the closest downstream population centres (other than locations of identified or potential critical groups or locations identified in an ERA, or equivalent) for the most dominant contaminants and environmental pathways and where there is public concern regarding emissions [12] and [15].
Great Falls Dam (GFD) Power Dam	Sample collected daily by Manitoba Hydro staff at Power Dam					×				×	(e) (may) The gradient in contaminant concentration is expected over a spatial extent, this monitoring location is along the gradient [15]. i) (should) This locations is at the closest downstream population centres (other than locations of identified or potential critical groups or locations identified in an ERA, or equivalent) for the most dominant contaminants and environmental pathways and where there is public concern regarding emissions [12] and [15].

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	Waste Management Area - Surface Water Run-off (Ditch Water)[10] (See Figures A-5, A-6 and A-7)										
East of WMA (WMA-1)	Former Building 503 location								×		h) (should) This location serves as a background location for WMA ditch water. This ditch may contain run-off from the Inactive Landfill or historical operations at Building 503 or Cs-pond remediation work.
East of WMA (WMA-2)	Closer to WMA, just east of dam								×		h) (should) This location serves as a background location for WMA ditch water. This ditch may contain run-off from the Inactive Landfill or Cs-pond remediation work.
SE of WMA (WMA-3)	Outlet of swale east of ILW bunkers	×		×	×	×	×				(a) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Surface drainage water shall be sampled and analysed for activity levels monthly during the months when surface waters are present and not frozen". These documents are referenced in WL Site Licensing Handbook [4]. (c) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (d) (should) As per the 2017 WL Annual Safety Report [28], some parameters at these locations have exceeded the drinking water screening levels and/or are above background levels. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) These locations were chosen to verify the effectiveness of containment and effluent controls, and are within reasonable proximity to the points of discharge and in the likely path of the discharges. Surface water sampling is conducted as part of the Monitoring and Surveillance [31] for the WMA and as part of the Periodic Inspection Plan for the WMA Concrete bunkers [32].
SW of WMA (WMA-4)	Between WMA and Canisters	×		×	×	×	×				
SW of Canisters (WMA-5)	Southwest corner of Canister fence	×		×		×	×				(a) (shall) The Concrete Canister Storage Facility states that "Surface drainage water shall be sampled, at a minimum at the locations shown in the "Whiteshell Laboratories Concrete Canister Storage Facilities

[10] WMA Ditch Locations 8, 9 and Control are considered direct effluents to the Winnipeg River and are included in the Effluent Monitoring Plan

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
West of Canisters (WMA-6)	In ditch along the west Canister fence	×		×		×	×				Annual Safety Review- 1997", (AECL-MISC-378-97), and analyzed for activity levels monthly during the months when surface waters are present and not frozen." A similar statement is made in the Safety Analysis Report [27] for the CCSF. These documents are referenced in WL Site Licensing Handbook [4]. (c) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) These locations were chosen to verify the effectiveness of containment and effluent controls, and are within reasonable proximity to the points of discharge and in the likely path of the discharges.. Surface water sampling is conducted as part of the Monitoring and Surveillance [31] for the WMA and as part of the Periodic Inspection Plan for the WMA Concrete bunkers [32].
Road West of Canisters (WMA-7)	At junction of the road to WMA and the road leading to RM of LDB	×		×		×	×				
Drill Site Rd (WMA-10)	At junction of the Drill Site road and the road leading to RM of LDB	×		×		×	×				
West Side of WMA (WMA-12)	Ditch between LLW #1 and LLW #2	×		×	×	×	×				(a) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Surface drainage water shall be sampled and analysed for activity levels monthly during the months when surface waters are present and not frozen". These documents are referenced in WL Site Licensing Handbook [4]. c) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (d) (should) Any locations in which contaminant BVs have been exceeded or are predicted to be exceeded should be included in the EMP [12]. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the
East side of WMA (WMA-13)	East side ditch between Trench 1 and Trench 15 and near Trench 16	×		×	×	×	×				
NW Corner of WMA (WMA-15)	Northwest corner of WMA ditch system	×		×	×	×	×				
NW of WMA (WMA-19A)	Northwest of SMAGs	×		×	×	×	×				
North Center of WMA (WMA-19B)	Northeast of SMAGs	×		×	×	×	×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
NE of WMA (WMA-19C)	Northeast of former Cs pond soil pile in WMA	×		×	×	×	×				gradient [15]. (f) (should) These locations were chosen to verify the effectiveness of containment and effluent controls, and are within reasonable proximity to the points of discharge and in the likely path of the discharges. Surface water sampling is conducted as part of the Monitoring and Surveillance [31] for the WMA and as part of the Periodic Inspection Plan for the WMA Concrete bunkers [32].
	Landfill Dugouts (see Figure A-8)										
Landfill Dugouts (ILS)	Normally six locations are sampled annually depending on seasonal precipitation and operational concerns (see Figure A-9).			×	×		×				c) (should) Leachate into surface and/or groundwater was identified in the CSR as a potential effect Table 5-2. (d) (should) Elevated levels of tritium and some metals are found in the Landfill dugout water as reported in the series of annual safety reports [28]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges as identified in CSR [12] as per Table 5-2 .
	WMA Water – Miscellaneous (see Figure A-5)										
B417 Tank catch/containment tray (WMT)	Monitoring of Liquid Waste Storage tank Catch/Containment Tray Water at WMA B417	×					×				(a) (shall) The WMA Facility Authority [24] document states *"Those storage structures for solid wastes that incorporate sumps for in-leakage collection shall be monitored annually, and any accumulated water shall be removed and treated, if required*." The WMA Safety Analysis [14] has a similar statement indicating that sampling of this water is performed. This requirement is reiterated in [30]. These documents are referenced in WL Site Licensing Handbook [4]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges as identified in CSR [12] as per Table 5-2

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
SMAGs sump (SMAGS)	Monitoring of the sump waters from the SMAGs facility prior to pump-out (samples includes west tank)	×					×				(a) (shall) The WMA Facility Authority [24] document states *"Those storage structures for solid wastes that incorporate sumps for in-leakage collection shall be monitored annually, and any accumulated water shall be removed and treated, if required*." The SMAGs Safety Analysis Report [29] states *"Sump tanks shall be monitored monthly. Liquid shall be sampled for analysis at first evidence of accumulation"*. These documents are referenced in WL Site Licensing Handbook [4]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
SSC sump (SSC)	Monitoring of Soil Storage Compound Primary and Secondary Membrane Inspection Tank water prior to pump-out	×					×				(a) (shall) The WMA Facility Authority [24] document states *"Those storage structures for solid wastes that incorporate sumps for in-leakage collection shall be monitored annually, and any accumulated water shall be removed and treated, if required*." The WMA Safety Analysis [14] has a similar statement indicating that sampling and testing of this water is performed. These documents are referenced in WL Site Licensing Handbook [4]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
SSC standing water	Monitoring of Soil Storage Compound – standing water prior to pump-out	×					×				
WMA Misc Sumps	Monitoring of various sump waters prior to pump-out	×					×				
WMA Excavations	Monitoring of water collected in various locations prior to pump-out			×			×				(c) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	WL Main Campus and Outer Areas Water - Miscellaneous										
Manholes	Monitoring of manhole water in various locations prior to pump-out			×			×				(c) (should) As per Table 5-2, the potential effect of *"surface water contamination associated with migration of contamination from the removal of drains and other buried services and remediation"* (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the monitoring locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
Excavations	Monitoring of water in various locations prior to pump-out			×			×				(c) (should) As per Table 5-2, the potential effect of *"surface water contamination associated with migration of contamination from the removal of drains and other buried services and remediation"*. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the monitoring locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
Primary Cell of the Sewage Lagoon	Monitoring of water prior to isolation from Secondary Cell						×				(f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the monitoring locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
Aquatic Biota and Public Health[11]											
	FISH (walleye (pickerel), pike, common sucker, and whitefish) see Figures A-2										
Pinawa (Sylvia Lake) (J40)	Background – upstream from Seven Sisters Fall Dam								×		(h) (should). This location serves as a background location for comparison to locations downstream of the WL processed outfall [15].
K-11 (2 km downstream of WL Outfall)	Sample location may vary from 0.5 km to 2.0 km downstream of the Outfall		×								(b) (shall) This location is closest location to critical group (Farms A and F) [15].

[11] Wild rice has been identified as a Valued Component to the Sagkeeng Anicinabe [63]. CNL is currently investigating the locations of harvesting areas down stream of WL site.

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
K-23 (5 km downstream of WL outfall)	This is where the drainage from the north portion of the WL site enters the Winnipeg River via Farm A.		×			×				×	(b) (shall) This location is representative of a site's identified liquid effluent critical group(s), then this location shall be included in the EMP [15]. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (i) (should) This monitoring location is nearby a residential area (just off Riverland Road) and where there is public concern regarding emissions [15] and [12].
Terrestrial Biota and Public Health											
	Large Game (flesh and bone), (Deer, Bear, Grouse, Rabbit), Livestock (Beef, Pork, Lamb, Poultry), Honey										
Within the vicinity (3 km radius) of Whiteshell Labs	Game , Livestock (Beef/Pork/Lamb/Poultry) Honey collected/raised within the vicinity of the airborne effluent critical group (see Figure A-2)		×							×	(b) (shall) Air Effluent Critical groups C, B and E [15] are within Ambient Radiation Monitoring stations (ARMS) and critical groups A, D and F are within a 5 km radius of the site. (i) (should) Honey is collected from suppliers in the local communities (Seven Sisters, Lac du Bonnet Whitemouth) within 3 km of the site.
Outside the vicinity of Whiteshell Labs (>3 km radius of the site) [12]	Game, Livestock (Beef/Pork/Lamb/Poultry), Honey collected/raised outside the airborne effluent critical group of the site (see Figure A-2)					×			×	×	(e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (h) (should) This location serves as a background location for comparison to locations within 5 km of the site [15]. (i) (should) Game is collected as road kill from local areas and livestock is purchased from local suppliers (Lac du Bonnet and Whitemouth) where there is public concern regarding emissions [15] and [12].

[12] This is an air deposition pathway, canola, honey, poultry, pork, and beef can be obtained from the local colony near Whitemouth. Background samples can be obtained from local stores that bring in produce from un-impacted areas.

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	Native Vegetation (mixed grasses, weeds and clover) see Figures A-2 and A-5										
ARMS1	North west corner of the WL Site Boundary on east side of the Winnipeg River		×						×		(b) (shall) Air Effluent Critical groups C, B and E [15] are within Ambient Radiation Monitoring stations (ARMS) and critical groups A, D and F are within a 5 km radius of the site. (h) (should) This location serves as a background location for comparison to locations within the WMA [12].
ARMS3	South west corner of the WL Site Boundary on the east side of the Winnipeg River										
ARMS4	West central location on WL property on west side of the Winnipeg River		×						×		(b) (shall) Air Effluent Critical groups C, B and E [15] are within Ambient Radiation Monitoring stations (ARMS) and critical groups A, D and F are within a 5 km radius of the site. (h) (should) This location serves as a background location for comparison to locations within the WMA [15].
ARMS5	North central location on the WL property on the west side of the Winnipeg River		×						×		
WMA1	Outside of WMA in the flow path of ground and surface water from the WMA, may also include effects from aerial deposition								×		h) (should) This location serves as a background location for comparison to locations within the WMA [15].
WMA2	In the north region of a series unlined trenches (T15 to T23)	×		×	×	×	×				(a) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Samples of vegetation shall be collected annually and analysed for any changes in activity from normal background levels." These documents are referenced in WL Site Licensing Handbook [4]. (c) (should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (d) (should) Any locations in which contaminant BVs have been
WMA3	In the ground and surface water flow of Trench 13b and near low level waste bunker 4	×		×	×	×	×				
WMA4	In ground and surface water direction of run-off from standpipe row G and ILW Bunker 7	×		×	×	×	×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
WMA5	Southwest of the incinerator and in the southern region of unlined trenches)T-4, T-7, T-8, T-10)	×		×	×	×	×				exceeded or are predicted to be exceeded should be included in the EMP. Elevated levels of radioactivity in vegetation are found in the WMA as reported in the series of annual safety reports [28]. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12].
WMA6	East of and between ILW Bunker 4 and 3	×		×	×	×	×				
WMA7	East of the incinerator and outside of the WMA	×		×	×	×	×				
	Garden Vegetables and Canola										
Upstream of Outfall (UPSTRM)	Collected from Pinawa. Whitemouth or Seven Sisters Falls - Root, fruit, and leafy type vegetables and Canola								×		(h) (should) This location serves as a background location for comparison to locations downstream of the WL processed outfall [15]. Vegetables are purchased from suppliers in the local communities (Pinawa Seven Sisters or Whitemouth) normally through local markets [15] and [12] or donations from CNL staff.
Downstream of Outfall (DNSTRM)	Collected from farms downstream of the OFS or from Lac du Bonnet or Great Falls Root, fruit, and leafy type vegetables and Canola		×							×	(b) (shall) Local suppliers along the east side of the river are representative of critical group Farm A [15]. (i) (should) Vegetables are purchased from suppliers in the local communities (Lac du Bonnet Great Falls) normally through local markets [15] and [12] or donations from CNL staff.
Soil (geology)											
WMAE	Known affected area from past loading of the standpipes (see Figure A-5).			×	×	×	×				(c) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (d) (should) These locations are areas in which contaminant BVs have been exceeded or are predicted to be exceeded. Elevated levels of radioactivity in soil are found in the WMA as reported in the series of annual safety reports [28]. (e) (may) A gradient in contaminant concentration is expected over a
WMAF				×	×	×	×				
WMAG				×	×	×	×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
WMA Ditch system	Known affected areas from facility operations (see Figure A-5).			×	×	×	×				spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [15] and [12].
Excavation/Land Clearance	Soil Clearance samples	×									(a) (shall) Impacted areas shall be remediated to clearance levels as per the WL EAFP.[8], and in accordance with the WL Closure Land-Use and End-State criteria [33]. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4].
Sewage Lagoon Secondary Cell (SL2) Discharge Path (Figure A-9)	Soil Samples collected along the Sewage Lagoon Discharge Path	×									(a) (shall) Impacted areas shall be characterized and remediated to clearance levels as per the WL EAFP.[8], and in accordance with the WL Closure Land-Use and End-State criteria [33]. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4].The frequency of sampling and parameters to be tested for area included in the plan and also detailed in WLDP-03704-ENA-005 [34].
Sewage Lagoon Primary Cell (SL1) Discharge Path		×									
Aquatic Biota and Public Health											
	Winnipeg River Sediments – Surface										
Upstream Of WL Outfall	J04 (-0.76 km from outfall) J02 (-0.37 km from outfall)								×		(h) (should) These locations serves as a background locations for comparison to locations at, and, downstream of the WL processed outfall [8] and [12].
Downstream of WL Outfall (see Figure A-2)	OFL (outfall)	×			×	×	×				(a) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], annual sampling continues as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (d) (should) Elevated levels of radioactivity in sediment are found in the Winnipeg River as reported in the series of annual safety reports [28].
	K01 (0.15 km from outfall)	×			×	×	×				
	K03 (0.52 km from outfall)	×			×	×	×				

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	K05 (0.79 km from outfall)	×			×	×	×				(e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges Table 5-2 [12].
	K14 (2.56 km from outfall)	×	×		×	×	×			×	(a) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], annual sampling continues as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (b) (shall) This location is representative of Critical group Farm A [15]. (d) (should) Elevated levels of radioactivity in sediment are found in the Winnipeg River as reported in the series of annual safety reports [28]. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges [8]. (i) (should) These monitoring locations are nearby farms and cottage areas where there is public concern regarding emissions [15] and [12].
	K19 (3.48 km from outfall)	×	×		×	×	×			×	
	K22 (4.63 km from outfall)	×	×		×	×	×			×	
	K23 (4.78 km from outfall)	×	×		×	×	×			×	
	K24 (4.93 km from outfall)	×	×		×	×	×			×	
	K30 (13.06 km from outfall)	×	×		×	×	×			×	
	Winnipeg River Sediments – Depositional Zones										
Target Area 1 [36].	Located upstream of WL, and is the background reference area.								×		(h) (should) These locations serves as a background locations for comparison to locations downstream of the WL processed outfall as per WLDP-03704-REPT-007 [36].
Target Area 2 [36].	Southwest end of Lac du Bonnet	×	×		×	×	×			×	(a) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12],

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
Target Area 3 [36].	Northwest end of Lac du Bonnet upstream from McCarthur Falls Dam	×	×		×	×	×			×	sampling of depositional areas as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations and to verify the predictions in the CSR. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (b) (shall) This location is representative of Critical group Farm A [15]. (d) (should) Elevated levels of radioactivity in sediment are found in the Winnipeg River as reported in the series of annual safety reports [28]. (e) (may) A gradient in contaminant concentration is expected over a spatial extent, these monitoring locations are distributed along the gradient [15]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [8]. (i) (should)These monitoring locations are nearby residential, farm and cottage areas where there is public concern regarding emissions [15] and [12].
	Landfill Dugout Sediments (see Figure A-8)										
ILF	Landfill dugout sediment sampling as per [34] and [38].	×			×		×				(a) (shall) As part of the WL EAFP [8] "monitoring of the dugouts around the landfill should be continued every 5 years to determine if contamination levels have risen significantly. Enhanced monitoring of the Landfill area should be implemented to detect possible contamination of sub-surface drainage". The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (d) (should) Elevated levels of radioactivity and some metals have been found in the landfill dugout sediment as reported in the series of annual safety reports [28]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and the locations are within reasonable proximity to the points of discharge and in the likely path of the discharges [12],

Criteria Identification [6]		Need for Monitoring Criteria - Location [6]									Justification
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	
Monitoring Location (emLine Code)	Comment										
	Sewage Lagoon Sediments										
SL1	Sediments in Primary Cell as per [34].	×			×		×				(a) (shall) As part of the WL EAFP [8] " Sewage lagoon Primary and Secondary Discharge pathway soils are to be collected every five years starting in 2012 [34. The WL EAFP is WL Site Licence condition 1.8 [3] and referenced in WL Site Licensing Handbook [4]. (d) (should) Elevated levels of radioactivity and some metals have been found in the landfill dugout sediment as reported in the series of annual safety reports [28]. (f) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, the monitoring locations are within reasonable proximity to the points of discharge and in the likely path of the discharges .
SL2	Sediments in Secondary Cell as per [34].	×			×		×				

Criteria from 900-509200-STD-010 [6]:

(a) (shall) If environmental monitoring of a location is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that location shall be included in the EMP.

(b) (shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP.

(c) (should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP.

(d) (should) Any locations in which contaminant BVs have been exceeded or are predicted to be exceeded should be included in the EMP.

(e) (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient.

(f) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges.

(g) (should) If environmental monitoring at a location is triggered by the MISA Protocol [1], then this location should be included in the EMP.

(h) (should) In addition to the locations mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e. representative of natural background) should be included in the EMP as reference areas.

(i) (should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or identified in the ERA) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions.

5.2.6 Parameters to be monitored

5.2.6.1 Chemical Parameter, Physical Stressor or Effect to be Monitored

In order to determine which physical stressors and/or parameters require monitoring under the non-radioactive EMP, another set of *Need for Monitoring Criteria (Need for Monitoring Criteria – Parameter)* has been developed as outlined in *Environmental Monitoring Program* [6] and is applied to those locations determined to require monitoring.

These criteria were applied to those locations requiring monitoring (see Table 5-3). The results of this review are summarized in Table 5-5 and Table 5-6. Further details pertaining to the reasoning for this monitoring including historical changes in this monitoring are outlined in the *WL Effluent Verification Monitoring Plan* [16] and non-radiological monitoring of groundwater, soils was introduced in 2008 based on a review of the site reference hazard information and on-site effluent data.

5.2.6.2 Radionuclides

The radionuclides chosen for monitoring in and around WL include all those that trigger the environmental monitoring criteria. The rationale used in the selection of radionuclides to be monitored in the EMP is discussed below, and a matrix of the monitored parameters and their relation to the environmental monitoring criteria are presented in Table 5-5.

Fate of radionuclides in the environment

Certain conditions have to be present in order for radioactivity to accumulate to measurable levels in the environment. The radioisotope must be released in significant quantity from WL and must be capable of being efficiently transported through the environment. Also, the radioisotope must have a sufficiently long half-life to allow time for environmental transport, sample collection, sample processing and counting. These factors are considered in the selection of radionuclides for inclusion in the EMP, as well as in the selection of the monitoring (i.e. sample collection and analysis) frequency.

Significant dose contributors

There is no regulatory requirement to monitor the concentration of specific radionuclides in the environment. Also, radionuclides are only important contaminants as defined in CSA N288.4 [7] if they contribute a dose of 10% or more of the relevant dose benchmark to members of the public i.e. 1 mSv per year. They were deemed important for the EMP because of a regulatory requirement to report the potential dose to the public from WL operations. To this end, the radionuclides selected for monitoring include those estimated to contribute 1% or more of total radiation dose to a critical group, based on the results of historical monitoring and dose assessments for the WL site (Table 5-4). These doses are associated with water ingestion (Cs-137 and Sr-90), meat and fish ingestion (Cs-137), and for 2013, vegetable ingestion (Sr-90).

Table 5-4
Dose Contribution by Radionuclide for the WL Site

Parameter	2013		2014		2015		2016		2017	
	Adult	Infant	Adult	Infant	Adult	Infant	Adult	Infant	Adult	Infant
Cs-137	4%	3%	99%	85%	100%	100%	90%	85%	100%	100%
Sr-90	96%	97%	1%	15%	0%	0%	10%	15%	0%	0%

Parameters identified in the Environmental Risk Assessment

The radionuclides selected for monitoring in the EMP include those that have the potential to produce effects in the receiving environment. Tritium, carbon-14, cesium-137 and strontium-90 in surface waters in the WL WMA were identified as contaminants of potential concern in the CSR [12].

Parameters relevant to dose/exposure assessments

As part of the CSR, dose assessments were performed for Winnipeg River sediments and contaminant migration from the trenches in the WMA where contaminants of potential ecological concern (COPEC) were identified during the preliminary screening evaluation. These dose assessments considered the total dose from all radionuclides present at any given location, not only the dose from radionuclides identified as COPECs. This information was used to determine that the contaminated river sediments could be left in-situ and that remediation of at least four trenches within the WMA would be required. On-going monitoring of the Winnipeg River sediments and on-going monitoring of the surface waters around the WMA is required.

Verifying the effectiveness of containment and effluent controls

At locations where environmental monitoring is being done to verify the effectiveness of containment and effluent controls, monitoring is for radionuclides that could potentially be present in effluent discharges. These radionuclides were identified using various sources of information, including:

- The results of other environmental monitoring activities (e.g. routine effluent and groundwater monitoring, non-routine monitoring including special investigations, etc.);
- A review of radionuclide inventories and usage on site;
- Process knowledge derived from historical assessment, waste records and staff knowledge; and
- The Significant Environmental Aspects (SEA) database for WL.

Where there is limited knowledge of contaminants of potential concern, a wide array of parameters are targeted, and as monitoring data become available the suite of parameters can be reduced as appropriate. Guidelines for the reduction of monitoring are given in Section 6.2.

Table 5-5
Criteria and Justification for Monitoring of Parameters

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Air Quality								
Wet/Dry Deposition								
Gross Alpha						×		(o) Measurement of radioactivity serves to support atmospheric dispersion models, confirm the absence of effects (i.e. due diligence), and provide information during an emergency. Air inhalation is a dominant dose pathway for alpha emitters. Alpha activity measurement in deposition samples can be used to confirm that absence of effect [15].
Gross Beta						×		
Gamma Emitters[13]						×		
Surface Water[14]								
Winnipeg River (up and down stream)[15]								
Tritium		×	×			×	×	(k) (shall) The concentration of a contaminant as there is the potential for the contaminant or physical stressor to produce effects in the receiving environment [12] (Section 7). (l) (should) Water ingestion is a relevant pathway for exposure to these radionuclides (tritium, Sr-90, Cs-137 (gamma/gross beta), Am-241 (gamma/gross alpha)) for critical groups that get their drinking water from the river [15]. (o) (may) Measurement of radioactivity serves to support atmospheric dispersion models, confirm the absence of effects (i.e. due diligence), and provide information during an emergency. Water ingestion of HTO, Tc-99 (gross beta) and Np-237 (gross alpha) from air effluent releases is a relevant dose pathway for these isotopes [15]. (p) (should) Parameter is released to the Winnipeg River in measurable quantities from effluent streams at WL. Monitoring is to verify the effectiveness of containment and effluent controls for WL facilities and WMAs [28].
Gross alpha		×	×			×	×	
Gross beta		×	×			×	×	
Strontium-90		×	×			×	×	
Gamma emitters		×	×			×	×	
Uranium		×	×			×	×	
Run-off from WMA (Ditch Water)[16]								
Tritium	×	×					×	(j) (shall) These parameter values are required for the WMA [14] and CCSF [27] annual safety reports.
Gross alpha	×	×					×	
Gross beta	×	×					×	

[13] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

[14] The outfall effluent was reviewed and it was determined [41] that there was no need to expand the Environmental Monitoring program to include non-radiological analysis of Winnipeg River water.

[15] Isotopic Plutonium analysis and C-14 analysis are not required as C-14 is below detection limits from the OFS and plutonium is near detection levels.

[16] Ditch water will be assessed for C-14 in the 2019 field season.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
								(k) (shall) There is the potential for the contaminant or physical stressor to produce effects in the receiving environment. Ditch water contains contaminants that or are predicted to exceed BVs as per WL CSR Table 5-2 from [12]. p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants could potentially be present in effluent discharges.
Uranium						×		(o) (may) (iv) Crushed granite from the URL was used as base material for the construction island at the north end of the WMA and also at the south side of the WMA road near the new WMA complex. Uranium added to the parameter list as a result [28].
Gamma Emitters[17]							×	(p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants could potentially be present in effluent discharges as per WL CSR Table 5-2 from [12].
Carbon-14						×		(o) (may) Measurement of radioactivity serves to confirm the absence of effects (i.e. due diligence). For Terrestrial Animals, exposure to C-14 is a relevant pathway for animals that drink water from ditches/river [15].

[17] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Strontium-90, and other possible isotopes or parameters						×		(o) (may) The results for the parameters above are evaluated using the following screening criteria. The beta emitter with the most restrictive MAC in the potential contaminants of concern for WL is Sr-90 (MAC 5 Bq/L). WL EnvP assume Sr-90 is in equilibrium with Y-90 so a screening criteria of 10 Bq/L is used for gross beta. If the sample result is above 10 Bq/L the samples are submitted for Sr-90 analysis (to confirm the theory). Gamma spec analysis provides individual results for (Co-60, Nb-94, Sb-125, Cs-134, Cs-137(Ba-137m), Pm-147, and Am-241). If all of the gross beta is accounted for then the effort is complete. If not, WL staff evaluate the data against the most restrictive isotope not already detected and assume that is what it is (most likely Tc-99). If the value is above the MAC for Tc-99 (200 Bq/L) WL staff confirm that it is present. If it is not that particular isotope staff continue the search (Cl-36, Ni-63, etc). The alpha emitter with the most restrictive MAC and likely to be present is uranium (0.5 Bq/L/20 ppb). Since the groundwater in the WL area contains natural uranium (~2 to 200 ppb) it is the most likely alpha present. The rock surrounding the WL site is slightly enriched in uranium and its decay products including Ra-226. We also know that if uranium is present, then the progeny of uranium can contribute to the alpha and beta activity (0.025 to 0.045 Bq/ppb gross alpha and 0.016 to 0.035 Bq/ppb gross beta, there is higher contributions if the samples is counted right after collection versus one week later). If uranium (and uranium progeny) does not account for the alpha activity (1 ppb uranium is ~ 0.025 Bq/L gross alpha) present staff would review the gamma spec analysis to see if Am-241 is present as it is an indicator of the presence of plutonium isotopes. If the value is above the MAC for Am-241 and/or plutonium, the samples are sent for plutonium analysis. If the value is still above the MAC for that isotope staff would continue the search. Additional analyses (metals, VOCs, SVOCs) if required.
Surface Water – Landfill Dugouts								
Gross alpha						×	×	(o) (may) The choice of contaminants to monitor in the environment was based on the following: (i) The level of risk from an unintended release of contaminants from a facility is unknown and potential of concern as per WL CSR Table 5-2 from [12]. (p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants could potentially be present in effluent discharges as per WL CSR Table 5-2 from [12].
Gross beta[18]						×	×	
Gamma Emitters[19]						×	×	
Strontium-90						×	×	
Tritium						×	×	
Uranium (part of total metals)						×	×	
Non-rad parameters listed in see Table 5-6						×	×	
Surface Water – from B417 Tank catch/containment tray (WMT)								

[18] A preliminary investigation for Tc-99 and Sr-90 in the landfill dugouts was conducted in 2018 and the results were inconclusive (WL-EM-2019-005 [42]). Additional sampling will take place in 2019 during a wet period and/or after a few days of heavy rainfall.

[19] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Gross alpha	×						×	(j) (shall) These parameter values are required by the WMA Facility Authority [24] document states *"Those storage structures for solid wastes that incorporate sumps for in-leakage collection shall be monitored annually, and any accumulated water shall be removed and treated, if required*." The WMA Safety Analysis [14] has a similar statement indicating that sampling of this water is performed. (p) (should) This monitoring is performed to verify the effectiveness of containment of the B417 tank. Cesium-137 is detected in the catch/containment tray. Residual gross beta is assumed to be Sr-90/Y-90.
Gross beta	×						×	
Gamma Emitters[19]	×						×	
Surface Water – from SMAGs Sump, SSC Sump, SSC Standing Water, WMA Misc Sumps and WMA standing water (excavations)								
Gross alpha	×					×	×	(j) (shall) These parameter values are required by the WMA Facility Authority [24] document states *"Those storage structures for solid wastes that incorporate sumps for in-leakage collection shall be monitored annually, and any accumulated water shall be removed and treated, if required*." The WMA Safety Analysis [14] has a similar statement indicating that sampling of this water is performed. (o) This monitoring is performed to determine the appropriate disposition pathway for the water. Gross beta is assumed to be Sr-90/Y-90. (p) (should) This monitoring is performed to verify the effectiveness of containment of the WMA storage structures as per WL CSR Table 5-2 from [12].
Gross beta	×					×	×	
Gamma Emitters[19]	×					×	×	
Tritium	×					×	×	
pH	×					×	×	
Visual Inspection for film, sheen or discolouration, deleterious substances	×					×	×	
Surface Water – from Manholes and Excavations on WL Main Campus and Outer Areas								
Gross alpha		×				×	×	(k) (shall) As per Table 5-2, the potential effect of *"surface water contamination associated with migration of contamination from the removal of drains and other buried services and remediation"*. These parameters would are potentially present. Gross beta is assumed to be Sr-90/Y-90. (o) (may) This monitoring is performed to determine the appropriate disposition pathway for the water [9]. (p) (should) This monitoring is performed to verify the effectiveness of containment of the active drain lines as per WL CSR Table 5-2 from [12].
Gross beta		×				×	×	
Gamma Emitters[19]		×				×	×	
pH		×				×	×	
Visual Inspection for film, sheen or discolouration, deleterious substances		×				×	×	
Surface Water – from Primary Cell of the Sewage Lagoon								
Gross alpha						×	×	(o) (may) This monitoring is performed to determine the appropriate disposition pathway for the water [9]. (p) (should) This monitoring is performed to verify the effectiveness of operational controls in place to prevent contaminants from being dumped down the domestic drains [9]. Gross beta is assumed to be Sr-90/Y-90.
Gross beta						×	×	
Gamma Emitters[21]						×	×	
Aquatic Biota and Public Health								
Fish (up and down stream - walleye (pickerel), pike, common sucker, and whitefish)[20]								
Gross beta			×			×		

[20] Gross alpha analysis is not performed on fish, the dominant dose pathway is gross beta/gamma emitters.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Gamma Emitters[21]			×			×		(l) (should) Fish ingestion is a relevant pathway for exposure to these radionuclides (Zn-65, Cs-134, Cs-137 (gamma/gross beta) for critical groups that consume fish from the Winnipeg River [15]. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc [8].
mass	×							(j) shall be measured if required by Annual Fish Permit.
length	×							(j) shall be measured if required by Annual Fish Permit.
Number of each species	×							(j) shall be measured if required by Annual Fish Permit.
Sediment (surface)								
Gross alpha	×					×	×	(j) (shall) Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], annual sampling continues as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations. These parameters are in the effluent from the site and could be present in the sediment. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc. (p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants could potentially be present in effluent discharges as per WL CSR Table 5-2 from [12].
Gross beta	×					×	×	
Gamma Emitters	×					×	×	
Strontium-90							×	(p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges. Strontium-90 included based on current and past liquid effluent. Composite sample for each sampling site [46].
Sediment (depositional cores)								
Gross alpha	×							(j) (shall) If concentration of a contaminant is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that location shall be included in the EMP. Although the contamination in the Winnipeg River sediments was found to present no risk to human or ecological health [12], sampling of depositional areas as part of the WL EAFP [8] to ensure that no additional impacts to Winnipeg River sediments as a result of decommissioning operations and to verify the predictions in the CSR. Full parameter list is also included in reference [36].
Gross beta	×							
Gamma Emitters[22]	×							
Strontium-90	×							
Metals referenced in [36] and included in Table 5-6.	×							
Terrestrial Biota and Public Health								

[21] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

[22] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Game (Deer, Bear, Grouse, Rabbit), Livestock (Beef, Pork, Lamb, Poultry) – flesh (muscle) [23]								
Gross alpha			×			×		(l) (should) The EMP should include contaminants relevant to the exposure/dose assessments that are normally part of an ERA (or equivalent). Meat ingestion is a relevant pathway for exposure to these radionuclides for critical groups. These include C-14[24], gross beta emitters (Cs-134 (also gamma), Cs-137 (also gamma), Fe-55, I-129, Ni-63, Pm-147, Sr-90 (Y-90)), Zn-65 (also gamma), gross alpha emitters, U-234, U-235 (also gamma), U-238) [15]. Contaminant concentrations measured in biota are useful in the ERA in assessing contaminant bioavailability, assessing food-chain exposures at higher trophic levels, and facilitating estimation of organism dose. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc. Annual monitoring is part of the EAFP [8]. These parameters are in the site effluent and could be present in game and/or livestock.
Gross beta			×			×		
Gamma Emitters[18]			×			×		
Game Animals (moose, deer) – bone								
Gross beta			×			×		(l) (should) The EMP should include contaminants relevant to the exposure/dose assessments that are normally part of an ERA (or equivalent). Contaminant concentrations measured in biota are useful in the ERA in assessing contaminant bioavailability, assessing food-chain exposures at higher trophic levels, and facilitating estimation of organism dose. These include C-14, gross beta emitters (Cs-134 (also gamma), Cs-137 (also gamma), Fe-55, I-129, Ni-63, Pm-147, Sr-90 (Y-90)), Zn-65 (also gamma), gross alpha emitters, U-234, U-235 (also gamma), U-238) [15]. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc. Annual monitoring is part of the EAFP [8]. These parameters could be in the bone of game animals.
Strontium-90			×			×		
Gamma Emitters[18]			×			×		
Honey, Canola								
Tritium (free and OBT)						×		(o) (may) Released to the air in measurable/significant quantities from WR1. Concentrations are not expected to be elevated in river or on land. Monitoring serves to confirm the absence of impacts [15].
Native Vegetation (mixed grasses, weeds, and clover)								
Gross alpha	×		×				×	(j) (shall) The WMA Facility Authority [24] document and WMA Safety Analysis [14] document states "Samples of vegetation shall be collected annually and analysed for any changes in activity from normal background levels." These parameters allow this analysis. (l) (should) Terrestrial plant ingestion is a relevant pathway for exposure to Ce-144 (part of gamma/gross beta) [15].
Gross beta	×		×				×	
Gamma Emitters[25]	×		×				×	
Strontium-90	×		×				×	

[23] Water ingestion is a dominant dose pathway for air and liquid emissions of tritium so tritium analysis is not required for this media.

[24] Carbon-14 analysis of air effluents are not anticipated to be of significance and will be assessed in 2019 before introducing this pathway analysis.

[25] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
								(p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants could potentially be present in effluent discharges as per WL CSR Table 5-2 from [12].
Tritium (free and OBT)						×		(o) (may) Released to the air in measurable/significant quantities from WR1. Concentrations are not expected to be elevated in river or on land. Monitoring serves to confirm the absence of impacts [15]. (o) (may) Released to the surface in measurable/significant quantities from WMA. Concentrations may be elevated vegetation. Monitoring serves to confirm the absence of impacts [15].
Garden Vegetables (leaf[26], root, fruit)								
Gross alpha			×				×	(l) (should) Garden Crop ingestion (Sr-90) is a relevant pathway for exposure to these radionuclides for critical groups [15]. Contaminant concentrations measured in biota are useful in the ERA in assessing contaminant bioavailability, assessing food-chain exposures at higher trophic levels, and facilitating estimation of organism dose. Annual monitoring is part of the EAFP [8]. (p) (should) This monitoring is being done to verify the effectiveness of containment and effluent controls, and these contaminants that could potentially be present in effluent discharges as per WL CSR Table 5-2 from [12].
Gross beta			×				×	
Gamma Emitters[25]			×				×	
Strontium-90			×				×	
Soil (Geology)								
Soil – WMA								
Gross alpha		×	×			×		(k) (should) As per Table 5-2, the potential effect of "leaks into surface water from in-situ trenches" was identified. (l) (should) Annual monitoring is part of the EAFP [8]. Ground shine is a relevant pathway for exposure to these gamma emitting radionuclides (Co-60, Eu-152, Eu-154, Mn-54, Nb-94, Sb-125) [15]. (o) (may) The choice of contaminants to monitor in the environment is as a gross trend indicator of contaminant migration.
Gross beta		×	×			×		
Strontium-90		×	×			×		
Gamma Emitters[25]		×	×			×		
Soil – Land clearance								
Gross alpha	×		×					(j) (shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator. Need for demonstration of no or acceptable impact [33]. (l) (should) Ground shine is a relevant pathway for exposure to these gamma emitting radionuclides (Co-60, Eu-152, Eu-154, Mn-54, Nb-94, Sb-125) [15].
Gross beta	×		×					
Strontium-90	×		×					
Gamma Emitters[27]	×		×					
Non-rad parameters listed in see Table 5-6	×		×					

[26] Leafy vegetables should include local wild mushrooms and fruit should include local wild blueberries.

[27] Gamma radionuclides of interest include Am-241, Ce-144, Co-60, Cs-134, Cs-137 (Ba-137md), Eu-152, Eu-154, I-129, Mn-54, Nb-94, Sb-125 (Te-125md), U-235 (Th-231d), Zn-65, Pb-210, K-40, Bi-212, Pb-212, Bi-214, Pb-214, Ra-226, Th-227, Ac-228, Pa-233, Pa-234m, Th-235.

Environmental Media/Location	Criteria for Parameters to be Monitored							Justification
	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
Sediment/Soil –Lagoon and Lagoon Discharge Path								
Gross alpha	×		×					(j)(shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator. Need for demonstration of no or acceptable impact [33]. The full list of parameters are also shown in [34] and [38]. (l) (should) Ground shine is a relevant pathway for exposure to these gamma emitting radionuclides (Co-60, Eu-152, Eu-154, Mn-54, Nb-94, Sb-125). (l) (should) These parameters were chose to support the ERA for the closure of the Sewage Lagoon.
Gross beta	×		×					
Strontium-90[28]	×		×					
Gamma Emitters[27]	×		×					
Non-rad parameters listed in see Table 5-6	×		×					
Sediment - Landfill Dugouts								
Gross alpha	×		×					(j)(shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator. Need for demonstration of no or acceptable impact [33]. The full list of parameters and locations are also shown in [34] and [38]. (l) (should) These parameters were chose to support the ERA for the closure of the Landfill.
Gross beta	×		×					
Strontium-90[28]	×		×					
Gamma Emitters[27]	×		×					
Non-rad parameters listed in see Table 5-6	×		×					

Criteria:

(j) (shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator.

(k) (shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment.

(l) (should) The EMP should include contaminants relevant to the exposure/dose assessments that are normally part of an ERA (or equivalent).

(m) (should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group.

(n) (should) The non-radioactive contaminant(s) chosen for monitoring should be those triggered by the MISA Protocol [1].

(o) (may) The choice of contaminants to monitor in the environment may also be based on the following:

- i) The level of risk from an unintended release of contaminants from a facility is unknown or has been determined by the ERA (or equivalent), to be of concern;
- ii) The level of risk from unmonitored releases of contaminants from a facility is unknown or has been determined by an ERA (or equivalent) to be of concern;
- iii) The emission of contaminants is highly variable;
- iv) There are other business reasons, i.e. stakeholder concerns, due diligence, etc.

(p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.

[28] If gross beta levels are not accounted for by K-40 and Cs-137 (or other beta/gamma emitters), Sr-90 analysis is performed.

Table 5-6
Non-Radiological Parameters and Frequencies for Environmental Samples

ATG	*Parameter*	*Landfill Dugout Water*	**Surface water[29] (not used as drinking water)**	*Soil[30] (Land Clearance)*	*WPG River Sediment[33]*	*Lagoon & Discharge Pathway Soil and Sediments[31]*	*Landfill Dugout Sediments[32]*
3	pH	Annual	Prior to relocation	Prior to clearance	--	--	--
	% Moisture	--	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 Year
6	Phosphorus (Total)	Annual	--	--	--	--	--
7	Conductivity	Annual	--	--	--	--	--
	Antimony, Total	--	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Barium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Beryllium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Boron, (Total)	Annual	--	--	--	--	--
9	Cadmium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
	Chromium, (Total)	--	--	--	Every 20 years	Every 5 years	Every 5 years
9	Chromium, hexavalent (Cs(VI)) and trivalent (Cr(III))	Annual	--	Prior to clearance	--	--	--
9	Cobalt, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Copper, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Lead, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Molybdenum, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Nickel, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Selenium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Silicon, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Silver, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Strontium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Thallium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Tin, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Titanium, (Total)	Annual	--	--	--	--	--

[29] This includes SMAGs Sump, SSC Sump, SSC Standing Water, WMA Misc Sumps and WMA standing water (excavations) and Manholes and Excavations on WL Main Campus and Outer Areas identified in Table 5-5.

[30] Parameters for analysis are assessed based on the reference hazard of the area being investigated.

[31] Every 5 years starting in 1999 as per WLDP-03704-ENA-005 [34].

[32] Landfill dugouts soils are to be collected every five years starting in 2007 as per WLDP-03704-ENA-005 [34].

[33] Every 20 years starting 2006 as per EAFP.

ATG	*Parameter*	*Landfill Dugout Water*	Surface water[29] (not used as drinking water)	*Soil[30] (Land Clearance)*	*WPG River Sediment[33]*	*Lagoon & Discharge Pathway Soil and Sediments[31]*	*Landfill Dugout Sediments[32]*
9	Uranium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Vanadium, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Zinc, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
9	Zirconium, (Total)	Annual	--	--	Every 20 years	Every 5 years	Every 5 years
9a	Iron, (Total)	Annual	--	Prior to clearance	--	--	--
9a	Magnesium, (Total)	Annual	--	--	--	--	--
-	Sodium , (Total)	Annual	--	--	--	--	--
10	Arsenic, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
12	Mercury, (Total)	Annual	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
14	Phenolics	Annual	--	--	--	--	--
16	Volatile, Halogenated (Bromodichloromethane, chloroform, methylene chloride, Trichloroethylene, Carbon tetrachloride)	Annual	--	Prior to clearance	--	--	--
17	Volatiles, Non-Halogenated (includes acetone, BTEX)	--[34]	--	Prior to clearance	--	--	--
-	Total Organic(as HB 40)[35]	Annual	--	--	Every 20 years	Every 5 years	Every 5 years
-	Total Hydrocarbons[36]	--	--	Prior to clearance	Every 20 years	Every 5 years	Every 5 years
-	PCB	--	--	Prior to clearance	--	--	--
19	Extractables, Neutral di-n-butyl Phthalate (DBP) Di-2-Ethylhexyl Phthalate (DEHP),	One time[37]	--	--	---	--	--
20	Extractables, Acid (Phenolics)	One time	--	--	---	--	--
23	Extractables, Chlorinated (chlorobenzenes)	One time	--	--	---	--	--
25	Solvent Extractables (Oil and Grease)	Annual	--	--	---	--	--
30	Chloride, Sulphate, Nitrate (N) and Nitrite (N)	Annual	--	--	--	--	--
	Visual Inspection for film, sheen or discolouration, deleterious substances	Annual	Prior to relocation	--	--	--	--

[34] BTEX analysis has been performed on the landfill dugout for many years with no detection of these parameters so this analysis has been discontinued [42].

[35] HB 40 by UV if GC/MS concentration is over 75 ppm.

[36] CCME PHC CWS (F1-F4) categorized as F2 (C10-C16), F3(C16-C34), and F4 (C34-C50) ranges

[37] A one-time analysis for confirmation of absence purposes.

5.2.7 Quality assurance (QA) and quality control (QC)

In order to ensure that the data collected through the program is valid, the monitoring performing laboratories have strong QA/QC programs as required by the *EnvP Program Radiological and Non-Radiological Monitoring Service Quality Assurance Plan* [47]. These laboratories utilize QC tools such as blanks, spiked blanks, and replicate samples to address precision, accuracy, sensitivity, and to detect errors in the data. The field and laboratory QC programs are described in laboratory specific sampling and analysis procedures as per [48] and [49].

The quality verification data generated by the laboratories are supplied to the Environmental Specialist who performs an evaluation to confirm that the performance and acceptance criteria in Section 5.5 are met.

5.2.7.1 Field Quality Verification Monitoring

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong QA/QC programs as required by the *EnvP Program Radiological and Non-Radiological Monitoring Services Quality Assurance Plan* [47]. Note: This QA Plan is in line with the requirements of N288.4 [7].

In addition to this, field Quality Verification (QV) monitoring is in place for both the Effluent Verification Monitoring Program and the EMP with the frequency set to accommodate both of the programs. MISA requires that sampling take place annually on one effluent stream but recommends all ATGs be part of the field QV program. The MISA recommended frequencies [1] are outlined in Table 5-7:

Table 5-7
Field QV Frequency Recommended by MISA

Sampling Frequency	Field QV Frequency
Daily	Monthly
Weekly	Quarterly
Monthly	Semi-annual
Quarterly	Semi-annual
Semi-annual	Annual

With the current QV monitoring schedule, the WL site exceeds the field QV requirements outlined by MISA and conforms with most the MISA recommendations.

More specifically, the majority of the field QV is completed on one of the *effluent* monitoring points, the Outfall (OFS) as this is the most frequently and widely monitored of all of the monitoring points. However, for those parameters which are not monitored at OFS but are monitored elsewhere, one of the locations with the most frequent monitoring of that parameter was chosen for the collection of field QV samples. The current field quality verification monitoring schedule can be found in [50].

It should be noted that the field samples collected on a daily, weekly and monthly frequency are taken on the same day as the semi-annual monitoring under the EMP (i.e. whether frequency is daily, weekly, monthly or semi-annual, all will be taken on the same day as the monitoring sample for that parameter under the non-radioactive EMP).

The type of field QV sampling applicable for each of the Analysis Test Groups is outlined in Section 10.0 of the *Protocol for the Sampling and Analysis of Industrial/Municipal Waste Water* [1]. These include the following types of samples serving different purposes and re required in different combinations depending on the parameter:

<u>Types and Purposes</u>:

A. Duplicate – Precision
B. Travelling Blank – Contamination
C. Spiked Blank – Accuracy

5.2.8 Additional Monitoring Details

5.2.8.1 Type of Data to be Collected

For surface water media types requiring non-radiological parameter monitoring, water concentrations are measured and further information can and is calculated (e.g. loading/flux).

NOTE: There have been no environmental concerns identified through contaminant monitoring where toxicity tests (i.e. biological effects monitoring) was deemed necessary therefore, there has been no toxicity testing completed at these monitoring locations under the routine non-radioactive EMP.

5.3 Step 3: Boundaries of the EMP

The EMP includes monitoring within the site boundary, to address potential biological effects and exposure pathways for ecological receptors; and in areas outside the boundary of the WL site, to address pathways leading to human exposure.

The boundaries of the EMP are shown in Figure 3-1. Monitoring starts beyond the final point of control for an airborne or waterborne release, and extends beyond the site boundary to include the locations of all potential critical groups for the WL site.

A more detailed description of locations where potentially impacted areas intersect with ecological receptor habitat within the site boundary is available in the CSR [12] and Affected Lands and Contaminated Structures Detailed Decommissioning plan [51].

This monitoring plan does not address effluent monitoring at WL and it does not address the exposure of workers or visitors to the WL site to nuclear substances, which is controlled by CNL's Radiation Protection Program. A summary of all monitoring activities for the WL site is given in Table 5-8.

Table 5-8
Summary of WL Monitoring Activities

Environmental Component	Sampling Location	Parameters	Sampling Frequency
Air	WL Perimeter and Off-Site	γ (Thermoluminescent Dosimeters (TLDs))	Continuous
	WL Site	Dust Particulates (TSP, PM_{10}, Gross α/β, γ-spec) Quantities of fuel combusted for building heating. Diesel burned in their standby generators. Quantity of Total (filterable) Particulate Matter, particulate below 10 microns (PM_{10}), particulate below 2.5 microns ($PM_{2.5}$)[38] Record of Dust Control Treatments and Site Inspections Halocarbon	Continuous during building demolition Internal worksheet tools are used to perform the calculations required to report to the NPRI. In addition, Environment Canada provides companies with various calculators (road dust, landfill gas) All releases of halocarbons are recorded and those over 10 kg are reported to Environment Canada
Air Effluents	WL Facilities (B100 (WR1), B200, B300) and WMA Facilities	Gross α/β, γ-spec, C-14[39] tritium[40]	Continuous
Noise	WL Site	Noise monitoring	During periods of high activity
Topography	Surface drainage areas	Visual inspection of OFS pipe (above ground) for evidence of subsidence Visual Inspection of WMA ditch system and other drainage pathways identified in Storm Water Management plan Visual Inspection of the Winnipeg River Bank in the vicinity of the WL site	Semi-Annually
Surface Water	Winnipeg River	Gross α/β, Sr-90, Tritium, Uranium, γ-spec	Daily to Weekly, monthly composite analyzed
	WMA Ditches[41]	Tritium, Uranium, Gross α/β, γ-spec, C-14[42]	Periodically during ice free

[38] As the result of travel on gravel roads, sand blasting activities, use of gas powered vehicles, propane tanks, other CO_2 emissions, burn pile.

[39] Air effluents needs to be assessed in 2019 for the presence of Carbon-14.

[40] Tritium analysis is only required for B100 air effluent.

[41] If gross beta levels are above 10 Bq/L the samples are submitted for Sr-90. If the alpha activity is above 0.5 Bq/L and not all alpha is accounted for by uranium and Am-241 is present in the gamma spec, the samples may be submitted for isotopic plutonium analysis. Additional analyses may be performed at the request of Facility Management or EnvP Program Manager.

[42] Ditch water will be assessed for C-14 in the 2019 field season.

Environmental Component	Sampling Location	Parameters	Sampling Frequency
			periods[43]
	Landfill Dugouts	Gross α/β, Tritium, non-radiological (total metals including uranium)	Annually
	Primary Cell of the Sewage Lagoon	Gross α/β, γ-spec	Prior to isolation from Secondary Cell and/or Discharge
	Main Campus Miscellaneous (manholes, excavations, sumps)	Gross α/β, γ-spec, pH, visual inspection for film, sheen or discoloration, deleterious substances, and other parameters (Table 5-6)	Prior to pump-out/relocation
Surface Water	B417 Tank catch/containment tray	Gross α/β, γ-spec	Monthly (April to October)
	SMAGs Sump, SSC Sump, SSC Standing Water, WMA Misc Sumps and WMA standing water (excavations)	Gross α/β, γ-spec, tritium, pH, visual inspection for film, sheen or discoloration, deleterious substances, and other parameters (Table 5-6)	Prior to pump-out/relocation
Atmospheric Deposition	Off-Site	Gross α/β, γ-spec	Monthly
Groundwater [62]	WMA[44]	Gross α/β, tritium, uranium non-radiological, field measurement of pH, conductivity and temperature water level measurements	Semi-Annually
	Landfill, Lagoon[39]	Gross α/β, tritium, uranium non-radiological, field measurement of pH, conductivity and temperature water level measurements	Annually (Spring)
	Main Campus (including locations in the vicinity of, and up and down gradient of, WR1)	Gross α/β, tritium, uranium non-radiological, field measurement of pH, conductivity and temperature Water Level measurements	Semi-Annually (basal and bedrock), Annually (water table and clay-till)
Liquid Effluents [16]	B100 (WR1) and B300 tanks, Outfall Sampling Location Sewage	Gross α/β, tritium, γ-spec. Sr-90, uranium, non-radiological,	Continuous on discharge

[43] Ditch locations are checked and, if water is flowing, are sampled after rain events greater than 5 millimetre of rain in a 24-hour period, preceded by at least 48 hours of no precipitation. Samples should also be taken during the spring (snow) melt and not more than weekly unless there is some operational concern that triggers additional sampling.

[44] If gross beta levels are above 2 Bq/L the samples are submitted for gamma spectrometric analysis, if it exceeds 5 Bq/L the samples are submitted for Sr-90 analysis. If the alpha activity is above 0.5 Bq/L, the samples are submitted for gamma spectrometric analysis and possibly isotopic plutonium analysis. Additional analyses may be performed at the request of Facility Management or EnvP Program Manager.

Environmental Component	Sampling Location	Parameters	Sampling Frequency
	Lagoon, Ditch location 8, 9 and Control	Pu-238, Pu-239/240[45], C-14[46]	
Sediments	Winnipeg River (depositional zone cores)	Gross α/β, γ-spec, Sr-90 (composite for each sample) and other parameters (Table 5-6)	Every 20 years starting 2006[47]
Sediments	Winnipeg River (surface sediment)	Gross α/β, γ-spec, Sr-90 (composite for each sample)	Annually
Fish[48]	Winnipeg River (one upstream location and two downstream)	Gross β, γ-spec	Annually
Wildlife Deer, Bear, Grouse, Rabbit	On-Site, Off-Site	Gross α/β, γ-spec, Sr-90 (bone)	As Available[49]
Garden Crop[50]	Up and Downstream of Whiteshell Laboratories	Gross α/β, γ-spec, and Sr-90	Annually
Honey/Canola[51]	Off-site local sources	Tritium (free and organically bond)	Annually
Beef/Pork/Lamb/Poultry[52]	Off-site local sources	Gross α/β, γ-spec	Annually
Native Vegetation	WL Perimeter ARMs, WMA	Gross α/β, γ-spec, Sr-90, Tritium (free and organically bond)	Annually
Soils	WMA affected areas	Gross α/β, γ-spec	Annually
Soils/sediments	Excavations/Land Clearance[53]	Gross α/β, γ-spec, non-radiological parameters (Table 5-6)	Pre-clearance
Soils/sediments	Landfill Dugouts[53]	Gross α/β, γ-spec, non-radiological parameters (Table 5-6)	Every 5 years (starting 2007)
Soils/sediments	Sewage Lagoon Sludge	Gross α/β, γ-spec, Sr-90,	Every 5 years (starting 1999)

[45] Plutonium (quarterly composite) analysis (Pu-238, Pu-239/240) is performed out outfall effluent.

[46] C-14 analysis is performed on B100 tank discharges and on the Outfall Sampling location.

[47] For Deposition Areas, thirteen cores are collected at each site. More information on sampling locations and sampling method is detailed in WLDP-03704-REPT-007. Depositional zones are to be samples every 20 years to verify validity of EA conclusions.

[48] Fish netting activities must be in compliance with the annual permit issued under the Fisheries Act (Manitoba). Report of these activities must also be completed as the conditions listed in the permit.

[49] Game are obtained by CNL staff through roadkills and/or from local trappers. Animal collection activities must be in compliance with the permit issued under the Wildlife Act. Reporting of these activities must also be completed as per the conditions listed in the permit. Species (normally deer, moose, bear, grouse or rabbit) sex and age should be report to the WL Environmental Specialist along with the radioactivity in Bq/kg, fresh weight for flesh (and bone - for deer/moose).

[50] Leafy vegetables should include local wild mushrooms and fruit should include local wild berries (possible choices - blue berries, Saskatoon berries, raspberries, strawberries, plums, gooseberries, chokecherries, pin cherries) [63].

[51] This is an air deposition pathway, canola, honey, poultry, pork, and beef can be obtained from the local colony near Whitemouth. Background samples can be obtained from local stores that bring in produce from un-impacted areas.

[52] Livestock are obtained by EnvP staff from local farmers/farmer's markets.

[53] If gross beta levels are not accounted for by K-40 and Cs-137 (or other beta/gamma emitters), Sr-90 analysis is performed.

Environmental Component	Sampling Location	Parameters	Sampling Frequency
	and Discharge Paths	non-radiological parameters (Table 5-6)	
Land Surveys	On-Site, Off-Site	γ-spec	Annually[54]
Species at Risk (Barn Swallows and Bats)	On-Site	Monitor Compensatory Habitat	Semi-Annually
Wildlife Mortality	On-site (plant road)	Track wildlife mortality (including birds, reptiles and mammals)	Continuous, as reported by staff

5.4 Step 4: How the Monitoring Results will be Used to Meet the Defined Objectives

This section outlines how the monitoring identified in Section 5.2 will be used to meet the program objectives. The process for the interpretation and reporting of the EMP results is outlined in *Environmental Monitoring Program* [6].

5.4.1 Monitoring to Assess the Level of Risk to Human Health

The radioactive data obtained from the EMP are used to assess the level of risk to human health and safety by calculating radiation doses to the most exposed off-site members of the public (i.e. critic groups) as identified in the DRL model for WL [15].

These calculations address the significant exposure pathways and, where available, incorporate local intake fractions based on a site-specific survey of human receptors in the area. Calculations are based on the CSA N288.1 guidelines and the COG Guidance Document (when available, site-specific data on use of local food and water sources are used), and are performed using spreadsheets and/or the IMPACT code [15]. Recent dose reports [46] outline the dose calculation methods in detail.

Annual average contaminant concentrations are used to calculate annual average dose to the public. Human exposure concentrations are corrected for natural background using the results of monitoring at reference locations so that the dose contribution from WL can be compared to the public dose limit. Radionuclides present below the detection level (L_D) are included in the dose calculations. Radionuclides present below the critical level (L_C) are not included in the dose calculations.

Calculated doses are compared to the regulatory limits in Section 5.4.2.1.

5.4.2 Monitoring to Demonstrate Compliance with Limits

The discussion in the Annual EMP Report will mostly be focused on the most significant impacts observed during the monitoring year, as determined by high contaminant concentrations or

[54] Land Gamma (Road Survey) must be performed in the fall before the first snowfall.

deviations in contaminant trends. Significant impacts are identified by the use of different types of limits.

Three types of limits are applied in the EMP:

- regulatory limits;
- screening criteria, to detect contaminant concentrations above natural background; and
- ecological effects-based criteria (i.e. BV) to identify areas where there is a potential for ecological risk.

5.4.2.1 Regulatory limits

Calculated doses to members of the public, as described in Section 5.4.1, are compared to

- the public dose limit of 1 mSv/a [75]; and,
- the dose triggers for ALARA [76] of 50 µSv/a to individual members of the public, and 1 person-Sv annual collective dose (both occupational and public).

5.4.2.2 Background Screening Criteria

The evaluation process initially involves the application of background screening criteria selected to identify contaminant concentrations that are abnormal.

The screening criteria consist of a combination of generic background concentrations (e.g. background concentrations from the literature, or regionally applicable data on natural background concentrations) and site-specific background concentrations. The site-specific background concentrations are determined by monitoring conditions at one or more reference areas, which are located on or near the WL site but have not been adversely affected by WL operations. The site-specific values usually consist of the upper limit (e.g. mean plus two standard deviations) of the average for the reference location(s). These values are identified and included in Table 5-9 and Table 5-10.

The background screening review is used to generate a list of “parameters of interest (key or critical parameters)” that are subject to further evaluation. The evaluation process involves the generation of trend charts, a review of the trends, and discussion in the Annual EMP Report.

Exceedance of a background screening criterion is not considered a non-conformance.

Table 5-9
Environmental Monitoring Radiological Method Detection Limits (MDL) and Background Values

Environmental Medium	Parameter	Unit	MDL[55]	Background Value	Source
Air Quality and Noise	TLDs	µGy/a	85[56]	< 1200 145-515	[52] [53]
	Land Gamma Survey	nSv/h	10	< 60	[46] (mean plus 2s of background of 2012 to 2017 data)
	Noise	dB	28-42	47	[68]
Wet/Dry Deposition[57]	Gross Alpha	Bq/m^2	1	2	BG is mean plus (n-1) times the standard deviation of 2012 to 2017 [46]
	Gross Beta	Bq/m^2	6	14	
	Cesium-137	Bq/m^2	0.1	0.3	
	Potassium-40	Bq/m^2	6	12	
	Strontium-90[58]	Bq/m^2	0.5	0.7	
Surface water (not used as drinking water)[59]	Gross Alpha	Bq/L	0.30	0.3	BG is geometric mean plus two times the standard deviation of 2009 to 2017 control locations data MAXXAM MDL
	Gross Beta	Bq/L	0.30	0.3	
	Potassium-40	Bq/L	10	0.3	
	Cesium-137	Bq/L	1	< 1	MAXXAM MDL
	Carbon-14	Bq/L	2	< 2	MAXXAM MDL [46]
	Strontium-90	Bq/L	1	< 1	[46] MAXXAM/PACE MDL
	Technetium-99	Bq/L	0.2	< 0.2	
	Americium-241	Bq/L	0.05	< 0.05	MAXXAM MDL [46]
	Tritium oxide	Bq/L	8	< 8	[46]
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	0.025 (< 10[60])	[46]
	Gross Alpha	Bq/L	10	< 10	[45]
	Gross Beta	Bq/L	10	< 10	[45]
	Tritium	Bq/L	8	< 8	[45]

[55] MDLs were calculated using background or blank values as per EPA MDL method 40 CFR Part 136 Appendix B or are from Annual Safety Reports normally based on sample size, count times and counting statistics or value is from Contract Lab analysis sheet.

[56] Detection limit calculated using background values from 2012 to 2017.

[57] The MDL is based on a rain pail (1,320 cm2) or snow sheet sample (1,320 cm2) resulting in 0.2 g of sample ash and counted 100 min for gross beta and Sr-90 analysis, and 400 minutes for gross alpha or 800 min for Cs-137, and K-40 analysis.

[58] Strontium-90 analysis of atmospheric deposition samples was discontinued in 2019. Tritium analysis was considered due to emissions from WR1 (1.5E+09 Bq/wk) but discounted as the average release of tritium from the site is 9E-05 %DRL.

[59] Control ditch location unaffected by WL operations. These are normally collected as 1 litres samples and are ashed before alpha, beta and gamma counting.

[60] Local well waters within the Canadian Shield contain naturally occurring uranium [59] at concentrations >100 ppb, the presence of uranium and its progeny are not unexpected. The reason for high uranium concentrations can be attributed to the presence of dissolved carbonate which is effective for leaching naturally occurring uranium from minerals under oxidizing conditions.

Environmental Medium	Parameter	Unit	MDL[55]	Background Value	Source
Surface Water (Sumps, SL1 and Water Relocation Samples within the WMA)[61]	Cesium-137	Bq/L	5	< 5	[45]
	Americium-241	Bq/L	10	< 10	[45]
	Potassium-40	Bq/L	100	<100	[45]
Surface water (used as drinking water)	Cesium-137	Bq/L	0.003	0.007	BG is average plus two standard deviations of 2007 to 2017 of upstream (SFD) data [46]
	Gross Alpha	Bq/L	0.023	0.050	
	Gross Beta	Bq/L	0.023	0.090	
	Potassium-40	Bq/L	0.040	0.087	
	Strontium-90	Bq/L	0.003	0.009	
	Americium-241	Bq/L	0.006	< 0.002	
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	0.025 (<10)	
	Tritium oxide	Bq/L	3	7	
Fish	Gross beta	Bq/kg (fresh weight)	5	200	BG is the geometric mean plus 2 times the standard deviation of of 2012 to 2017 upstream data (rounded) [46]
	K-40	Bq/kg (fresh weight)	6	200	
	Cs-137	Bq/kg (fresh weight)	1	1.7	
Game, Livestock	Gross alpha	Bq/kg (fresh weight)	5	<11	[66], [58]
	Gross beta	Bq/kg (fresh weight)	5	Deer – 162 Grouse – 233	BG is the geometric mean plus 2 times the standard deviation of 2001 to 2016 data (outer areas)
	Cesium-137	Bq/kg (fresh weight)	1	Deer - 6 Grouse – 5	
	Potassium-40	Bq/kg (fresh weight)	100	Deer - 149 Grouse – 260	
	Strontium-90 (Deer bone)	Bq/kg (fresh weight)	8	64	
Canola	Tritium (free and OBT)	Bq/kg (fresh weight)	HTO 30 OBT 8	HTO < 40 OBT < 8	[60]
Honey	Tritium (free and OBT)	Bq/kg	HTO 30 OBT 19	HTO < 40 OBT < 19	[60]
Native Vegetation	Gross alpha	Bq/kg (fresh weight)	60	90	[46], BG is geometric mean plus 2 standard deviation of 2012 to 2017 data
	Gross beta	Bq/kg (fresh weight)	50	822	

[61] Normally collected as a one litre samples, gamma MDL is based on counting a 500 mL sample for 30 minutes and three 1 mL samples counted for alpha and beta. These samples include sump water, SL-1 (primary cell grab sample), manhole water and standing water from excavations. Gross alpha is assumed to be Am-241 and gross beta is assumed to be Sr-90.

Environmental Medium	Parameter	Unit	MDL[55]	Background Value	Source
	Potassium-40	Bq/kg (fresh weight)	100	960	[66], for BG value in ()
	Cesium-137	Bq/kg (fresh weight)	7	13 (4)	
	Americium-241	Bq/kg (fresh weight)	4	< 4	
	Beryllium-7	Bq/kg fresh weight)	6	NA	
	Strontium-90	Bq/kg (fresh weight)	6	7	
	Tritium (free and OBT)	Bq/kg (fresh weight)	HTO 10 OBT 4	HTO < 10 OBT < 4	[60]
Garden Crop	Gross alpha	Bq/kg (fresh weight)	4	Fruit - < 6 Root - < 6 Leaf – < 20	MDLs are from Kinetrics, [46], BG is geometric mean plus 2 times standard deviation of 2012 to 2017 data
	Gross beta	Bq/kg (fresh weight)	13	Fruit - 110 Root - 190 Leaf – 1200	
	Potassium-40	Bq/kg (fresh weight)	10	Fruit – 120 Root - 220 Leaf – 1680	
	Cesium-137	Bq/kg (fresh weight)	1	Fruit - < 1 Root - < 1 Leaf – < 1	
	Americium-241	Bq/kg (fresh weight)	4	Fruit – < 4 Root - < 4 Leaf – < 4	
	Beryllium-7	Bq/kg (fresh weight)	8	Fruit - 24 Root - 30 Leaf – 110	
	Strontium-90	Bq/kg (fresh weight)	0.1	Fruit - 5 Root - 5 Leaf – 9	
Soil (WMA)	Gross alpha	Bq/kg	100	970	Maxxam Lab MDL, BG data is mean plus 2s of non-impacted areas (B408, B409, B415, B416, B428) land clearance samples [66], for BG value for Cs-137
	Gross beta	Bq/kg	100	1800	
	Potassium-40	Bq/kg	3	750	
	Cesium-137	Bq/kg	10	20 to 110 Bq/kg	
	Americium-241	Bq/kg	10	< 10	
	Strontium-90	Bq/kg	100	< 100	
Soil (Land Clearance)	Gross alpha	Bq/kg	100	970	Maxxam Lab MDL,
	Gross beta	Bq/kg	100	1800	
	Potassium-40	Bq/kg	3	750	
	Cesium-137	Bq/kg	10	< 10	

Environmental Medium	Parameter	Unit	MDL[55]	Background Value	Source
	Americium-241	Bq/kg	10	< 10	BG data is mean plus 2s of non-impacted areas (B408, B409, B415, B416, B428) land clearance samples
	Strontium-90	Bq/kg	100	< 100	
Sediment	Gross alpha	Bq/kg	240	600	MDL is three times the standard deviation of the 2012 to 2017 data from the upstream locations. BG is geometric mean plus 2 times (rounded) the standard deviation of 2012 to 2017 data for upstream locations
	Gross beta	Bq/kg	350	900	
	Potassium-40	Bq/kg	420	900	
	Cesium-137	Bq/kg	13	< 20	
	Americium-241	Bq/kg	10	< 10	
	Strontium-90	Bq/kg	100	< 100	

Table 5-10
***Non-Radioactive Background Values* for the Whiteshell Laboratories Site and Their Comparison to Current Laboratory Method Detection Limits (LMDL)**

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Background Value*	Ref
			Surface Water[62]		
3	pH	pH unit	--	7.6	MAXXAM MDLs
6	Phosphorus (Total)	µg/L	5	230	BG- Mean plus 2 s of the 2003 to 2017 of Control location data
7	Conductivity	µS/cm	1.0	620	
9	Barium, (Total)	µg/L	1.0	75	MAXXAM MDLs BG - Mean plus 2 s of the 2016-2018 of Control location data
9	Beryllium, (Total)	µg/L	0.10	< 0.10	
9	Boron, (Total)	µg/L	50	< 50	
9	Cadmium, (Total)	µg/L	0.01	< 0.01	
9	Chromium, hexavalent (Cs(VI))	µg/L	0.5	To be assessed	MAXXAM MDL
	Chromium, trivalent (Cr(III))	µg/L	1	To be assessed	MAXXAM MDL
9	Cobalt, (Total)	µg/L	0.2	0.8	MAXXAM MDLs, BG- Mean plus 2 s of the 2016-2018 of Control location data
9	Copper, (Total)	µg/L	0.5	15	BG - Mean plus 2 s of the 2003 to 2017 of Control location data
9	Lead, (Total)	µg/L	0.2	0.3	
9	Molybdenum, (Total)	µg/L	1.0	4	MAXXAM MDLs, BG- Mean plus 2 s of the 2016-2018 of Control location data
9	Nickel, (Total)	µg/L	1.0	4.6	BG- Mean plus 2 s of the 2003 to 2017 of Control location data
9	Selenium, (Total)	µg/L	0.10	0.24	MAXXAM MDLs, BG is Mean plus 2 s of the 2016-2018 of Control location data
9	Silicon, (Total)	µg/L	100	8340	
9	Silver, (Total)	µg/L	0.020	< 0.02	
9	Strontium, (Total)	µg/L	1.0	350	
9	Thallium, (Total)	µg/L	0.10	0.04	
9	Tin, (Total)	µg/L	5.0	< 5	
9	Titanium, (Total)	µg/L	5.0	10	
9	Vanadium, (Total)	µg/L	5.0	< 5	
9	Zinc, (Total)	µg/L	5.0	18	MAXXAM MDLs, BG- Mean plus 2 s of the 2003 to 2017 of Control location data

[62] Control Ditch Location data for comparison to ditch water, landfill dugout, catch/containment tray, sump water, manhole water and standing water from excavations.

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Background Value*	Ref
9	Zirconium, (Total)	µg/L	0.10	1	MAXXAM MDLs, BG - Mean plus 2 s of the 2016-2018 of Control location data
9a	Iron, (Total)	µg/L	10	840	MAXXAM MDLs BG - Mean plus 2 s of the 2003 to 2017 of Control location data
9a	Magnesium, (Total)	µg/L	1.0	84,000	MAXXAM MDLs BG- mean (2017, 2018) plus 2SD
-	Sodium, (Total)	mg/L	0.05	43,000	
10	Arsenic, (Total)	µg/L	0.10	2.6	
12	Mercury, (Total)	µg/L	0.0020	0.098	MAXXAM MDLs BG- Mean plus 2 s of the 2003 to 2017 of Control location data
14	Phenolics (4AAP)	mg/L	0.001	0.005	MAXXAM MDLs, BG - Mean plus 2s of the 2003 to 2017 of Control location data
16	Trichloroethylene (trichloroethene)	µg/L	0.5	< 0.5	MAXXAM MDLs, BG – 2017, 2018 landfill dugout
17	Benzene,	µg/L	0.40	< 0.4	
	Toluene,	µg/L	0.40	< 0.4	
	Ethylbenzene,	µg/L	0.40	< 0.4	
	Xylene	µg/L	0.40	< 0.4	
17	Acetone	µg/L	15	< 15	MAXXAM MDLs, BG is less than MDL
19	Extractables, Neutral di-n-butyl Phthalate (DBP)	µg/L	NA	To be assessed	NA
	Di-2-Ethylhexyl Phthalate (DEHP),	µg/L	NA		
20	Extractables, Acid (Phenolics)	mg/L	0.001	0.005	BG - Mean plus 2s of the 2003 to 2017 of Control location data
23	Extractables, Chlorinated (chlorobenzenes)	µg/L	0.50	< 0.5	MAXXAM MDLs, BG – 2017, 2018 landfill dugout
25	Solvent Extractables (Oil and Grease)	mg/L	1.0	2	Mean plus 2 s of the 2003 to 2017 of Control location data MAXXAM MDLs
30	Chloride	mg/L	1.0	20	MAXXAM MDLs, BG – 2017, 2018 landfill dugout
30	Sulphate	mg/L	1.0	110	
30	Nitrate (N)	mg/L	0.02	0.07	
30	Nitrite (N)	mg/L	0.005	0.04	
			Soils[63]		
	pH	NA	NA	6 to 8	MAXXAM MDLs,
9	Antimony	mg/kg	0.5	0.5	MAXXAM MDLs,

[63] Soil from non-impacted areas

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Background Value*	Ref
9	Barium	mg/kg	1.0	180	BG – mean plus 2s of B408, 409, 415, 416, 418 428 clearance samples
9	Beryllium	mg/kg	0.40	1	
9	Cadmium	mg/kg	0.050	0.7	
9	Chromium	mg/kg	1	45	
9	Cobalt	mg/kg	0.30	20	
9	Copper	mg/kg	0.50	35	MAXXAM MDLs, BG – mean plus 2s of B408, 409, 415, 416, 418 428 clearance samples
9	Lead	mg/kg	0.10	20	
9	Molybdenum	mg/kg	0.10	1	
9	Nickel	mg/kg	0.80	40	
9	Selenium, (Total)	mg/kg	0.50	1.2	
9	Silver, (Total)	mg/kg	0.20	0.6	
9	Thallium, (Total)	mg/kg	0.10	0.4	
9	Tin, (Total)	mg/kg	1.0	1.1	
9	Uranium, (Total)	mg/kg	0.20	1.8	
9	Vanadium, (Total)	mg/kg	1.0	70	
9	Zinc	mg/kg	1.0	100	
9a	Iron	mg/kg	50	30,000 (>3%) {30, 330}	MAXXAM MDLs, BG Background Level in WL region of Manitoba [71] and {BG – mean plus 2s of B408, 409, 415, 416, 418 428 clearance samples}
10	Arsenic	mg/kg	0.50	8	MAXXAM MDLs, BG – mean plus 2s of B408, 409, 415, 416, 418 428 clearance samples
12	Mercury	mg/kg	0.050	< 0.07	
17	Benzene	mg/kg	0.0050	< 0.005	MAXXAM MDLs, BG- B409 clearance samples
	Toluene	mg/kg	0.020	< 0.02	
	Ethyl Benzene	mg/kg	0.010	< 0.01	
	Xylene	mg/kg	0.040	< 0.04	
	F1 (C6-C10)	mg/kg	10	< 10	
	F2 (C10-C16)	mg/kg	20	23	MAXXAM MDLs, BG- B409, 416, 418 and 428 clearance samples
	F3 (C16-C34)	mg/kg	20	60	
	F4 (C34-C50)	mg/kg	20	60	
Sediments[64]					
9	Antimony, (Total)	mg/kg	0.5	To be assessed	MAXXAM MDLs
	Barium, (Total)	mg/kg	1.0	To be assessed	MAXXAM MDLs
9	Beryllium, (Total)	mg/kg	0.4	< 1.3	MAXXAM MDLs, CSR [12]
9	Cadmium, (Total)	mg/kg	0.05	< 1.3	
9	Chromium, (Total)	mg/kg	1.0	4.9	
9	Cobalt, (Total)	mg/kg	0.50	2.4	
9	Copper, (Total)	mg/kg	1.0	2.4	
9	Lead, (Total)	mg/kg	0.50	< 1.3	
9	Molybdenum, (Total)	mg/kg	0.40	2.8	
9	Nickel, (Total)	mg/kg	1.0	4.7	
9	Selenium, (Total)	mg/kg	0.50	To be assessed	MAXXAM MDL

[64] From upstream location

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Background Value*	Ref
9	Silver, (Total)	mg/kg	0.20	< 1.4	MAXXAM MDL, CSR [12]
9	Thallium, (Total)	mg/kg	0.10	To be assessed	MAXXAM MDL
9	Tin, (Total)	mg/kg	1.0	To be assessed	MAXXAM MDL
9	Uranium, (Total)	mg/kg	0.20	To be assessed	MAXXAM MD]
9	Vanadium, (Total)	mg/kg	1.0	3.9	MAXXAM MDLs, CSR [12]
9	Zinc, (Total)	mg/kg	10	10.8	
10	Arsenic, (Total)	mg/kg	0.50	To be assessed	MAXXAM MDL
12	Mercury, (Total)	mg/kg	0.05	0.0034	CNL MDLs, CSR [12]
-	Total Organic(as HB 40)	mg/kg	1	< 60	

5.4.2.3 Benchmark Values (BV)

The evaluation process also involves the application of ecological effects-based criteria, i.e. BVs, selected to identify areas where there is a potential for ecological risk.

The BVs consist of a combination of

- Federal or provincial guidelines for environmental quality [19], [20], [21], [22], [23], [68], [70], [69], [72];
- Predicted levels from WL CSR [12];
- Lowest observable effect levels from the literature [60], [56];
- Radiation Screening Criteria used for identifying COPECs [56], [58]; or
- The geometric mean plus three times the standard deviation of the background values.

Benchmark values are intended to identify significant changes or high concentrations of contaminants at the monitoring locations. Exceedance of a BV does not necessarily indicate that ecological impacts would occur, but instead indicates that there is some potential for ecological impacts.

Note: Not all parameters measured under this program have an associated *Benchmark Value,* in fact, there are a number which do not; these generally consist of measures of environmental indicators (e.g. BOD) instead of pollutants; or they could be pollutants but have not had guidelines developed yet as they have not been federally identified as federal priority pollutants requiring the development of a guideline [21].

The BVs are listed in Table 5-11 and Table 5-12.

Exceedance of a BV is considered a non-conformance.

Table 5-11
Environmental Monitoring Radiological Method Detection Limits (MDL) and Benchmark Values (BVs)

Environmental Medium	Parameter	Unit	MDL[65]	Benchmark Value	Source
Air Quality and Noise	TLDs	µGy/a	85 145-515	< 2,000 (WL Main Campus)[66] < 10,000 (WL WMA. Canister Area)	[46], [65] BV is the geometric mean plus 3 times the standard deviation of 2012 to 2017 (perimeter fence for main campus and canister area for WMA)
	Land Gamma Survey	nSv/h	10	< 500	[46], [54]
	Noise	dB	28-42	85	[69]
Wet/Dry Deposition	Gross Alpha	Bq/m^2	1	3	[46], BV - average value for this station for 2012 to 2017 plus three standard deviations.
	Gross Beta	Bq/m^2	6	13 (17)	[55], BV in () is average value of results for this station for 2012 to 2017 plus three standard deviations.
	Cesium-137	Bq/m^2	0.1	3 (0.3)	
	Potassium-40	Bq/m^2	6	14	[46], BV - average value for this station for 2012 to 2017 plus three standard deviations.
	Strontium-90	Bq/m^2	0.5	3 (1)	[55], BV in () average value for this station for 2012 to 2017 plus three standard deviations.
Surface water (not used as drinking water)[67]	Gross Alpha	Bq/L	0.30	16.2 (20)	MDL based on Control Ditch Location data 2009 to 2018 [56] ([57])
	Gross Beta	Bq/L	0.30	666 (10)	
	Cesium-137	Bq/L	1	291	[56]

[65] MDLs were calculated using background or blank values as per EPA MDL method 40 CFR Part 136 Appendix B or are from Annual Safety Reports normally based on sample size, count times and counting statistics or value is from Contract Lab analysis sheet.

[66] The benchmark values were assessed against radiological safety zone classifications. The main campus is expected to be very low radiation hazard (< 0.5 microsievert/hour/< 4380 microgray per year) and the WMA and Canister Areas are expected to be low radiation hazard (> 0.5 but less than 10 microsievert/hour/< 87600 microgray per year)

[67] Normally collected as a one litre samples, gamma MDL is based on counting a 500 mL sample for 30 minutes, gross alpha and gross beta MDL assumes ash of ~100 mg and a 100 minute count time, Sr-90 is 100 mL aliquot radiochemical separation followed by 100 minute count time. These samples include ditch water, landfill dugout and catch/containment tray, sump water, manhole water and standing water from excavations.

Environmental Medium	Parameter	Unit	MDL[65]	Benchmark Value	Source
				3 (for WMA catch/containment tray[68])	
	Potassium-40	Bq/L	10	NA	MAXXAM MDL NA
	Carbon-14	Bq/L	2	200	MAXXAM MDL [20]
	Strontium-90	Bq/L	1	666 (10)	MAXXAM/PACE MDL [56] ([57])
	Technetium-99	Bq/L	0.2	200	MAXXAM/PACE MDL [20]
	Americium-241	Bq/L	0.05	16.2 (20)	MAXXAM MDL [56] , ([57])
	Tritium oxide	Bq/L	8	1.27E+07 (1E+07)	MDL based on Control Ditch Location data 2009 to 2018 [56], ([57])
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	2.5 (100[69])	[59]
Surface Water (Sumps and Water Relocation Samples within the WMA)[70]	Gross Alpha	Bq/L	10	16.2	[56]
	Gross Beta	Bq/L	10	666	[56]
	Tritium	Bq/L	8	7000 (12.7 MBq/L)	[19] ([56])
	Cesium-137	Bq/L	5	291	[56]
	Americium-241	Bq/L	10	16.2	[56]
	Potassium-40	Bq/L	100	NA	NA
Surface water (used as drinking water)[71]	Cesium-137	Bq/L	0.003	10	[19]
	Gross Alpha	Bq/L	0.023	0.5	[19]
	Gross Beta	Bq/L	0.023	5	[19]
	Potassium-40	Bq/L	0.040	NA	
	Strontium-90	Bq/L	0.003	5	[19]
	Americium-241	Bq/L	0.006	0.7	[20]
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	0.5 (20)	[19]
	Tritium oxide	Bq/L	3	7,000 (5.0 background level[72])	[19]
Fish	Gross beta	Bq/kg (fresh weight)	5	250	

[68] Alert Environmental Specialist if the Cs-137 activity in the Catch/Containment Tray exceeds 3.0 Bq/L of at any time (see WLWMA-106030-OP-001 [30]).

[69] Local well waters within the Canadian Shield contain naturally occurring uranium [59] at concentrations >100 ppb, the presence of uranium and its progeny are not unexpected. The reason for high uranium concentrations can be attributed to the presence of dissolved carbonate which is effective for leaching naturally occurring uranium from minerals under oxidizing conditions.

[70] Normally collected as a one litre samples, gamma MDL is based on counting a 500 mL sample for 30 minutes and three 1 mL samples counted for alpha and beta. These samples include sump water, manhole water and standing water from excavations. Gross alpha is assumed to be Am-241 and gross beta is assumed to be Sr-90.

[71] Normally collected as at least 25 litres samples, separate aliquot for tritium analysis, remainder is evaporated to dryness and the ash is alpha, beta and gamma counted, then processed for Sr-90 counting.

[72] Background levels of tritium taken from Health Canada's Canadian Radiological Monitoring Network – tritium in drinking water (saved as excel file).

Environmental Medium	Parameter	Unit	MDL[65]	Benchmark Value	Source
	K-40	Bq/kg (fresh weight)	6	250	BV is geometric mean plus 5 times the standard deviation of 2012 to 2017 upstream data (rounded)
	Cs-137	Bq/kg (fresh weight)	1	4[73]	[46]
Game, Livestock	Gross alpha	Bq/kg (fresh weight)	5	33	[66], [58]
	Gross beta	Bq/kg (fresh weight)	5	Deer – 193 Grouse – 294	BV is 3 times the geometric mean of 2001 to 2016 data
	Cesium-137	Bq/kg (fresh weight)	1	Deer [74] - 33 Grouse – 45	
	Potassium-40	Bq/kg (fresh weight)	100	Deer - 174 Grouse – 320	
	Strontium-90 (Deer bone)	Bq/kg (fresh weight)	8	80	
Canola	Tritium (free and OBT)	Bq/kg (fresh weight)	HTO 30 OBT 8	HTO [75] 104,000 OBT 45,2000	[60]
Honey	Tritium (free and OBT)	Bq/kg	HTO 30 OBT 19	HTO[62] 2.5E6 OBT 1.3E6	[60], [15]
Native Vegetation	Gross alpha	Bq/kg (fresh weight)	60	130	[46], BV is 3 times the geometric mean of 2012 to 2017 data
	Gross beta	Bq/kg (fresh weight)	50	1550[76]	
	Potassium-40	Bq/kg (fresh weight)	100	1550	
	Cesium-137	Bq/kg (fresh weight)	7	21	
	Americium-241	Bq/kg (fresh weight)	4	NA	
	Beryllium-7	Bq/kg (fresh weight)	6	NA	

[73] The concentration of Cs-137 in fish would have to be 1750 Bq/kg to trigger an ALARA (0.05 mSv/a) review.

[74] The concentration of Cs-137 in game would have to be 240 Bq/kg to trigger an ALARA (0.050 mSv/a) review.

[75] Values from the CNSC Implementation of Recommendations from the Tritium Studies Synthesis Report. It states that the IEMP Screening levels were developed by CNSC staff using the methodology outlined in CSA standard N288.1-14 and conservative assumptions. The screening level for a particular radionuclide in a particular medium (e.g., water, air, foodstuffs) represents the activity concentration that would result in a dose of 0.1 mSv per year, a dose at which no health impacts are expected.

[76] Dose to meadow grass for gross beta as Sr-90 would be 0.02 mGy/d, which is well below the benchmark values of 100 µGy/h (2.4 mGy/d) for doses to terrestrial biota [58].

Environmental Medium	Parameter	Unit	MDL[65]	Benchmark Value	Source
	Strontium-90	Bq/kg (fresh weight)	10 (0.05 Bq/g ash)	8	[46], BV is 3 times the geometric mean of 2012 to 2017 data
	Tritium (free and OBT)	Bq/kg (fresh weight)	HTO 10 OBT 4	HTO [62] 104,000 OBT 45,2000	[60]
Garden Crop	Gross alpha	Bq/kg (fresh weight)	4	Fruit - 10 Root – 10 Leaf – 20	MDLs are from Kinetrics, BV is geometric mean plus 3 times standard deviation of 2012 to 2017 data [46], or 0.05 mSv/a potential dose (trigger for ALARA review) whichever is less.
	Gross beta	Bq/kg (fresh weight)	13	Fruit - 130 Root - 210 Leaf – 1600	
	Potassium-40	Bq/kg (fresh weight)	10	Fruit – 140 Root - 250 Leaf – 2300	
	Cesium-137	Bq/kg (fresh weight)	1	Fruit - 2 Root - 2 Leaf – 1	
	Americium-241	Bq/kg (fresh weight)	4	Fruit - 6 Root - 4 Leaf – 6	
	Beryllium-7	Bq/kg (fresh weight)	8	Fruit - 1000 Root - 1000 Leaf – 1000	BV is based on a <0.005 mSv/a dose to a member of the public
	Strontium-90	Bq/kg (fresh weight)	0.1	Fruit - 10 Root - 10 Leaf – 20	BV is geometric mean plus 3 times standard deviation of 2012 to 2017 data (rounded), [46]
Soil (WMA)	Gross alpha	Bq/kg	100	1E+05	Maxxam Lab MDL, BVs from [57]
	Gross beta	Bq/kg	100	8E+02 [77]	
	Potassium-40	Bq/kg	3	900[78]	
	Cesium-137	Bq/kg	10	8E+02	
	Americium-241	Bq/kg	10	1E+05	
	Strontium-90	Bq/kg	100	2E+06	
Soil (Land Clearance)	Gross alpha (as Am-241)	Bq/kg	100	2436 (agriculture land use)	Maxxam Lab MDL, BVs from [61][79]

[77] Gross beta is assessed after K-40 contribution and Cs-137 contributions are removed and residual is assumed to be Sr-90/Y-90.

[78] BV for K-40 is mean plus 3 standard deviations of unaffected area soils.

[79] The soil BV is the soil activity concentration resulting in a 0.1 mSv/a dose for the residential land use identified in Table 3-2 of WL-509420-REPT-001.

Environmental Medium	Parameter	Unit	MDL[65]	Benchmark Value	Source
	Gross beta (as Cs-137)	Bq/kg	100	478[80]	
	Potassium-40	Bq/kg	3	900	
	Cesium-137	Bq/kg	10	478	
	Americium-241	Bq/kg	10	2436 (agriculture land use)	
	Strontium-90	Bq/kg	100	196	
Sediment	Gross alpha	Bq/kg	240	(1100) 2E+05 [57] 1000 [74] as natural uranium	MDL is three times the standard deviation of the 2012 to 2017 data from the upstream locations. BV in () is 3 times (rounded) the geometric mean of 2012 to 2017 data for upstream locations DOE Graded Approach to Evaluating Radiation Doses to Aquatic and Terrestrial Biota [56] NSRDR Unconditional Clearance Level [74]
	Gross beta	Bq/kg	350	(1900) 2E+04 [57]	
	Potassium-40	Bq/kg	420	(1800) 10,000 [74]	
	Cesium-137	Bq/kg	13	(28) 1E+05 [57] 100 [74]	
	Americium-241	Bq/kg	10	(1100) 2E+04 [56] 100 [74]	
	Strontium-90	Bq/kg	100	(1900) 2E+05 [56] 1000 [74]	

5.4.3 Short-term Evaluation of EMP Data

The following 3-Step process is followed to determine whether the program's monitored results are of ecological concern.

Step 1: Calculate the annual average concentration[81]:

Step 2: Determine if above the *Benchmark Value* (see Table 5-11 and Table 5-12).

Note: Not all parameters measured under this program have an associated *Non-Radioactive Benchmark Value*, as discussed in the previous section.

Nevertheless, it is possible that the generic CWQGs and PWQGs are over or under-protective at sites with unique conditions. For example, at the Control Ditch location, certain substances (iron) are naturally present in the environment at concentrations above the guidelines.

[80] Gross beta is assessed after K-40 contribution and Cs-137 contributions are removed and residual is assumed to be Sr-90/Y-90.

[81] Annual average (as opposed to annual maximums) is appropriate for comparison to *Non-radiological Benchmark Values* as these guidelines are based on long-term no-effects concentrations.

Therefore, CNL needs to take this background information into consideration when interpreting results as discussed below in Step 3.

Step 3: Determine if measured concentrations are above local background values. In order to do this, an upper limit of background is calculated for each associated background monitoring location using the 1989 Dunn method of the annual mean + 2SD value for the association between the Whiteshell site's background monitoring locations (Control Location Ditch and Intake) and monitoring locations.

The highest upper limit over a number of years is used where data is available. Annual averages of monitoring results per monitoring station are then compared to the watershed's upper limit of background. If the annual mean exceeds both the *Benchmark Value* and the upper limit of background, there is a potential for ecological concern and close attention should be paid to the situation which might include further sampling/ investigation. In the instance where the monitoring results are above the *Benchmark Value* but not above the background limit, there is no ecological concern. Figure 5-1 illustrates this 3-Step Process:

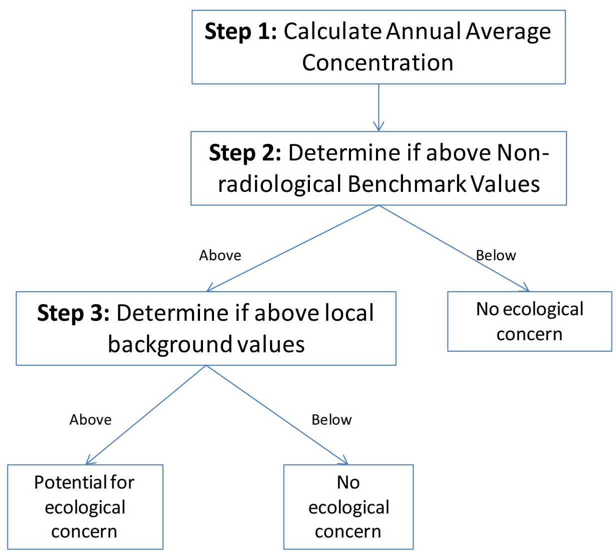

Figure 5-1 Short-Term Evaluation of Surface Water Monitoring Data

Table 5-12
Non-Radioactive Benchmark Values for the Whiteshell Laboratories Site and Their Comparison to Current Laboratory Method Detection Limits (LMDL)

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Benchmark Value*	Ref
Surface Water[82] (not used for drinking water)					
3	pH	pH unit	--	6.5-9.0	[21]
6	Phosphorus (Total)	µg/L	5	270	MAXXAM MDLs
7	Conductivity	µS/cm	1.0	740	BV Mean (2003 to 2017) plus 3s (ditch control location data)
9	Barium, (Total)	µg/L	1.0	1000	MAXXAM MDLs, [19]
9	Beryllium, (Total)	µg/L	0.10	100	MAXXAM MDLs, [23]
9	Boron, (Total)	µg/L	50	500	MAXXAM MDLs, [23]
9	Cadmium, (Total)	µg/L	0.01	0.09	MAXXAM MDL, [21]
9	Chromium, hexavalent (Cs(VI))	µg/L	0.5	1.0	MAXXAM MDL, [21]
	Chromium, trivalent (Cr(III))	µg/L	1	8.9	MAXXAM MDL, [21]
9	Cobalt, (Total)	µg/L	0.2	0.9	MAXXAM MDL, [22]
9	Copper, (Total)	µg/L	0.5	20	MAXXAM MDL, BV Mean (2003 to 2017) plus 3s (ditch control location data)]
9	Lead, (Total)	µg/L	0.2	6	
9	Molybdenum, (Total)	µg/L	1.0	25	MAXXAM MDLs, [21]
9	Nickel, (Total)	µg/L	1.0	7	MAXXAM MDLs, (2003 to 2017) plus 3s (ditch control location data)]
9	Selenium, (Total)	µg/L	0.10	1.0	MAXXAM MDLs, [23]
9	Silicon, (Total)	µg/L	100	9950	MAXXAM MDLs, BV mean (Ditch Control location- 2017, 2018) plus 3SD
9	Silver, (Total)	µg/L	0.020	0.25	MAXXAM MDLs, [21]
9	Strontium, (Total)	µg/L	1.0	7000	MAXXAM MDLs, [19]
9	Thallium, (Total)	µg/L	0.10	0.8	MAXXAM MDLs, [21]
9	Tin, (Total)	µg/L	5.0	30	MAXXAM MDLs, BV mean (2017, 2018) plus 3SD
9	Titanium, (Total)	µg/L	5.0	30	MAXXAM MDLs, BV mean (2017, 2018) plus 3SD
9	Vanadium, (Total)	µg/L	5.0	30	MAXXAM MDLs, BV mean (2017, 2018) plus 3SD
9	Zinc, (Total)	µg/L	5.0	1000	MAXXAM MDLs, [23]
9	Zirconium, (Total)	µg/L	0.10	37	MAXXAM MDLs, [21]
9a	Iron, (Total)	µg/L	10	1000	MAXXAM MDLs Mean plus 3s of the 2003 to 2017 of Control location data

[82] Includes landfill dugout waters and can be used for water relocation samples (where applicable), and as benchmarks for WMA, Lagoon and Landfill wells.

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Benchmark Value*	Ref
9a	Magnesium, (Total)	µg/L	1.0	110,000	MAXXAM MDLs BV - Mean plus 3s of the 2016 to 2018 of Control location data
-	Sodium, (Total)	mg/L	0.05	200,000	MAXXAM MDLs, [19]
10	Arsenic, (Total)	µg/L	0.10	5	MAXXAM MDLs, [21]
12	Mercury, (Total)	µg/L	0.0020	0.13	MAXXAM MDLs Mean plus 3s of the 2003 to 2017 of Control location data
14	Phenolics (4AAP)	mg/L	0.001	0.007	MAXXAM MDLs BV - Mean plus 3s of the 2003 to 2017 of Control location data
16	Trichloroethylene (trichloroethene)	µg/L	0.5 to 2	21	MAXXAM MDLs, [23]
17	Benzene, Toluene, Ethylbenzene, Xylene	µg/L µg/L µg/L µg/L	0.40 0.40 0.40 0.40	370 2 90 300	MAXXAM MDLs, [21] MAXXAM MDLs, [21] MAXXAM MDLs, [21] MAXXAM MDLs, [23]
17	Acetone	µg/L	15	>45	MAXXAM MDLs, BV is three times MDL
19	Extractables, Neutral di-n-butyl Phthalate (DBP) Di-2-Ethylhexyl Phthalate (DEHP),	µg/L µg/L	NA NA	19 16	[21]
20	Extractables, Acid (Phenolics)	µg/L	1	4	MAXXAM MDLs, [21]
23	Extractables, Chlorinated (chlorobenzenes)	µg/L	0.50	1.8	MAXXAM MDLs, [21]
25	Solvent Extractables (Oil and Grease)	mg/L	1.0	2.5	Mean plus 3s of the 2003 to 2017 of Control location data MAXXAM MDLs
30	Chloride	mg/L	1.0	640	MAXXAM MDLs, [21]
30	Sulphate	mg/L	1.0	500	MAXXAM MDLs, , [19]
30	Nitrate (N)	mg/L	0.02	550	MAXXAM MDLs, [21]
30	Nitrite (N)	mg/L	0.005	60	MAXXAM MDLs, [21]
			Soils[83]		
	pH	NA	NA	6 to 8	MAXXAM MDLs, CCME [70]
9	Antimony	mg/kg	0.5	20 (agriculture)	MAXXAM MDLs, CCME [70]
9	Barium	mg/kg	1.0	750 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Beryllium	mg/kg	0.40	4 (8)	MAXXAM MDLs, CCME [70]
9	Cadmium	mg/kg	0.050	1.4 (22)	MAXXAM MDLs, CCME [70]

[83] Soil Quality Guidelines for the Protection of Environmental and Human Health, Agricultural Limit (Industrial Limit)

ATG	Parameter	Unit	LMDL	Non-Radioactive Benchmark Value	Ref
9	Chromium	mg/kg	1	64 (87)	MAXXAM MDLs, CCME [70]
9	Cobalt	mg/kg	0.30	40 (300)	MAXXAM MDLs, CCME [70]
9	Copper	mg/kg	0.50	63 ((1)	MAXXAM MDLs, CCME [70]
9	Lead	mg/kg	0.10	70 (600)	MAXXAM MDLs, CCME [70]
9	Molybdenum	mg/kg	0.10	5 (40)	MAXXAM MDLs, CCME [70]
9	Nickel	mg/kg	0.80	45 (89)	MAXXAM MDLs, CCME [70]
9	Selenium, (Total)	mg/kg	0.50	1 (agriculture), 6	MAXXAM MDLs, CCME [70], BV- mean plus 3s of B408, 409, 415, 416, 418 428 clearance samples
9	Silver, (Total)	mg/kg	0.20	20 (agriculture)	MAXXAM MDLs, CCME [70]
9	Thallium, (Total)	mg/kg	0.10	1 (agriculture)	MAXXAM MDLs, CCME [70]
9	Tin, (Total)	mg/kg	1.0	5 (agriculture)	MAXXAM MDLs, CCME [70]
9	Uranium, (Total)	mg/kg	0.20	23 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Vanadium, (Total)	mg/kg	1.0	130 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Zinc	mg/kg	1.0	200 (360)	MAXXAM MDLs, CCME [70]
9a	Iron	mg/kg	50	30,000 (>3%)	MAXXAM MDLs, BV Background Level in WL region of Manitoba [71]
10	Arsenic	mg/kg	0.50	12 (12)	MAXXAM MDLs, CCME [70]
12	Mercury	mg/kg	0.050	6.6 (50)	MAXXAM MDLs, CCME [70]
17	Benzene	mg/kg	0.0050	0.0068	MAXXAM MDLs, CCME Tier 1 Levels [72]
	Toluene	mg/kg	0.020	0.08	MAXXAM MDLs, CCME Tier 1 Levels [72]
	Ethyl Benzene	mg/kg	0.010	0.018	MAXXAM MDLs, CCME Tier 1 Levels [72]
	Xylene	mg/kg	0.040	2.4	MAXXAM MDLs, CCME Tier 1 Levels [72]
	F1 (C6-C10)	mg/kg	10	210 (320)	MAXXAM MDLs, CCME Tier 1 Levels [72]
	F2 (C10-C16)	mg/kg	20	150 (260)	MAXXAM MDLs, CCME Tier 1 Levels [72]
	F3 (C16-C34)	mg/kg	20	1300 (2500)	MAXXAM MDLs, CCME Tier 1 Levels [72]
	F4 (C34-C50)	mg/kg	20	5600 (6600)	MAXXAM MDLs, CCME Tier 1 Levels [72]
Sediments[84]					
9	Antimony, (Total)	mg/kg	0.5	20 (soil, agriculture)	MAXXAM MDLs, CCME [70]
	Barium, (Total)	mg/kg	1.0	750 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Beryllium, (Total)	mg/kg	0.4	4 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Cadmium, (Total)	mg/kg	0.05	0.6	MAXXAM MDLs, [73]
9	Chromium, (Total)	mg/kg	1.0	37.3	MAXXAM MDLs, [73]
9	Cobalt, (Total)	mg/kg	0.50	40 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Copper, (Total)	mg/kg	1.0	35.7	MAXXAM MDLs, [73]
9	Lead, (Total)	mg/kg	0.50	35	MAXXAM MDLs, [73]
9	Molybdenum, (Total)	mg/kg	0.40	5 (soil, agriculture)	MAXXAM MDLs, CCME [70]

[84] Soil quality guideline used where no aquatic value was available.

ATG	*Parameter*	Unit	LMDL	*Non-Radioactive Benchmark Value*	Ref
9	Nickel, (Total)	mg/kg	1.0	45 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Selenium, (Total)	mg/kg	0.50	1 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Silver, (Total)	mg/kg	0.20	20 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Thallium, (Total)	mg/kg	0.10	1 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Tin, (Total)	mg/kg	1.0	5 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Uranium, (Total)	mg/kg	0.20	23 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Vanadium, (Total)	mg/kg	1.0	130 (soil, agriculture)	MAXXAM MDLs, CCME [70]
9	Zinc, (Total)	mg/kg	10	123	MAXXAM MDLs, CCME [70]
10	Arsenic, (Total)	mg/kg	0.50	5.9	MAXXAM MDLs, [73]
12	Mercury, (Total)	mg/kg	0.05	0.17	MAXXAM MDLs, [73]
-	Total Organic(as HB 40)	mg/kg	1	75	CNL MDLs, CSR [12]

5.4.3.1.1 Short and Long-Term Evaluation of EMP Data

The monitoring results are routinely reviewed looking for anomalous results and trends within the given monitoring year or over a number of years. It should be noted that concentrations of non-radioactive results tend to be variable in surface waters due to natural occurrences (e.g. rain fall events etc.) and therefore changes in monitoring results over time are not necessarily a direct result of anthropogenic activities.

5.4.3.1.2 Long-term Evaluation of EMP Data

The program itself is routinely reviewed to ensure the monitoring in place is appropriate, as the program is dynamic in nature. The types and frequencies of these reviews are shared among the Integrated Environmental Monitoring Program and are therefore outlined in *Whiteshell Laboratories Integrated Environmental Monitoring Program Framework* [5].

5.4.4 Monitoring to Confirm the Effectiveness of Containment / Effluent Control

Emissions based on effluent monitoring are compared to those inferred from the results of environmental monitoring to see how well they agree:

- The control of radionuclide releases to the Winnipeg River is determined by monitoring radionuclides in the effluent streams (e.g. Process Outfall and Sewage Lagoon) that discharge to the river. An approximate check on the accuracy of this effluent monitoring can be obtained by concurrent measurements of radionuclide concentrations in the river downstream of the discharges. The emissions data are used together with hydrological data reference water quality data to model water concentrations to confirm that the measured concentrations in the Winnipeg River are reasonable.
- The containment of active waste within the WMAs can be confirmed by monitoring surface water at upstream and downstream locations. The EMP will identify if any concentrations are increased downstream, indicating loss of containment.

If there is a discrepancy between the results of effluent monitoring and environmental monitoring, for example if certain radionuclides begin showing up in environmental samples that were not there previously, this is an indication that the present effluent monitoring and/or control measures are lacking. As new measures are instituted, progress is monitored by watching for those nuclides in future environmental samples.

5.4.4.1 Relocation of Water from Sumps, Standing water and/or Excavations within the WL WMA

Discharges shall not be directed to WMA ditch or released to the ground in the WMA, unless otherwise approved by the EnvP Program, in circumstances where the liquid has the following characteristics**:**

A pH less than 6 or greater than 9;
A temperature greater than 40°C; or,
A visible film, sheen or discolouration.
The risk for high levels of metals, TSS, organic content is assessed.

The liquid contains any of the following:
Animate products of biotechnology, Concrete mixtures, Floating debris, Food waste, Fuel, Motor oil, Paint and organic solvents, Sewage of any kind, Solvent extractable matter of animal, vegetable, mineral or synthetic origin.

Radiological contaminants in excess of the limits specified below;
Gross Beta 10 Bq/L;
Gross Alpha 10 Bq/L;
Tritium 7000 Bq/L;
Any gamma isotopes detected are above the applicable water quality guideline

If the radioactivity is above these levels and the decision is to discharge to the ditch system or ground in the WMA the value is assessed against the Radiation Screening Criteria [56]. There must be assurance that this surface water is not used as drinking water and is not being discharged near a drinking water well. Any water higher than these levels shall be assessed for treatment and/or disposal through the processed, storm or domestic drain. If the calculated levels are below admin levels for the OFS, the water can be put to the storm drain or process drain and discharged through the B300 and/or B100 LLLW systems. If the calculated levels would result in a site release above the Admin Levels the water can be further assessed to determine if there is a risk of exceeding the Action Levels for the site. If there is no risk that the level will approach the Action Level then the water can be discharged through the process drain to the B300 and/or B100 LLLW systems. This allows the discharge to be isolated if the levels are higher than calculated. If there is a risk the water will go over the Action Levels for the site, it should be evaporated in the B300 Shielded Facility and disposed of as solid waste.

Table 5-13
Radiation Screening Criteria

Americium-241	Bq/L	16.2
Cesium-137	Bq/L	291
Strontium-90	Bq/L	666
Tritium oxide	MBq/L	12.7

The water is normally run through a 5 micron filter prior to discharge. If the pH is not between 6 to 9, it should be adjusted before release.

5.4.4.2 Relocation of Water from Manholes and/or Excavations on the WL Main Campus

Discharges shall not be directed to the process, domestic or storm drain, or released to the ground, unless otherwise approved by the EnvP Program, in circumstances where the liquid has the following characteristics:

A pH less than 6 or greater than 9;
A temperature greater than 40°C; or,
A visible film, sheen or discolouration.
The risk for high levels of metals, Total Suspended Solids (TSS), organic content is assessed.

The liquid contains any of the following:
Animate products of biotechnology, Concrete mixtures, Floating debris, Food waste, Fuel, Motor oil, Paint and organic solvents, Sewage of any kind, Solvent extractable matter of animal, vegetable, mineral or synthetic origin.

Radiological contaminants in excess of the limits specified below;
Gross Beta 5 Bq/L ;
Gross Alpha 0.5 Bq/L;
Any gamma isotopes detected are above the applicable water quality guideline

If tritium is potential present – 7000 Bq/L

If the radioactivity is above these levels and the decision is to discharge to the process drain system or storm drain system, a comparison of the activity level to be discharged must be made against the site Admin Levels. If the calculated levels are below admin levels for the OFS the water can be put to the storm drain or process drain and discharged through the B300 and/or B100 Low Level Liquid Waste (LLLW) systems. If the calculated levels would result in a site release above the Admin Levels the water can be further assessed to determine if there is a risk of exceeding the Action Levels for the site. If there is no risk that the level will approach the

Action Level then the water can be discharged through the the B300 and/or B100 LLLW systems. This allows the discharge to be isolated if the levels are higher than calculated. If there is a risk the water will go over the Action Levels for the site, it should be evaporated in the B300 Shielded Facility and disposed of as solid waste.

If there is concern about high TSS in addition to the level of activity, the water can discharged through the domestic drain provided that the level of activity is below the Ecological Effect Concentration levels in Table 5-13.

For all discharges, it is best if the water is run through a 5 micron filter prior to discharge. If the pH is not between 6 to 9, it should be adjusted before release. If it is impractical to adjust the pH the water should be directed to the B300 or B100 LLLW system.

If there is a need to discharge the water to the ground and it is above the rad limits, an assessment of the potential radiological contaminants should be made using the following guidance and assessment of potential risk.

Each potential contaminant of concern will be part of either the Gross Beta or Gross Alpha analysis result. Of these, some can be detected individually by gamma spec analysis or alpha spec analysis. The beta emitter with the most restrictive Maximum Acceptable Concentration (MAC) in the potential contaminants of concern for WL is Sr-90 (MAC 5 Bq/L). WL EnvP assume Sr-90 is in equilibrium with Y-90 so a screening criteria of 10 Bq/L is used for gross beta. If the sample result is above 10 Bq/L the samples are submitted for Sr-90 analysis (to confirm the theory). Gamma spec analysis provides individual results for (Co-60, Nb-94, Sb-125, Cs-134, Cs-137(Ba-137m), Pm-147, and Am-241). If all of the gross beta is accounted for then the effort is complete. If not, WL staff evaluate the data against the most restrictive isotope not already detected and assume that is what it is (most likely Tc-99). If the value is above the MAC for Tc-99 (200 Bq/L) WL staff confirm that it is present. If it is not that particular isotope staff continue the search (Cl-36, Ni-63, etc). The alpha emitter with the most restrictive MAC and likely to be present is uranium (0.5 Bq/L/20 ppb). Since the groundwater in the WL area contains natural uranium (~2 to 200 ppb) it is the most likely alpha present. The rock surrounding the WL site is slightly enriched in uranium and its decay products including Ra-226. We also know that if uranium is present, then the progeny of uranium can contribute to the alpha and beta activity (0.025 to 0.045 Bq/ppb gross alpha and 0.016 to 0.035 Bq/ppb gross beta, there is higher contributions if the samples is counted right after collection versus one week later). If uranium (and uranium progeny) does not account for the alpha activity (1 ppb uranium is ~ 0.025 Bq/L gross alpha) present staff would review the gamma spec analysis to see if Am-241 is present as it is an indicator of the presence of plutonium isotopes. If the value is above the MAC for Am-241 and/or plutonium, the samples are sent for plutonium analysis. If the value is still above the MAC for that isotope staff would continue the search.

5.4.5 Monitoring to provide an indication of unusual or unforeseen conditions

The EMP serves as a second line of defence by detecting unusual levels in the environment in the event of an unknown release of activity that was not detected by other early warning systems (e.g. leak detection, administrative/action levels).

The detection of significant deterioration in the quality of surface water in the course of tracking the environmental performance of facilities leads to follow-up investigations of the cause of that deterioration.

5.4.6 Verify model predictions, refine models, and reduce uncertainty in model predictions

Monitoring at all potential critical group locations generates results that can be used to verify the predictions and reduce the uncertainty made by the DRL model, as well as to refine the DRL model.

Aquatic emissions data concurrent with water sampling will be available from the effluent monitoring program. The emissions can be used with hydrological data to model water concentrations to verify aquatic dilution factors.

5.4.7 Monitoring to demonstrate due diligence

One objective of environmental monitoring is to increase the credibility of the image of a facility in the eyes of the public. CNL has adopted the approach that they will maintain a more extensive EMP than the minimum specified in the regulations.

Since the DRL model has not suggested any likelihood of human health effects from radionuclides released from WL, and since CNSC RegDoc-3.1.1 [77] requires reporting of doses for persons at critical group or groups locations, monitoring at other locations demonstrates due diligence. Similarly, since the monitoring to check on effluent control and continuing containment is precautionary, it also serves to demonstrate due diligence.

5.5 Step 5: Performance and Acceptance Criteria

5.5.1 Performance criteria

Performance criteria for the EMP are defined in terms of

- the percent of planned samples obtained; and
- the percent of samples within data acceptance criteria (Section 5.5.4).

It is expected that a certain number of samples each year will be unavailable due to sampling equipment malfunction, garden crop failures, or other logistical reasons. The minimum targets for the number of planned samples to be obtained for acceptable EMP performance are listed in Table 5-14, with all parameters meeting data acceptance criteria.

The 90% and 75% targets are based on the potential effect that missing a monthly or quarterly sample would have on the annual average concentrations. In both cases, based on expected variability among samples, one missing sample would not significantly affect the annual average, or unacceptably reduce the precision in dose assessments based on average concentrations.

Table 5-14
Targets for Percent of Planned Samples to be Obtained in all Environmental Media

Collection frequency	Minimum target for % of planned samples obtained
Weekly	90%
Monthly	90%
Quarterly	75%
Semi-annual	100%
Annual	100%

5.5.2 Acceptance Criteria

1. **QV Limits**: The acceptance criteria in place on Quality Verification (QV) measurements for WL are established and documented in the lab level quality verification procedures as listed in [49]:

The handling of sample data for those samples is included in the program's *Environmental Monitoring Program* procedure [6].

2. **Sample Unavailability**: Sample unavailability for the Effluent Verification Monitoring Program (EVMP) could be the result of a number of circumstances; for example sampling according to the monitoring schedule was missed, the collected sample was contaminated or lost, an automatic sampler failure, etc. Acceptance Criteria for such events are shared company-wide and therefore are outlined in *Management and Monitoring of Emissions* [9], along with steps which need be taken to compensate for the missed data.

5.5.3 LMDLs versus WL Monitoring Limits:

Table 5-11 and Table 5-12 and compares the programs current Laboratory Method Detection Limits (LMDLs) for each parameter to the applicable monitoring limit(s) for that parameter. The program's LMDLs are all well below the benchmark values therefore ensuring that the monitoring results can be used to demonstrate compliance with these values.

5.5.4 Data acceptance criteria

The Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are referred to as Quality Verification tests, and are grouped as follows according to purpose:

- Contamination Tests, such as measurement of the reagent blank, establish the level of analyte present resulting from contamination of the analysis system or system components. Acceptance criteria for these performance tests are related to each analyte's method detection limit.
- Reproducibility Tests, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- Accuracy Tests, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

These internal quality verification tests are summarized and reported on each year and assessed against acceptance criteria.

In addition Environmental Management group participates in semi-annual proficiency testing programs and the results of these tests are summarized and included in the Environmental Monitoring report.

Samples sent to contract laboratory for analysis include;

- Animal, Fish and Vegetation samples for gross alpha, gross beta and Gamma Spectrometry,
- Soil sediments for gross alpha, gross beta and Gamma Spectrometry, and
- Groundwater and groundwater samples for gross alpha, gross beta, Sr-90, and Gamma Spectrometry.

Certificates of analysis are reviewed and results of all the analyses are verified to be within acceptance criteria.

The data acceptance criteria for specific parameters and environmental media are established by the Quality Assurance group in conjunction with the Environmental Management team. The criteria are applicable to the results of QC samples that are associated with each batch of program samples analyzed.

Quality assurance test results are compared against the acceptance criteria. Failures are grouped in accordance with analytical method used to evaluate them and tracked through CNL's ImpAct system for trending purpose. The failed results are investigated to determine if they have significant effect on the validity of analysis results. Corrective action plans associated with the non-conformances are initiated and all of the associated non-conformances are being tracked through CNL's ImpAct system. All affected results are reviewed and sample aliquots are reprocessed, where required.

A series of annual memos are prepared documenting the lab/field team performance acceptance criteria and a summary is included in the annual Environmental Monitoring report [67].

5.6 Step 6: Detailed design of the EMP

5.6.1 Planned samples and analyses

The detailed design of the EMP, including a schedule of the planned samples and analyses, is provided in the EMP monitoring schedule [10].

6. MODIFICATION OF THE EMP

Periodic reviews and annual performance assessments are the processes for making changes (i.e. reductions or additions) to the media, locations, or parameters being monitored as part of the EMP. If necessary, changes can also be made during the program year. The decision and rationale for any changes are formally documented as per the requirement in *Environmental Monitoring Program* [6].

6.1 Additions to the EMP

Additions to the EMP are made in the context of the systematic informed planning process described in Section 5.

6.2 Reduction of monitoring

Deletion of samples from the EMP and reductions in sampling or analysis frequency are appropriate if the changes do not impact the effectiveness of the EMP.

In cases where the absence of anomalous results and/or the absence of results above the detection level are observed over a five year monitoring period, the monitoring frequency may be reduced based on the professional judgment of EMP Staff. Consideration is given to operational experience, the results of the local population survey (e.g. the survey indicates the absence or unavailability of the sample media), and the results of historical monitoring (e.g. the results demonstrate that the contaminants are not present).

If there is a need to reduce the frequency of sample collection or analysis, the justification should include an evaluation showing that the increased sampling interval does not impact the accuracy of the results (e.g. longer analysis intervals may not be appropriate for radionuclides with a short half-life). This can be done by comparing the sample results at the current monitoring frequency with the sample results at the proposed monitoring frequency using appropriate statistical methods.

Reductions in monitoring can be absolute or can be made under the caveat that the parameters be periodically (e.g. every five years) analysed in order to confirm their continued absence. This periodic re-checking is referred to as “confirmational monitoring”. Should the contaminants be detected in anomalous concentrations from the confirmational monitoring, the previous sampling frequency is restored.

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Appendix A

Figures

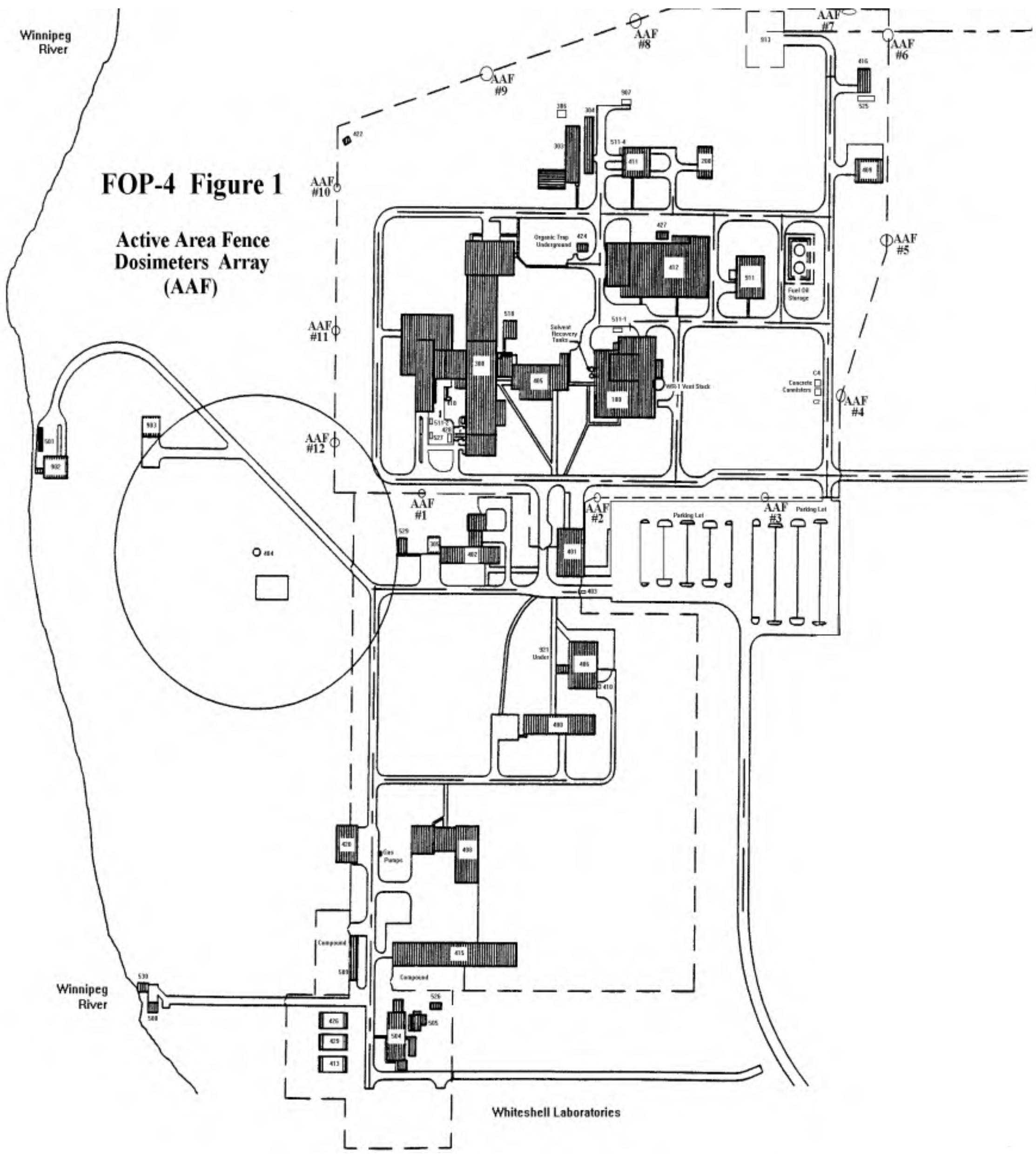

Figure A-1 Main Campus TLD Placement

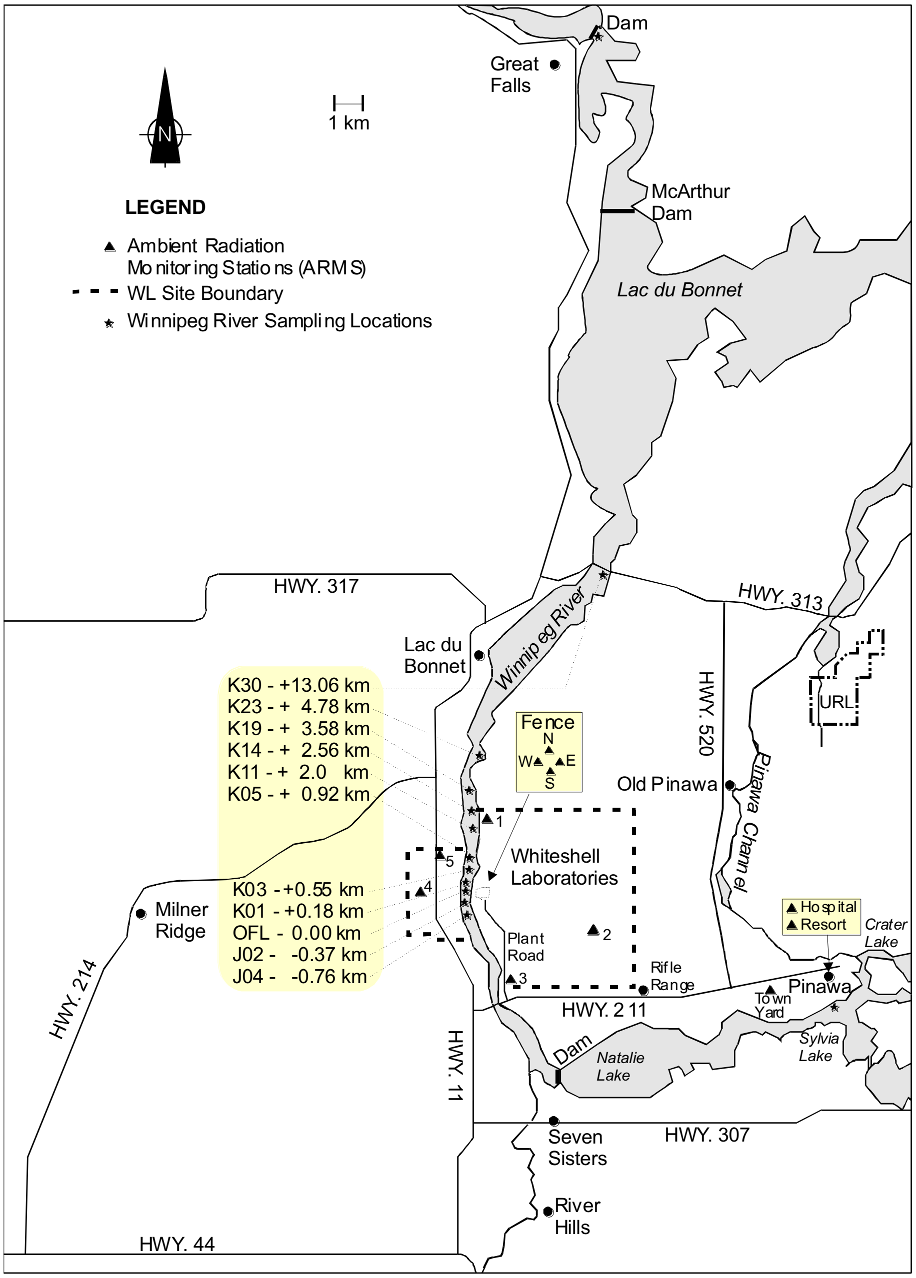

Figure A-2 WL Monitoring Locations

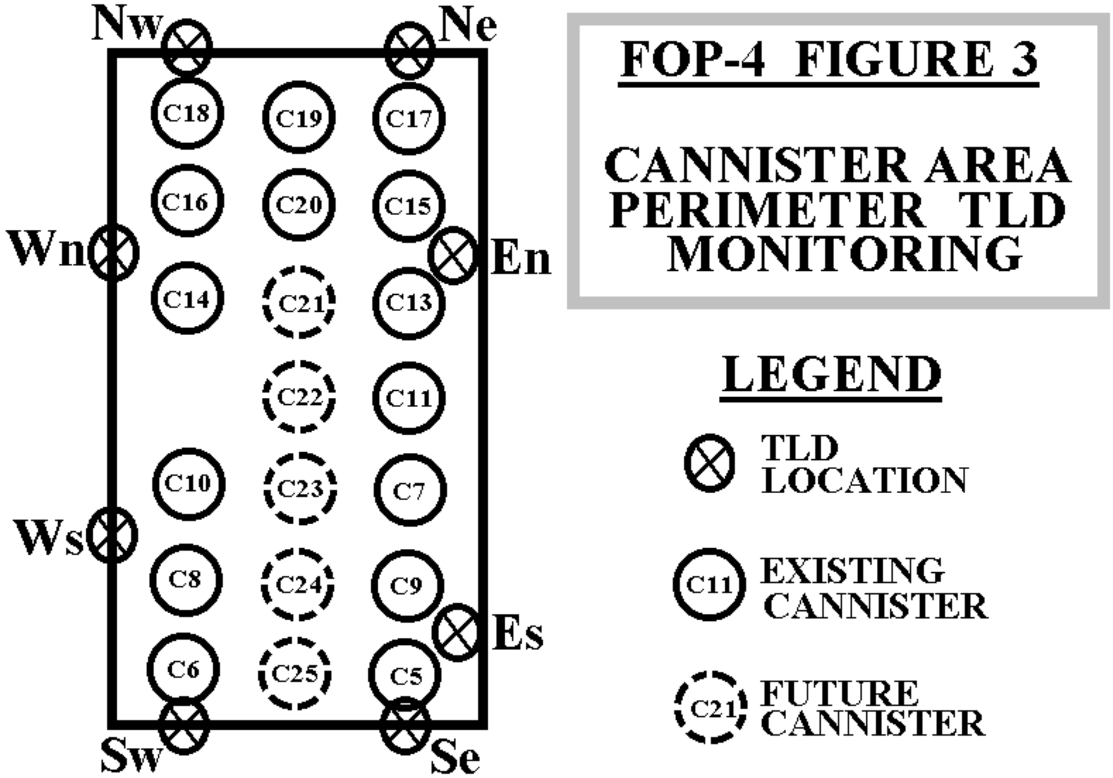

Figure A-3 WL Canister TLD Monitoring Locations

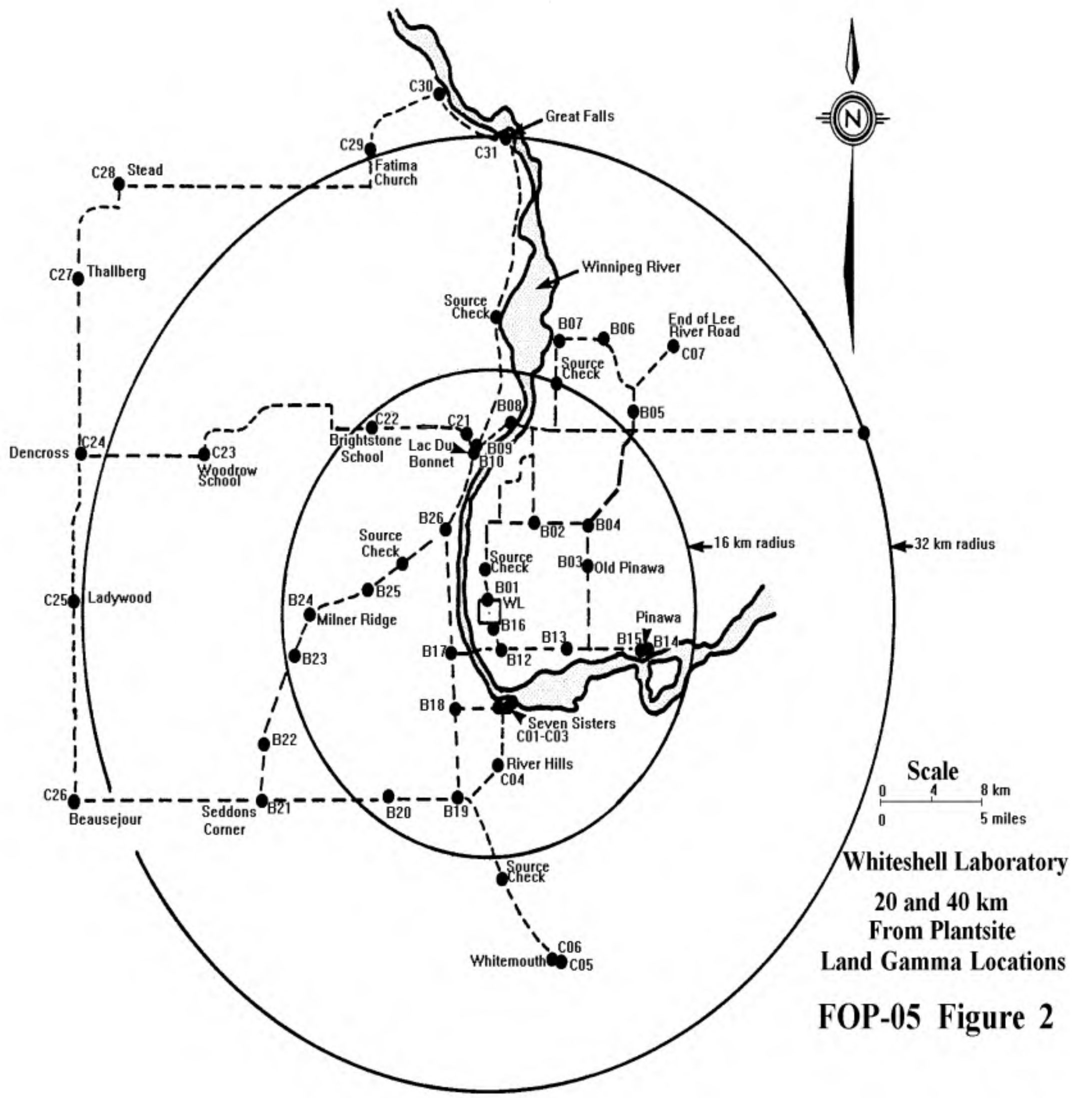

Figure A-4 WL Land Gamma Outer Area Monitoring Locations

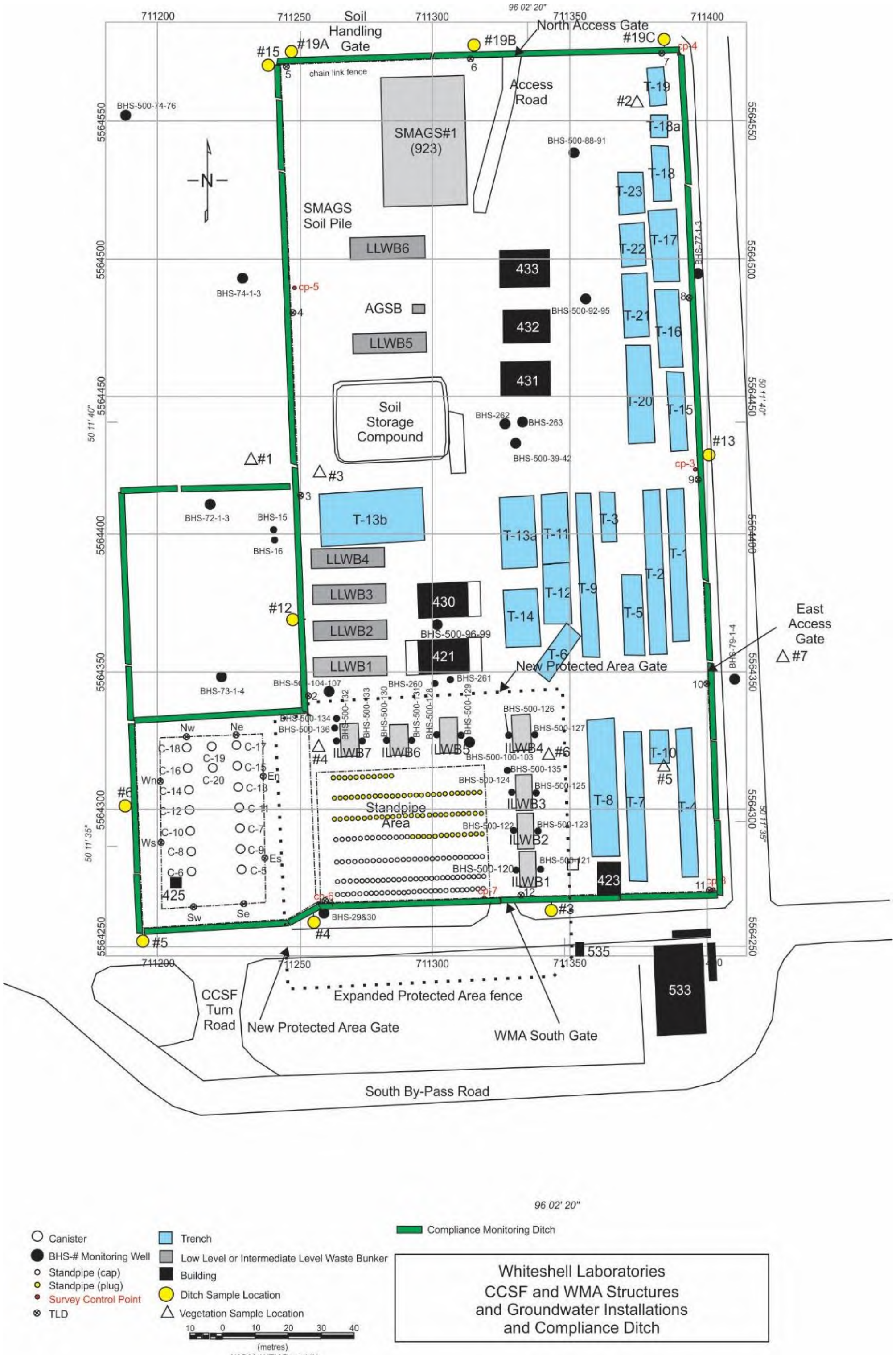

Figure A-5 WL WMA Monitoring Locations

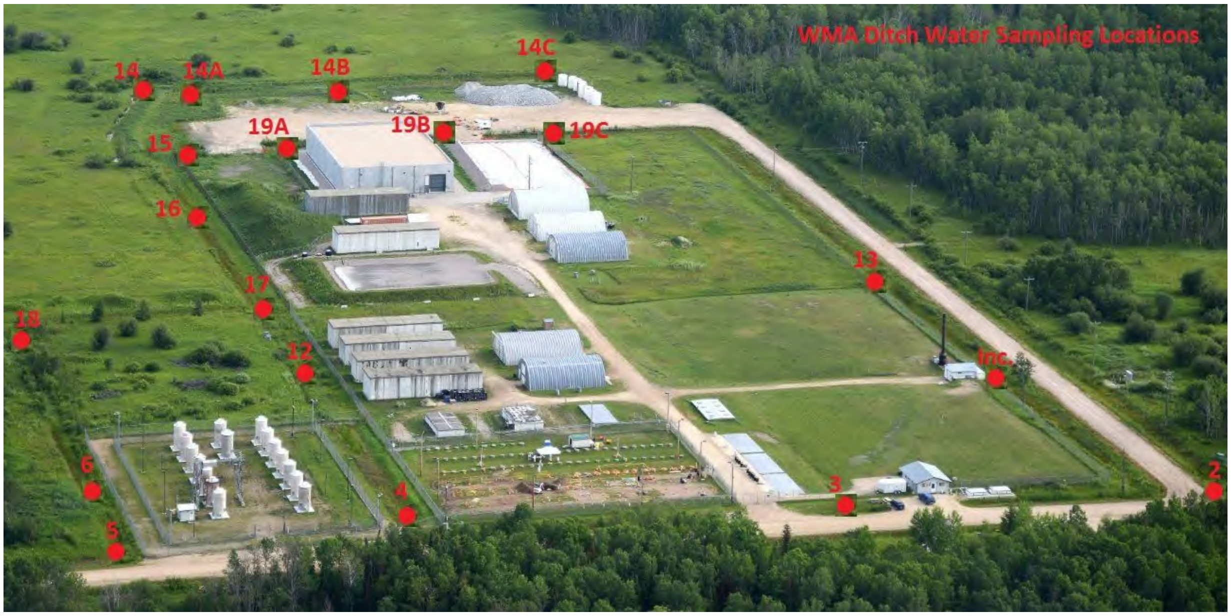

Figure A-6 WL WMA Surface Water Run-off Monitoring Locations

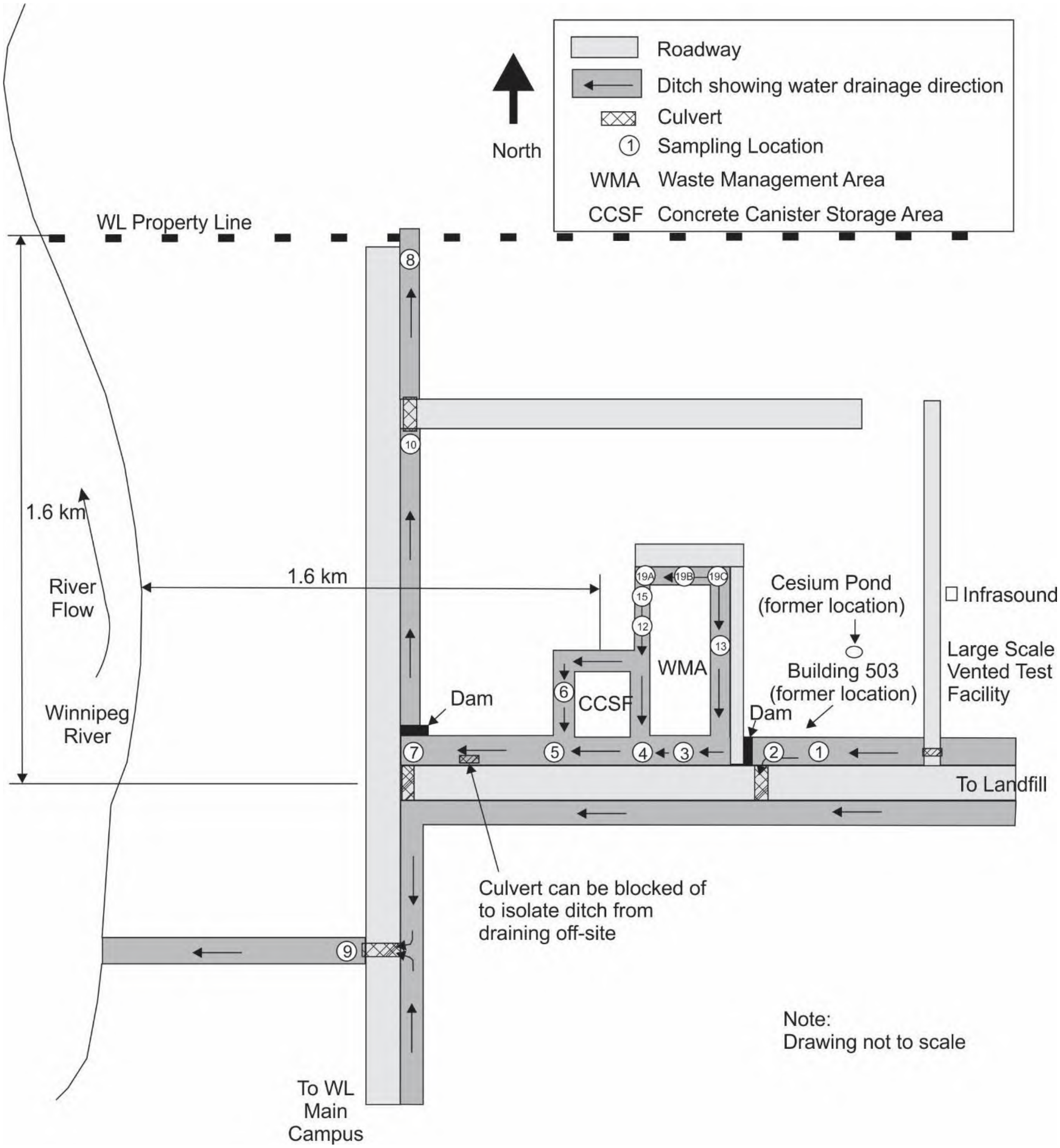

Figure A-7 WL WMA Surface Water Runoff Monitoring Locations

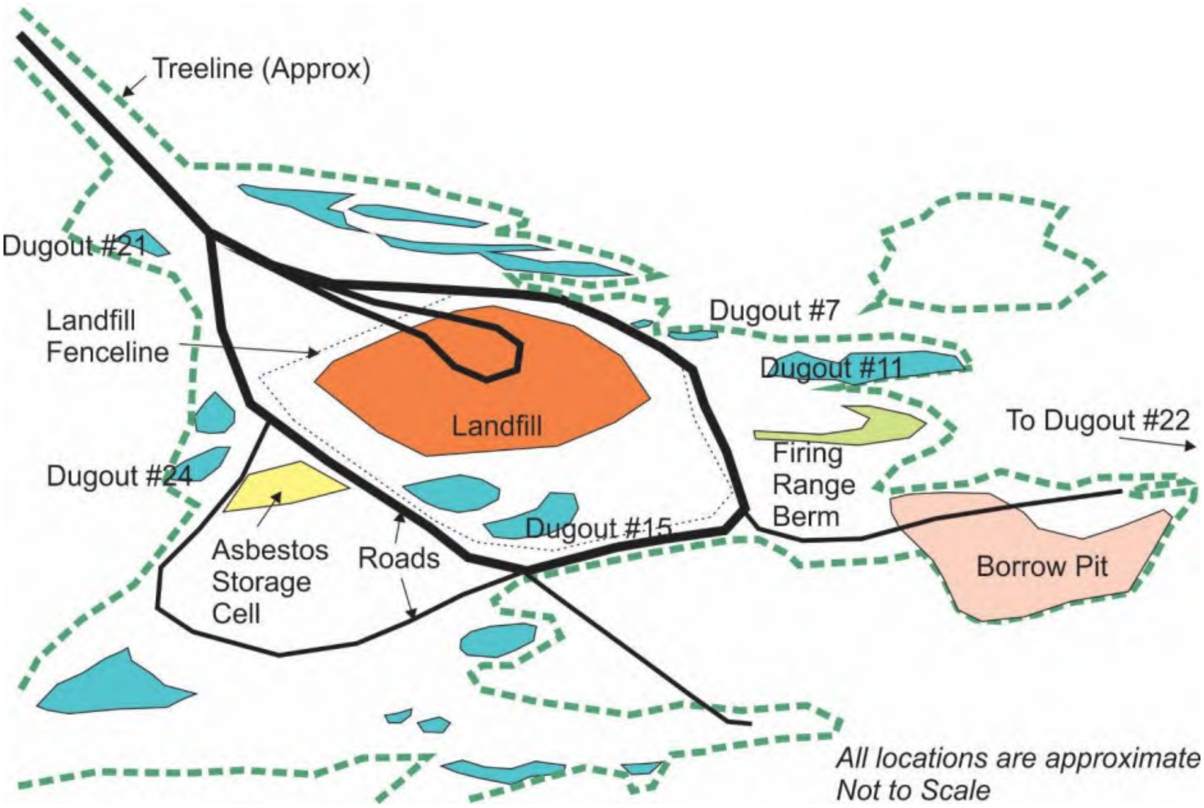

Figure A-8 WL Landfill

Figure A-9 WL Main Campus and Lagoon

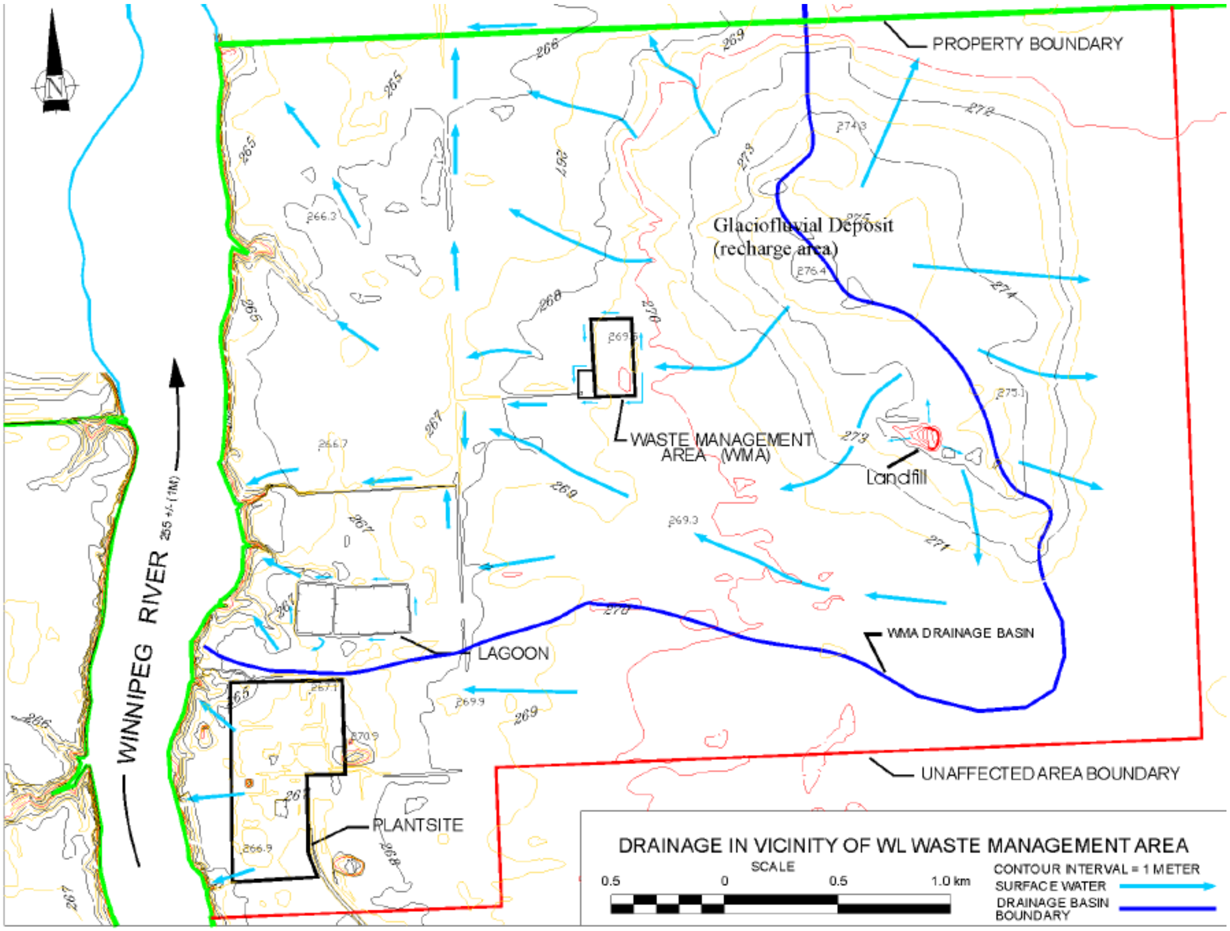

Figure A-10 WL Drainage in Vicinity of WL WMA

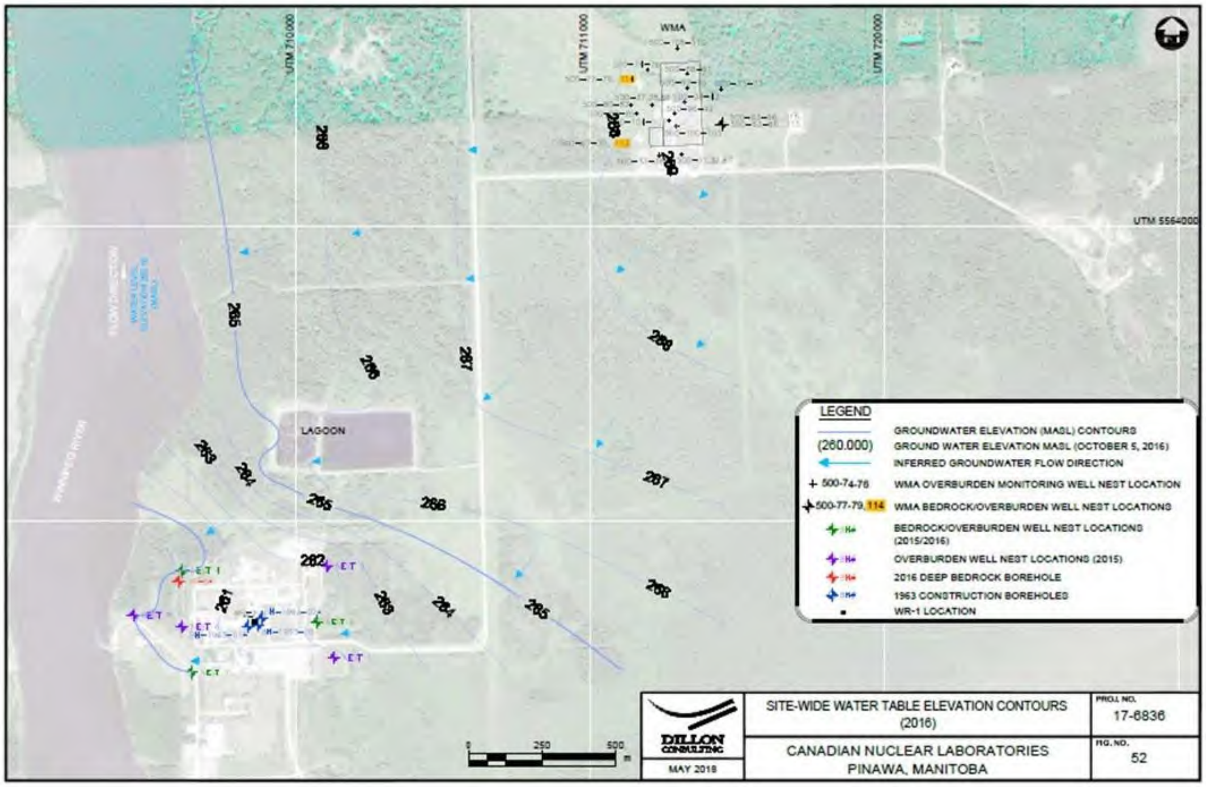

Figure A-11 Site-Wide Water Table Elevation Contours

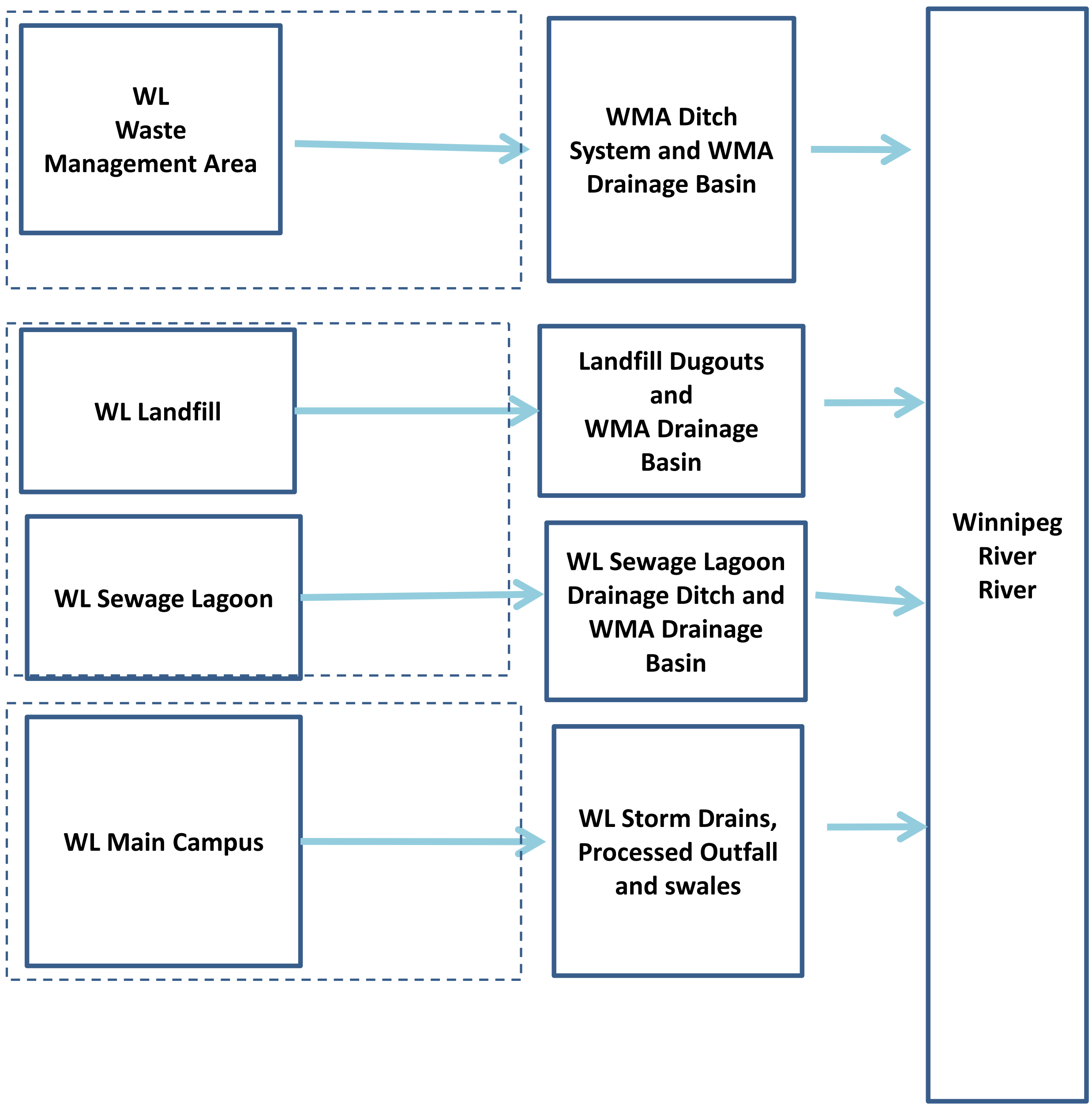

Figure A-12 WL Site Conceptual Model

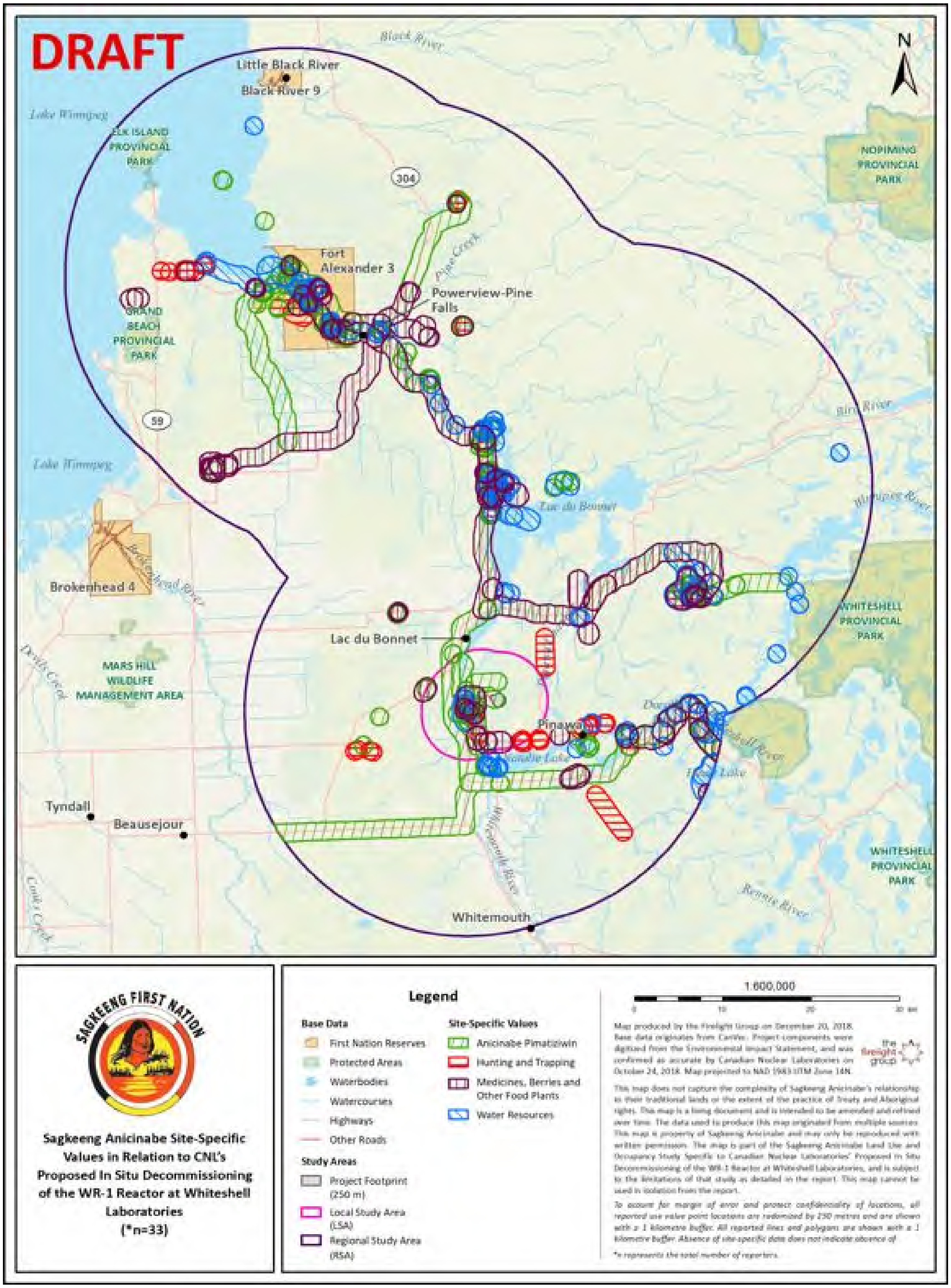

Figure A-13 Sagkeeng Reports Site Specific Medicine, Berries and Other Food Plants

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OVERVIEW

WHITESHELL LABORATORIES INTEGRATED MONITORING PROGRAM FRAMEWORK

WL SITE DOCUMENTATION

WL-509200-OV-001

Revision 1

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Approved by:		2020/12/14
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Effective date: 2020/12/14

UNRESTRICTED

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Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
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1. SCOPE

This document outlines the framework in place at Canadian Nuclear Laboratories' (CNL) Whiteshell Laboratories (WL) for the Integrated Environmental Monitoring Program as required by the company-wide procedures *Management and Monitoring of Emissions* [1], *Environmental Monitoring Programs* [2] and the *Protection and Monitoring of Groundwater* [3], as well as the WL Environmental Assessment Follow-Up Program [4] specification document and the *Environmental Protection Program Radiological and Non-Radiological Monitoring Services Quality Assurance Plan* [5].

This framework is applicable to all individual monitoring programs which comprise WL's Integrated Environmental Monitoring Program; therefore this document includes:

a) Program details which are <u>WL-specific</u> and common among each of the individual programs (e.g. program reviews).

This framework document does <u>not</u> include:

a) Program details which are not common among all of the individual programs making up WL's Integrated Environmental Monitoring Program; instead these details are included in the specific programs' monitoring plan(s) (e.g. the systematic informed planning process used to develop each program); or,

Program details which are company-wide (instead these are included in the company-wide procedures [1], [2], [3] and [5]).

Given the large amount of documentation in place to fulfill this program, this framework document is intended to be used by the WL Environmental Protection (EnvP) Program as a convenient tool to both document and communicate the structure which is in place for the WL Integrated Environmental Monitoring Program.

2. PURPOSE

Firstly, this framework document provides an overview of the WL site and its operations, providing key information of the site's environmental aspects for which the site's Integrated Environmental Monitoring Program has been developed (Section 4). This outline is then followed by an introduction of the Integrated Environmental Monitoring Program, (Section 4.2). Lastly, details on the monitoring program's execution, specifically those execution details which are common to all of the individual monitoring programs making up the Integrated Monitoring Program are provided, including: associated documentation (Section 5.2.1), program reviews (Section 5.2.2), program objectives (Section 5.2.3), and program responsibilities and training (Section 5.2.4).

3. DEFINITIONS

Refer to Appendices A and B in 900-509200-PDD-001, Environmental Protection Program Description Document [6] and Management and Monitoring of Emissions [1] for definitions and acronyms pertaining to this document. For additional terms, refer to the Acronyms, Abbreviations, and Definitions of Terms web page on the CNL Intranet.

4. OVERVIEW

4.1 WL Site Operations

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares as shown in Figure 1. The WL site is owned by Atomic Energy of Canada Ltd. (AECL) and operated by CNL under a licence [7] issued by the CNSC. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the east bank of the Winnipeg River. It is downstream from the towns of Pinawa and Seven Sisters Falls, and upstream of the communities of Lac du Bonnet and Pine Falls.

The Whiteshell Reactor-1 (WR-1) organic-cooled experimental test reactor was shut down in 1985. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL.

In 2014, Canadian Nuclear Laboratories (CNL) Ltd. was created as a wholly owned subsidiary of AECL. Implementation of the Government-Owned, Contractor-Operated model was achieved with share transfer of CNL from AECL to Canadian National Energy Alliance (CNEA) in 2015 September.

Activities to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report [9] supporting the approval of the Environmental Assessment of the WL Decommissioning Project have been underway since 2003 January.

The Whiteshell document WL-508200-PRO-212 [8] lists the main nuclear facilities at the WL site. The Nuclear Facilities are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and B305), and WR-1 Reactor.

The major operating facilities are the Shielded Facilities, and the WMA. The Shielded Facilities includes the Hot Cell Facility and the Immobilized Fuel Test Facility area which includes a decontamination center and waste processing/handling area. Areas undergoing sampling and characterization activities include WR-1 Reactor Building and Active Liquid Waste Treatment Center (ALWTC). The ALWTC was shut down near the end of 2017, and is now being decommissioned. In total, these facilities are the major sources of radiological airborne effluent releases from the site. The primary source of liquid effluent releases at WL is the process water outfall (Outfall), which discharges continuously to the Winnipeg River. The secondary source of liquid effluent is the sewage lagoon (Lagoon), which is normally discharged semi-annually to the Winnipeg River.

Finally, the site contains numerous smaller non-nuclear facilities, development and analytical laboratories and support facilities (Power House, various workshops, maintenance shops, etc.). Industrial boilers are operated at the Power House to provide steam heating to the majority of the site, while some facilities in the outer areas are heated with propane.

Waste management facilities designed for the storage or disposal of wastes are located in WMA. Radiological and non-radiological contaminants that appear in groundwater down gradient of the WL WMA and other monitoring sites are largely the result of early operations.

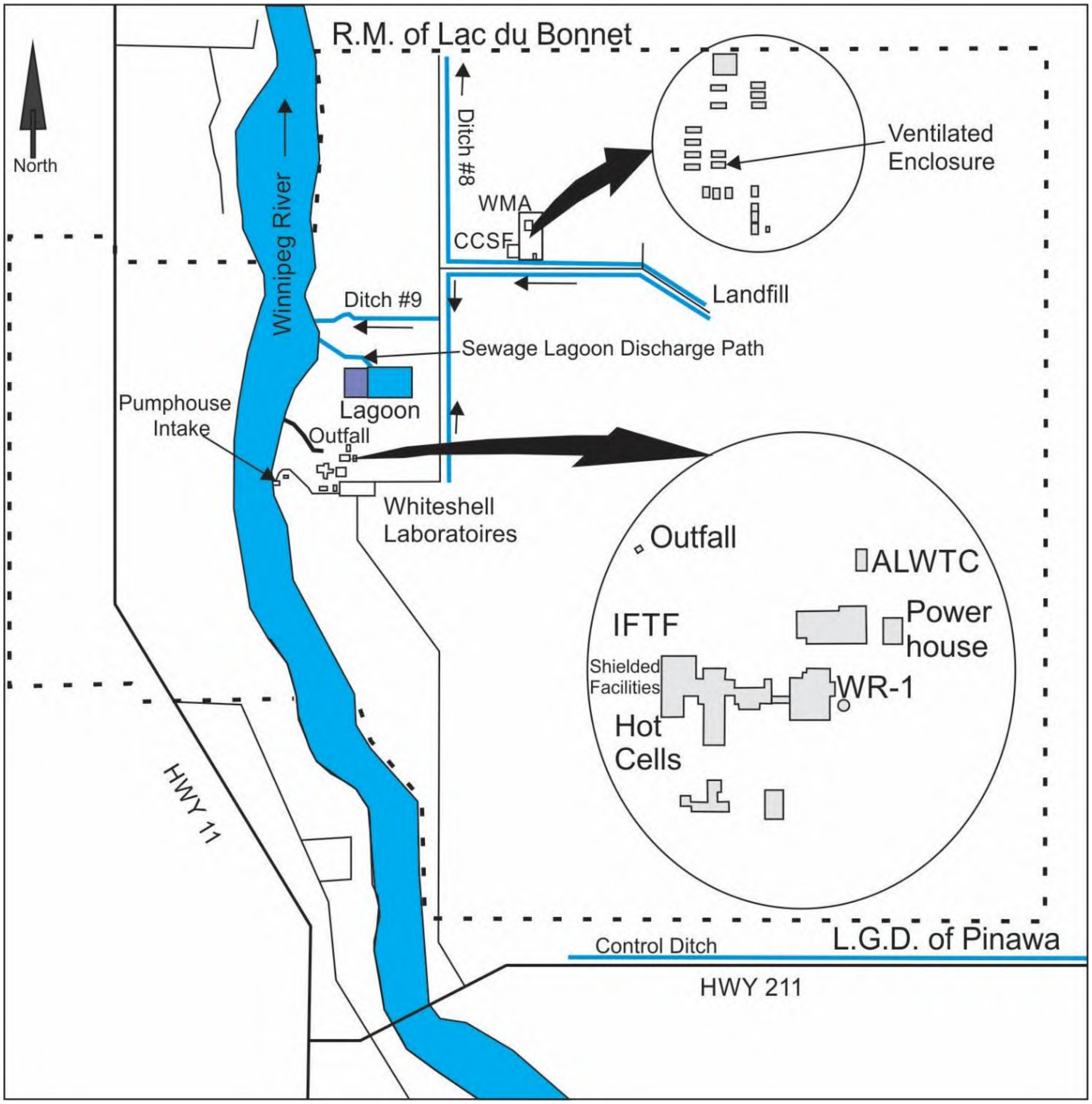

Figure 1: Near Field Map of WL Site

4.2 WL's Integrated Environmental Monitoring Program

WL's Integrated Environmental Monitoring Program is designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere and consists of three distinct programs: the Effluent Verification Monitoring Program (EVMP), the Environmental Monitoring Program (EMP) and the Groundwater Monitoring Program (GWMP) (see Figure 2). Historically, WL's Effluent and Environmental Monitoring Programs have been separated into radiological and non-radiological components which continue to be evident in the program's documentation structure; however, it should be noted that the combining of these programs into a single effluent and a single environmental program has been initiated and is reflected in recently revised and created documentation.

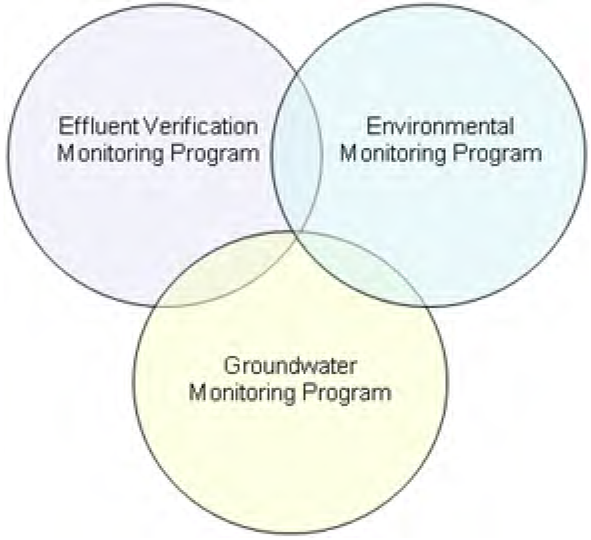

Figure 2: WL's Monitoring Programs which make up the Site's Integrated Environmental Monitoring Program

Each of the programs aligns with the associated Canadian Standards Association (CSA) Standard as outlined in Figure 5.

The monitoring and evaluation of environmental impacts from WL operations and decommissioning activities is carried out using a wide range of effluent, groundwater and environmental monitoring activities that enable the measurement of concentrations and fluxes of contaminants in every significant compartment involved in the migration of contaminants throughout the environment. The exchange of environmental data and evaluations of conditions and environmental performance between these activities provides an integrated approach to monitoring the fate of contaminants in the environment, and this integration (depicted pictorially as the overlapping of the circles in Figure 2) also ensures consistency among the various monitoring programs in terms of monitoring location and parameter. The network of contaminant pathways is illustrated in a general sense in Figure 3 with the first tier of potential impact from a facility or operation being its effluents (airborne and waterborne) and, for some facilities, groundwater.

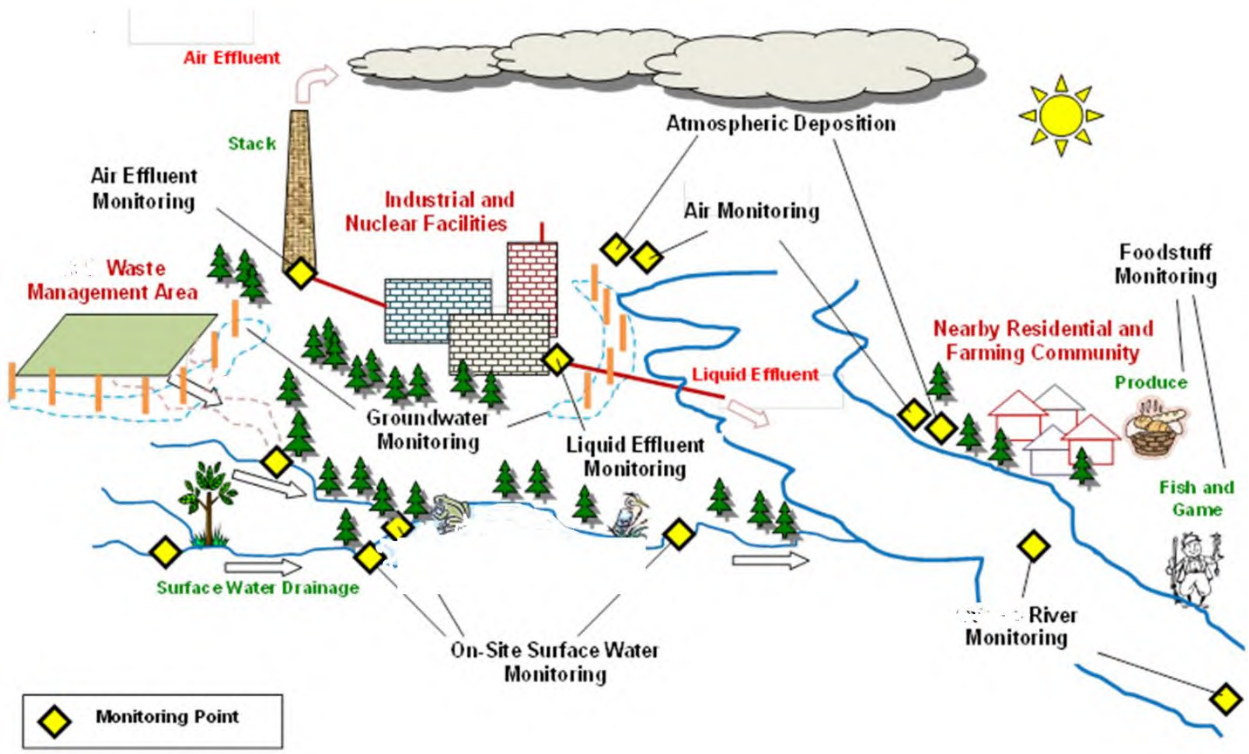

Figure 3: The Integrated Environmental Monitoring Program Concept

Waterborne effluents, whether storm water, or treated facility waste waters, can affect the quality of nearby surface waters and in turn lead to exposure to humans living downstream of the site. These exposures can result from the ingestion of water or of food (e.g., fish) that has come into contact with the water, and from direct exposure through swimming or bathing.

Airborne effluents can initially lead to exposure through inhalation and air immersion, and the deposition of airborne contaminants onto soil, vegetation, and surface water. Airborne effluents can also lead to uptake by farm and game animals through a variety of direct and indirect exposure pathways, leading to the contamination of animal products such as milk, beef, poultry etc. The monitoring of contaminants in airborne and waterborne effluents and in the different environmental compartments (e.g., surface water, drinking water, vegetable produce, milk, beef, game animals, etc.) along exposure pathways is therefore an important element in evaluating the impacts of WL operations.

The transfer of contaminants from facilities and site operations to soils can have an impact on the quality of groundwater as infiltrating rainwater and snow melt flush the contaminants downward into the water table. Unlike the contaminant migration associated with airborne and waterborne effluents, this form of contaminant migration in the environment occurs very slowly because of the slow velocity of groundwater travel and the tendency of most contaminants to adsorb to soil and organic matter, reducing their mobility in groundwater. Nevertheless, contaminants that do exhibit mobility in groundwater flow systems eventually discharge into surface waters on the WL site which drain to the Winnipeg River, or discharge directly to the Winnipeg River. Sampling of groundwater and surface water along this migration route is therefore another important element in evaluating the impacts of site operations.

In effect, as illustrated in Figure 4, the Integrated Environmental Monitoring Program achieves three main tasks:

a) Direct release monitoring (via the EVMP);

b) Contaminant pathways monitoring (via the combination of EVMP, GWMP, and EMP); and,

c) Biological effects monitoring (via the EMP).

This integrated approach to environmental monitoring means that the evaluation of impacts on the environment from WL facilities and operations is carried out in a logical, comprehensive manner and is used to demonstrate compliance and protection of the environment and health and safety of the public.

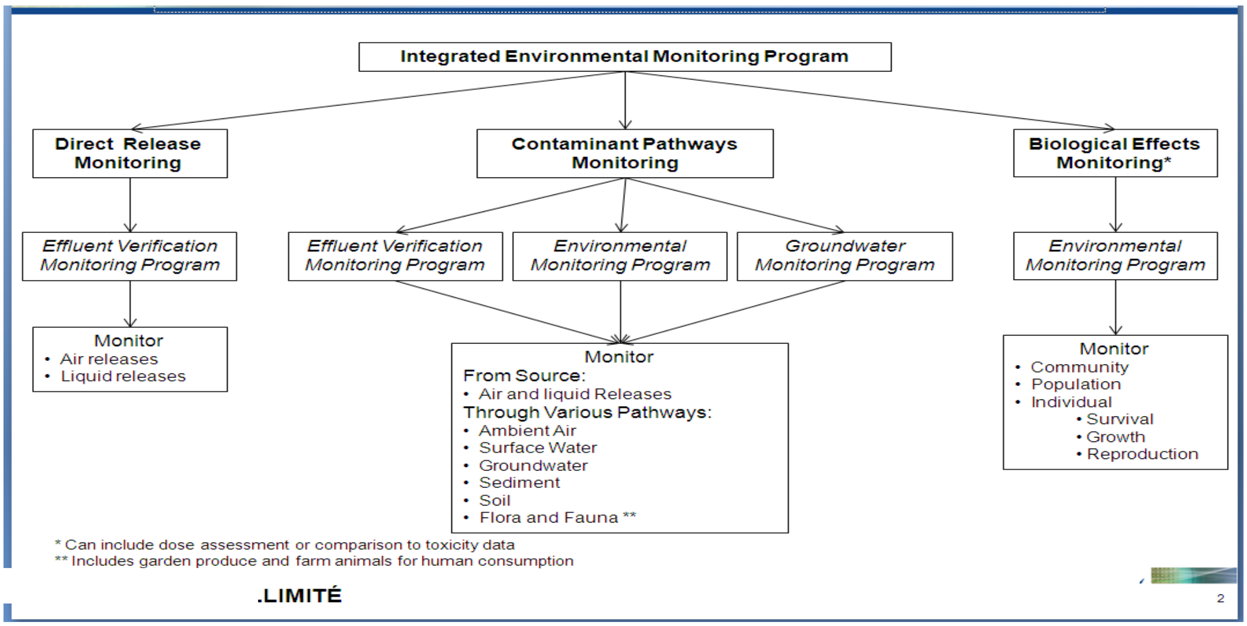

Figure 4: WL's Integrated Environmental Monitoring Program Design

5. PROCESS

5.1 Dynamic Nature of WL's Integrated Environmental Monitoring Program

The Integrated Environmental Monitoring Program is dynamic in nature meaning that it is continually evolving based on various sources of information received. A depiction of this dynamic nature is illustrated in Figure 5.

The basis for the program is the WL Comprehensive Study Report (CSR) [9] and the WL Site's Dose Model [10]. The CSR [9] and the results from the Environmental Assessment Follow-up Program (EAFP) [4] serve to evaluate the risk to relevant human and non-human biota receptors resulting from exposure to contaminants and stressors related to the WL site and its activities, and recommends further monitoring or assessment as needed based on the results, to clarify risks or reduce uncertainties in this assessment. The preparation of a site wide environmental risk assessment was initiated in 2020 to update the information in the CSR [9]. This assessment will generate conclusions which will be used to design and update the monitoring program, as well as any recommendations for further work required to adequately determine WL's environmental risk. These recommendations are generally completed separately from the routine monitoring program in Supplementary Studies/Special Investigations, however, they could result in changes to the routine programs.

The WL Site Dose Model [10] provides Derived Release Limits (DRLs) for the operation of the nuclear facilities at WL which are limits that apply to emissions of both radiological airborne and waterborne effluents during normal operations below which WL is required to operate. These limits represent release rates that correspond to human critical group exposures at the public dose limit.

Additional routine inputs into the monitoring program which can result in changes to the program design include:

a) Data generated from the routine monitoring itself (e.g., a trend of interest is identified resulting in the need to increase monitoring in that location);

b) Outcomes of both integrated and annual program reviews (e.g., the need for an additional monitoring location based on site past or present operations);

c) Changes made to regulatory documents and/or standards;

d) Findings identified through internal or external audits (e.g., recommendation for the use of a different analysis method); and/or

e) Changes in the routine operations of the site which are periodically reviewed through the Environmental Aspect Assessment process (e.g., a new process is implemented resulting in a change to a facility's routine emissions).

In addition to these routine inputs, there are various non-routine sources of information which can influence the monitoring program. These may include:

a) Reviews of non-routine operations through an environmental review and/or Environmental Assessment;

b) Supplementary Studies/ Special Investigations which could result from recommendations stemming from the site EAFP, program audits, program reviews, etc. NOTE: These studies are run in parallel with the monitoring programs and the results, if applicable, are fed into the routine monitoring program; and/or

c) Results from Operation Control Monitoring (OCM), performed by site facilities for the early detection of unplanned releases. This data can be used by the monitoring program for troubleshooting purposes, if needed.

All of the routine and non-routine inputs identified above incorporate the ALARA concept (As Low As Reasonably Achievable) which meets the continual improvement requirement of CNL's management of its environmental impacts and risks.

The progress on, and results from, the EAFP are reviewed on an annual basis. Site Dose Model documents are updated approximately every five years, integrating knowledge from the routine and non-routine information gathering which has taken place since the last update. These updates result in conclusions and recommendations for the monitoring programs and the cycle once again commences.

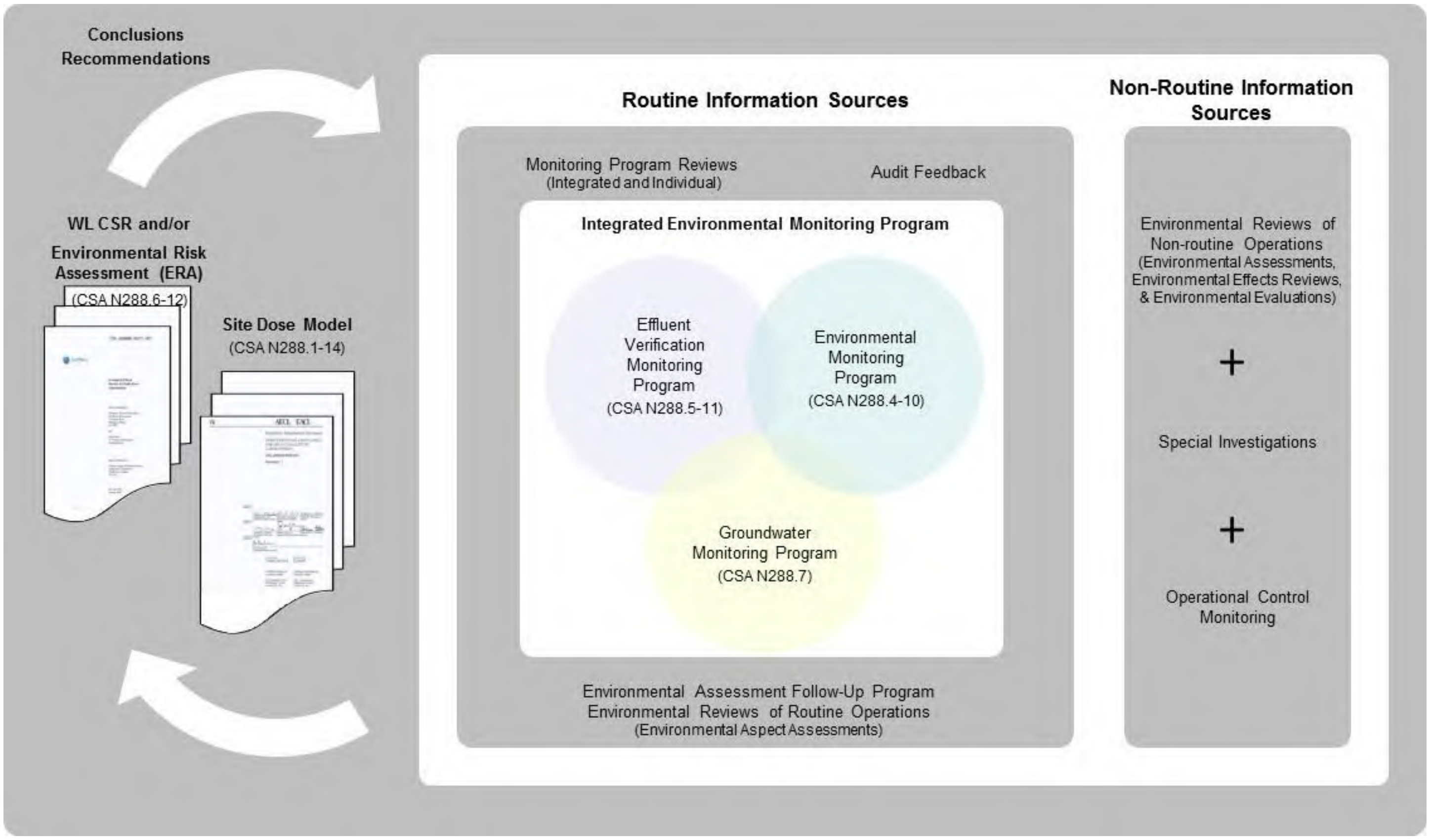

Figure 5: Dynamic Nature of WL's Integrated Environmental Monitoring Program

5.2 Execution of WL's Integrated Environmental Monitoring Program

This section provides information on the execution of the WL Integrated Environmental Monitoring Program. Program details which are common to all constituent programs that make up WL's Integrated Environmental Monitoring Program are found in [1], [2], [3] and [5].

5.2.1 Program Documentation

5.2.1.1 Procedure Structure

Figure 6 illustrates the hierarchy of the documentation outlining WL's Integrated Environmental Monitoring Program.

This first tier of documents, depicted by the top row, consists of three requirements documents, outlining the general requirements and responsibilities for each of the three monitoring programs. Note: Those with "CW" and "900" numbering are CNL company-wide procedures.

This framework document is in Tier 2; it takes the requirements from the first tier documents and introduces WL's Integrated Environmental Monitoring Program, addressing commonalities among the three separate programs.

The third tier of documents include the details of each of the monitoring programs, including reasoning behind the monitoring which is in place for each individual program.

The fourth tier of documents consists of methods and details, including specifics on Quality Assurance (QA) programs, for each laboratory performing monitoring for the Integrated Environmental Monitoring Program.

The entire program is encompassed by a Quality Assurance Plan, ensuring that the data used by the program are technically valid.

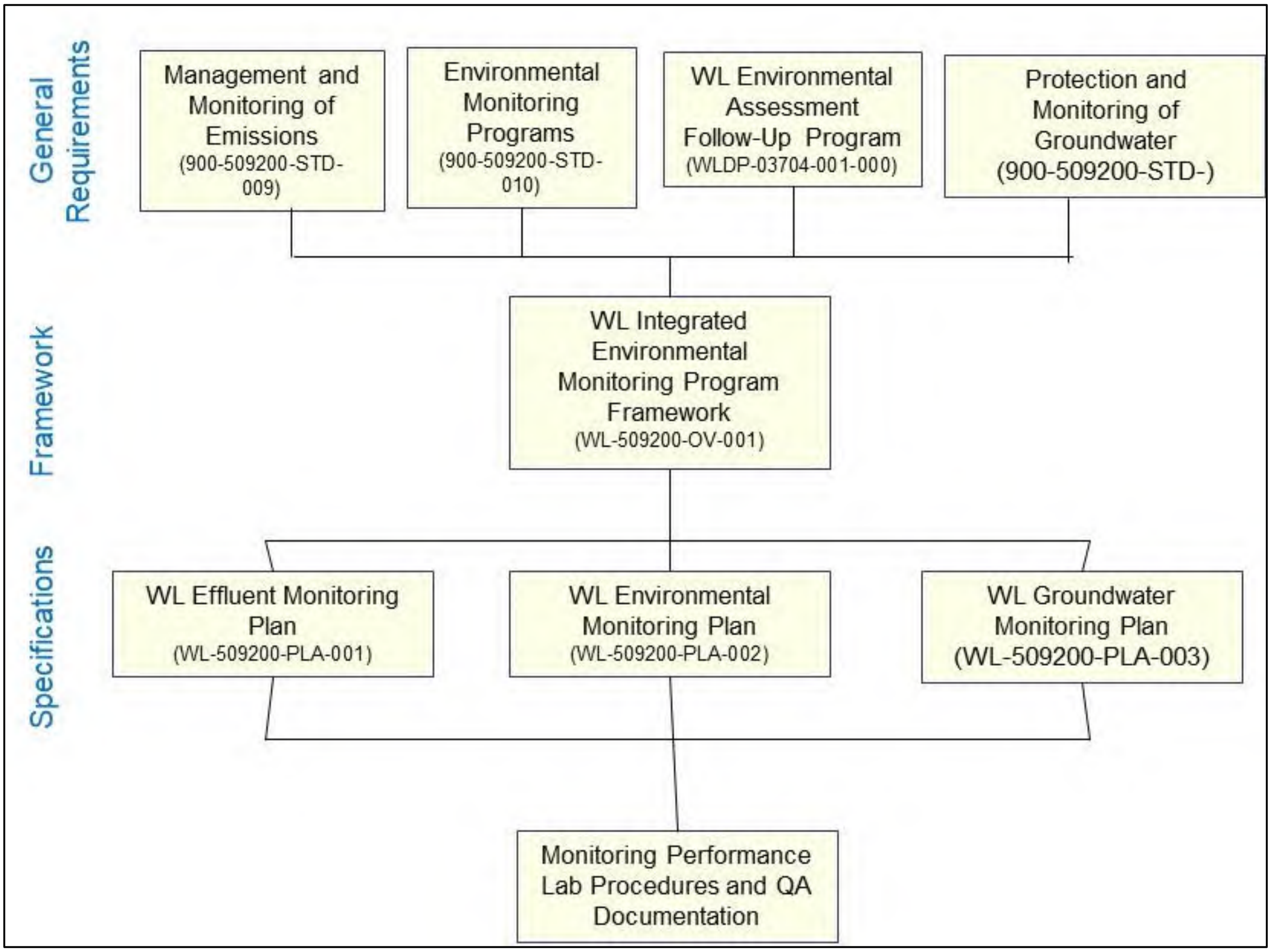

Figure 6: WL's Integrated Environmental Monitoring Program Documentation Structure

The complete list of the documentation used to execute the program is included in Appendix B.

5.2.1.2 Reports

WL produces a consolidated annual report each calendar year to present the details from the monitoring under the Integrated Environmental Monitoring Program (latest issue - *Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [11]) as required by the WL's Site Licence [7].

In addition to this overall report, further details on the EVMPs are reported each calendar year in the WL *Annual Safety Review in 2019* [12] (latest report) as required by the CSA Standard N288.5 [13], and the EMP and GWMP in the annual *WL Environmental Monitoring Report* [14] (latest report) and the *Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [11] as required by CSA Standard N288.4 [15] and CSA Standard N288.7 [16].

5.2.1.3 Roadmap of WL's Compliance with the CSA N288.4, N288.5 and N288.7 Standards

As evidenced in *Management and Monitoring of Emissions* [1] and *Environmental Monitoring Programs* [2], the WL Radiological and Non-radiological EMP and EVMPs have been revised to come into compliance with CSA Standard N288.4 [15] and the CSA Standard N288.5 [13]. This is also true of the *Protection and Monitoring of Groundwater* [3]. A companywide document has been issued in compliance with CSA N288.7 [16]. The series of program documentation developed and under development to ensure this compliance is mapped out in Appendix A for reference purposes.

As noted in the CSA Standards themselves, compliance with the Standard requires adherence to only those clauses in the standard qualified by the terms "shall: or "shall consider". Not all parts of the Standards will be implemented at WL. Instead some recommendations and permissions (i.e., those parts of the Standard which use the wording "should" or "may") have not been adopted for various reasons. These decisions are documented in gap analyses [17], [18], [19] and [20] performed between the monitoring programs and the CSA Standards.

5.2.2 Program Reviews

5.2.2.1 Annual Assessments

In addition to the continual review of monitoring results throughout the year, an annual assessment of the data for each of the individual monitoring programs is completed in preparation of the programs' annual reports [11], [12] and [14].

This annual assessment includes the comparison of results to previous years' results looking to identify trends etc., which may not have become evident during the routine review of the data.

A hydrogeological assessment is performed each year by a contractor [21].

Findings from these annual assessments are included in the programs' annual reports [11], [12] and [14]. Any required changes to the program resulting from this review are captured in the program's subsequent Annual Program Review (see Section 5.2.2.2).

5.2.2.2 Annual Program Review

Individual periodic Program Reviews are completed for the EMP, EVMPs and GWMP. These programs are scheduled based on the calendar year (CY); as such, efforts are made to complete the reviews and incorporate any changes into the program's monitoring schedule in advance of the next year's sampling campaign.

Generally, these reviews cover:

a) The effectiveness of the existing program in accomplishing its objectives;
b) Any program design problems or gaps which have been identified;
c) Any program procedural problems (within EnvP or the labs);
d) A summary of monitoring results from the previous CY and any major issues where the Program needs to be changed; and
e) The disposition of corrective actions from the last Annual Program Review.

Documentation of the reviews is prepared (e.g., meeting minutes, report etc.). Resulting actions from the review are included in both the review's report as well as CNL's action tracking database (ActionWay). Closure verification of the actions by the action's responsible manager may be required thereby ensuring verification of the effectiveness of these corrective actions is completed.

5.2.2.3 Periodic Integrated Environmental Monitoring Program Review

An Integrated Periodic Program Review covering the EVMP, EMP and GWMP involves re-examining the need for and the adequacy of the Integrated Monitoring Program and each of its elemental programs through:

a) A review of the criteria for determining the need to establish an EVMP, EMP and GWMP; and
b) A review of the adequacy of the program with respect to the identified environmental risks on the site which were identified through the CSR, or other studies of similar type.

Documentation of the review in the form of a formal report or memo is prepared.

The need for, and adequacy of, the program addressed shall be reviewed:

a) prior to applying for a licence to begin a new stage in the lifecycle of the nuclear facility or licensed activity;
b) following the proclamation or amendment of any pertinent statute, regulation, licence, or permit that governs the nuclear facility or licensed activity;
c) following any change in the commitments made to a regulatory agency or other stakeholder;
d) following any modification of the physical plant or any change in the nuclear facility or licensed activity or the site ecology or surrounding land uses that has the potential to substantially alter the nature of what is covered under the program;
e) following any change in the receiving environment that that has the potential to significantly change the potential risk to pathways/receptors as a result of the nuclear facility or licensed activity
f) following a significant revision to the CSM;
g) following any update or revision of the Environmental Assessment and/or ERA for the facility;
h) if otherwise required by the Authority Having Jurisdiction;
i) if new scientific advances require change to the approach of a program; and,
j) not more than five years after the last review of the need for and adequacy of the program.

5.2.3 Program Objectives

5.2.3.1 Effluent Verification Monitoring Program

The monitoring objectives of the WL EVMP are listed in the first column in Table 1 below. Note that the second column in Table 1 provides a linkage between the monitoring criteria listed in *Management and Monitoring of Emissions* [1] and the monitoring objectives. In effect, this linkage illustrates how the application of the effluent monitoring criteria (demonstrated in the individual monitoring plan [22]) helps ensure that monitoring activities fall directly under one or more of the programs' monitoring objectives.

Table 1: WL EVMP Monitoring Objectives

Monitoring Objectives	Effluent Verification Monitoring Criteria (taken from [1])
Primary Monitoring Objectives	
a) To demonstrate compliance with regulatory emission limits and any other regulatory requirements (e.g., Action Levels) concerning the emission of nuclear/hazardous substances from the source;	(a) (shall) If monitoring of the effluent stream is designated for monitoring in-, or is required to demonstrate compliance with-, a site or facility operating/decommissioning licence, statute, regulation, or permit, then that effluent stream shall be monitored. (h) (shall) If effluent monitoring of a contaminant or physical stressor is explicitly specified by a site or facility operating/decommissioning licence or required by a statute, regulation or permit to discharge, then that contaminant or physical stressor shall be monitored. (n) (should) If a contaminant is likely to approach or has the potential to exceed regulatory emission limits or internal emission limits, then that contaminant should be monitored. (o) (should) If a non-radioactive contaminant is a reportable substance under the National Pollutant Release Inventory (NPRI) and is released in an effluent stream at greater than 10% of the mass or concentration threshold for that contaminant, then it should be monitored.
b) To demonstrate adherence to internal levels set on emission amounts (e.g., Administrative Levels or Internal Investigation Levels), for purposes of effluent control;	(b) (shall) In the case of effluent streams not subject to Derived Release Limits (DRL), if the total Maximum Probable Emission Rate (MPER) for an effluent stream may exceed 1% of the applicable limits specified by the CNSC, then that effluent stream shall be monitored. (c) (should) If the total MPER for an effluent stream exceeds 0.0005 mSv per year to a member of an off-site critical group, then that effluent stream should be monitored. Normal emission rates, instead of MPER, may be used if the effluent stream has an Operational Control Monitoring Program (OCMP) in place. Note: The dose as a result of MPER emissions may be expressed as a fraction of the applicable Derived Release Limit (DRL) times the annual dose limit from which the DRL was derived. (l) (should) If the site-wide MPER for a radioactive contaminant exceeds 0.0001 mSv per year to a member of an off-site critical group, then that radioactive contaminant should be monitored. “70% Rule: The choice of effluent streams to monitor for this particular radioactive contaminant should be such that at least 70% of site emissions are monitored, e.g., monitor the top most significant effluent streams plus a sufficient number of other streams to ensure that at least 70% of site emissions of that radioactive contaminant are monitored. If this is not possible, then the need for monitoring for that radioactive contaminant should be assessed by an Environmental Specialist or equivalent based on professional judgment.

	Note: The dose as a result of MPER emissions may be expressed as a fraction of the applicable DRL times the annual dose limit from which the DRL was derived." (n) (should) If a contaminant is likely to approach or has the potential to exceed regulatory emission limits or internal emission limits, then that contaminant should be monitored.
c) To confirm the adequacy of controls on emissions from the source;	g) (should) In addition to the effluent streams mentioned above, locations with similar environmental conditions but without potential for facility-related effects (i.e., representative of natural background) should be included in the EVMP as reference. k) (shall) If there is an operational need to identify an unplanned or uncontrolled emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored.
d) To provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;	k) (shall) If there is an operational need to identify an unplanned or uncontrolled emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored.
e) To provide data to assess the level of risk on human health and safety, and the potential biological effects in the environment of the nuclear/hazardous substances of concern released from the facility; and	d) (should) If the effluent stream has potential to contribute to biological effects (as determined in an ERA or equivalent risk assessment), based on its constituent radioactive or non-radioactive contaminants, then that effluent stream should be monitored. e) (should) If the effluent stream contributes significantly to the dose/exposure for a receptor that has been identified as needing a dose/exposure assessment in an ERA or equivalent risk assessment, then that effluent stream should be monitored. Note: An effluent stream that contributes more than 10% of the relevant dose/exposure for the identified receptor can be considered to make a significant contribution. (i) (shall) If the results of an ERA or equivalent risk assessment indicate potential concern with the release of a contaminant, or with a physical stressor, then that contaminant or physical stressor shall be monitored. (j) (shall) If effluent monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored. (m) (should) In the case of a waterborne effluent stream, and when no ERA (or equivalent risk assessment) exists that can provide more specific guidance on the parameter(s) to be monitored, if annual average contaminant concentrations at a point of discharge from CNL site property or to a permanent surface water body on site may exceed Guidelines for Canadian Drinking Water Quality (or equivalent) for a radioactive contaminant, then that contaminant should be monitored.

f) To confirm predictions in environmental assessments.	e) (should) If the effluent stream contributes significantly to the dose/exposure for a receptor that has been identified as needing a dose/exposure assessment in an ERA or equivalent risk assessment, then that effluent stream should be monitored. Note: An effluent stream that contributes more than 10% of the relevant dose/exposure for the identified receptor can be considered to make a significant contribution.
Secondary Monitoring Objectives	
a) To provide data for trend analysis;	q) (should) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).
b) To provide assurance to employees and the public on the effectiveness of effluent control;	(f) (should) If monitoring of the effluent stream is triggered under the Municipal/Industrial Strategy for Abatement (MISA) Program, then that effluent stream should be monitored. (p) (should) If effluent monitoring of a non-radioactive contaminant is triggered under the MISA Protocol, then that contaminant should be monitored.
c) To provide data which, when combined with the results of environmental monitoring and modelling, can be used to test or refine the models of the environment used in the ERA (or equivalent) or dose/exposure assessments;	(j) (shall) If effluent monitoring of a contaminant supports a radiation dose assessment or assessment of potential exposure, then that contaminant shall be monitored.
d) To provide baseline data and capability for monitoring and assessment in emergency conditions; and	(k) (shall) If there is an operational need to identify an unplanned or uncontrolled emission (reasonably foreseeable upset event) of a contaminant into the environment, then that contaminant shall be monitored. (q) (should) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).
e) Other business purposes (e.g., demonstrating due diligence, meeting a stakeholder commitment, etc.).	q) (should) If monitoring is required for other business reasons (e.g., stakeholder concerns, due diligence, etc.).

5.2.3.2 Environmental Monitoring Program

The monitoring objectives of the WL EMP are listed in the first column in Table 2 below. Note that the second column in Table 2 provides a linkage between the monitoring criteria listed in *Environmental Monitoring Programs* [2] and the monitoring objectives. In effect, this linkage illustrates how the application of the environmental monitoring criteria (demonstrated in the individual monitoring plan [23]) helps ensure that monitoring activities fall directly under one or more of the programs' monitoring objectives.

Table 2: WL EMP Monitoring Objectives

Monitoring Objectives	**Environmental Monitoring Criteria (taken from [2])**
Primary Monitoring Objectives	
a) To assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility;	(b) (shall) If a location is representative of a site's identified critical group(s), then this location shall be included in the EMP. (c) (should) If a location represents an area in which contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then this location should be included in the EMP. (d) (should) Any locations in which contaminant Benchmark Values (BV) have been exceeded or are predicted to be exceeded should be included in the EMP. (e) (may) If a gradient in contaminant concentration is expected over a spatial extent, monitoring locations may be distributed along the gradient. (k) (shall) The concentration of a contaminant or the intensity of a physical stressor shall be measured if based on the results of an ERA (or equivalent), there is the potential for the contaminant or physical stressor to produce effects in the receiving environment. (m) (should) The radioactive contaminant(s) chosen for monitoring should be those estimated to contribute 1% or more of total radiation dose to members of a critical group. (r) (shall consider) Any environmental media that could contribute to the dose/exposure of a receptor that is anticipated to experience an effect shall be considered for inclusion in the EMP. (t) (should) Any environmental media in which contaminant BVs have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants.
b) To demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment;	(a) (shall) If environmental monitoring of a location is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that location shall be included in the EMP. (j) (shall) The concentration of a contaminant, intensity of a physical stressor, or effect on the environment shall be measured if required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or as otherwise directed by a regulator. (q) (shall) If environmental monitoring of specific media is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that media shall be included in the EMP.
c) To check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and provide	(f) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring

public assurance of the effectiveness of containment and effluent control;	should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: i. The level of risk from a potential spill or other unintended release of contaminants from a facility is unknown or has been determined by the ERA (or equivalent) to be of concern; ii. The level of risk from unmonitored releases of contaminants from a facility is unknown or has been determined by an ERA (or equivalent) to be of concern; iii. The emission of contaminants is highly variable; and/or iv. There are other business reasons, i.e., stakeholder concerns, due diligence, etc. (p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.
d) Further to the objective described above, which provides an indication on effectiveness of <u>effluent</u> control, where waste storage facilities and contaminated lands exist, the objective is to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring; and	(f) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be in locations within reasonable proximity to the points of discharge and in the likely path of the discharges. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: i. The level of risk from a potential spill or other unintended release of contaminants from a facility is unknown or has been determined by the ERA (or equivalent) to be of concern; ii. The level of risk from unmonitored releases of contaminants from a facility is unknown or has been determined by an ERA (or equivalent) to be of concern; (p) (should) If environmental monitoring is being done to verify the effectiveness of containment and effluent controls, then monitoring should be for those contaminants that could potentially be present in effluent discharges.
e) To verify the predictions made by an ERA (or equivalent), Derived Release Limit (DRL) model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA.	(l) (should) The EMP should include contaminants relevant to the dose/exposure assessments that are normally part of an ERA (or equivalent). (s) (should) Any environmental media for which contaminants/physical stressors of concern were identified in an ERA (or equivalent) should be included in the EMP. (t) (should) Any environmental media in which contaminant BVs have been exceeded or are predicted to be exceeded should be considered for inclusion in the EMP for measurement of those same contaminants. (u) (should) Selection of the environmental media to be monitored should be based on the following principles:

	i. Where practical, monitoring should be done near the end of a pathway (i.e., closer to the receptor) to give dose/exposure estimates with fewer uncertainties that arise from inaccuracies in the models and transfer coefficients; ii. The fate and distribution of contaminants along the pathway linking the source to the receptor should be considered when selecting the media to be sampled; and The mobility of the receptor relative to the area of contamination should be considered when selecting the media to be sampled.
Secondary Monitoring Objectives	
a) To provide data required to support site restoration programs, site operations or to plan for future stages of the facility lifecycle (e.g., decommissioning);	(o) (may) The choice of contaminants to monitor in the environment may also be based on the following: There are other business reasons, i.e., stakeholder concerns, due diligence, etc.
b) To provide resources and data that can be of value during the response to an accident or upset, and in the recovery from such an event;	(o) (may) The choice of contaminants to monitor in the environment may also be based on the following: i. The level of risk from a potential spill or other unintended release of contaminants from a facility is unknown or has been determined by the ERA (or equivalent) to be of concern;
c) To demonstrate due diligence;	(g) (should) If environmental monitoring at a location is triggered by the MISA Protocol, then this location should be included in the EMP. i.(should) The non-radioactive contaminant(s) chosen for monitoring should be those triggered by the MISA Protocol.
d) To meet a stakeholder commitment; and	(o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv. There are other business reasons, i.e., stakeholder concerns, due diligence, etc.
e) For other business purposes (e.g., monitoring emissions to support international treaties).	(i) (should) Consideration should be given to establishing monitoring locations in nearby population centres (other than locations of identified or potential critical groups or locations identified in an ERA or equivalent) for the most dominant contaminants and environmental pathways where there is public concern regarding emissions. (o) (may) The choice of contaminants to monitor in the environment may also be based on the following: iv. There are other business reasons, i.e., stakeholder concerns, due diligence, etc.

5.2.3.3 Groundwater Protection and Monitoring Program

The monitoring objectives of the WL GWPP and GWMP are listed in the first column in Table 3 below. Note that the second column in Table 3 provides a linkage between the monitoring criteria listed in *Protection and Monitoring of Groundwater* [3] and the monitoring objectives. In effect, this linkage illustrates how the application of the environmental monitoring criteria (demonstrated in the individual monitoring plan [24]) helps ensure that monitoring activities fall directly under one or more of the programs' monitoring objectives.

Table 3: WL GWPP and GWMP Goals and Objectives

Monitoring Goals and Objectives	Groundwater Monitoring Criteria taken from [3] and [24].
General Goals	
a) Demonstrate compliance with requirements of the CNSC (e.g. RegDoc 2.9.1 [14]) concerning the protection of groundwater and monitoring for the release of nuclear and hazardous substances from facilities;	(b) (Shall) If there are significant inventories of dispersible nuclear or hazardous substances, and these inventories are, or have been, in a location where a release to the ground would not be detected by past or existing, in facility monitoring, than that facility shall be included in the GWMP; (f) (should) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e. proximity or near source monitoring)
b) Have control measures to prevent or minimize the release of nuclear or hazardous substances directly or indirectly to groundwater by design and operation of SSCs;	(b) (Shall) If there are significant inventories of dispersible nuclear or hazardous substances, and these inventories are, or have been, in a location where a release to the ground would not be detected by past or existing, in facility monitoring, than that facility shall be included in the GWMP; (f) (should) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e. proximity or near source monitoring)
c) Understand the potential risks to human and ecological receptors from releases that affect GW;	(c) (should) If contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then that area should be included in the GWMP; b) (should) The monitoring program should address the COPCs derived from the evaluation of sources and potential releases to the subsurface described in Section 4.3.2.2 (i.e. those identified in the EA, ERA, and CSM) and those identified in the objectives of the GWMP.
d) Have in place a GWMP to provide timely data confirming that uncontrolled releases are not occurring and, if uncontrolled releases do occur, to signal when and where, and, e) Protect the identified groundwater end-uses that are potentially affected by releases to groundwater.	(b) (Shall) If there are significant inventories of dispersible nuclear or hazardous substances, and these inventories are, or have been, in a location where a release to the ground would not be detected by past or existing, in facility monitoring, than that facility shall be included in the GWMP; (f) (should) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e. proximity or near source monitoring) (d)(should) If contaminant benchmark values for soil or groundwater have been exceeded or are predicted

<table>
<tr><td colspan="2"></td><td>to be exceeded, than that area should be included in the GWMP.

(d) (should) In addition to monitoring for the presence of nuclear and hazardous substances, physical parameters such as conductivity and hydraulic head should also be considered. Physical parameters can serve well in indicating changing conditions

(g) (should) Indicator parameters should be considered to provide earlier identification of a COPC released to the subsurface than would monitoring that was limited to the contaminants of more concern (e.g., tritium, conductivity).</td></tr>
<tr><td colspan="3">(shall) Specific groundwater protection goals for a site shall:</td></tr>
<tr><td colspan="2">a) Be developed based on the conceptual site model (CSM);</td><td>g) (should) If a location is needed to further characterize the groundwater flow system or other aspects of the conceptual site model.

c) (should) The parameters selected for groundwater monitoring should be integrated with the parameters used in the EMP to track the fate of COPC migration throughout different environmental media (i.e., integration of pathways monitoring). Complete accordance between COPCs monitored in groundwater and downgradient surface water bodies is not required due to the limited mobility of many COPC’s;</td></tr>
<tr><td colspan="2">b) Include protection of human and ecological receptors potentially affected by GW contamination; and,</td><td>c) (should) If contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then that area should be included in the GWMP</td></tr>
<tr><td colspan="2">c) Include consideration of risks from potential contamination of the soil by groundwater or by non-aqueous phase liquids.</td><td>b) (shall) If there are significant inventories of dispersible nuclear or hazardous substances, and these inventories are or have been, in a location where a release to the ground would not be detected by past or existing, in facility monitoring, then that facility shall be included in the GWMP.</td></tr>
<tr><td colspan="2">(should) The development of specific groundwater protection goals for a site should take into account baseline conditions.</td><td>d) (should) Locations up-gradient of the facility should be included in the GWMP as baseline conditions</td></tr>
<tr><td colspan="3">(shall) Where a GWMP is determined to be necessary for a site or facility, the applicability of the following general objectives for a GWMP shall be considered:</td></tr>
<tr><td>a)</td><td>support the overall, general, and specific goals of the Groundwater Protection Program (GWPP);</td><td>(a) (shall) If groundwater monitoring is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that area shall be included in the GWMP;</td></tr>
</table>

		(b) (Shall) If there are significant inventories of dispersible nuclear or hazardous substances, and these inventories are, or have been, in a location where a release to the ground would not be detected by past or existing, in facility monitoring, than that facility shall be included in the GWMP; (f) (should) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e. proximity or near source monitoring) (d)(should) If contaminant benchmark values for soil or groundwater have been exceeded or are predicted to be exceeded, than that area should be included in the GWMP. (d) (should) In addition to monitoring for the presence of nuclear and hazardous substances, physical parameters such as conductivity and hydraulic head should also be considered. Physical parameters can serve well in indicating changing conditions (g) (should) Indicator parameters should be considered to provide earlier identification of a COPC released to the subsurface than would monitoring that was limited to the contaminants of more concern (e.g., tritium, conductivity).
b)	demonstrate compliance with requirements of the Authority Having Jurisdiction (AHJ) concerning the release of nuclear and hazardous substances from the source;	(a) (shall) If groundwater monitoring is required by any statute, regulation, licence, or permit that governs the operation of the nuclear facility, or otherwise directed by a regulator, then that area shall be included in the GWMP; a) (shall) The monitoring program shall address the COPC's and physical stressor required by any statute, regulation, licence or permit that governs the operation of a nuclear facility.
c)	provide data to verify the predictions made and models used in the Environmental Assessment (EA) or Environmental Risk Assessment (ERA), or reduce the uncertainty in predictions;	(c) (should) If contaminants of concern, physical stressors of concern, or potential effects were identified in an ERA (or equivalent), then that area should be included in the GWMP; b) (should) The monitoring program should address the COPCs derived from the evaluation of sources and potential releases to the subsurface described in Section 4.3.2.2 (i.e. those identified in the EA, ERA, and CSM) and those identified in the objectives of the GWMP.
d)	characterize baseline groundwater flow and groundwater quality;	A baseline characterization study was conducted prior to the operation of the site. (k) (should) Locations up-gradient of the facility should be included in the GWMP as background reference conditions
e)	characterize groundwater flow and groundwater quality during other phases of a site's lifecycle;	(l) (should) If a location is needed to further characterize the groundwater flow system or other aspects of the conceptual site model.

f)	provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring;	(d)(should) If contaminant benchmark values for soil or groundwater have been exceeded or are predicted to be exceeded, than that area should be included in the GWMP. (d) (should) In addition to monitoring for the presence of nuclear and hazardous substances, physical parameters such as conductivity and hydraulic head should also be considered. Physical parameters can serve well in indicating changing conditions (g) (should) Indicator parameters should be considered to provide earlier identification of a COPC released to the subsurface than would monitoring that was limited to the contaminants of more concern (e.g., tritium, conductivity).
g)	to the extent possible, monitor for releases from high risk Structures, Systems, and Components (SSCs) associated with a given facility;	(f) (should) If a location is needed for detection, and possibly quantification, of leakage from a specific SSC;(i.e. proximity or near source monitoring (g) (should) Indicator parameters should be considered to provide earlier identification of a COPC released to the subsurface than would monitoring that was limited to the contaminants of more concern (e.g., tritium, conductivity).
h)	evaluate monitoring data against groundwater evaluation criteria related to nuclear and hazardous substances in groundwater;	Data evaluation criteria (i.e., criteria against which the data are evaluated in order to determine the significance or meaning of the data) are developed for interpretation of monitoring results in relation to the objectives of the monitoring program. It should be noted that not all parameters measured under the GWMP have an associated criterion; these generally consist of measures of environment indicators instead of pollutants; or they could be pollutants but have not had guidelines developed yet as they have not been federally or provincially identified as priority pollutants requiring the development of a guideline
i)	provide information to assess risks from site-affected groundwater to human health and the environment;	(g) (should) If a location is needed for the detection of COPC release from a distributed source; (h) (should) If a location is needed for detection of COPC releases from a region or site containing multiple potential sources; (i) (should) If a location is needed for periodic evaluation of ongoing COPC migration from a past or ongoing release to the subsurface; (i.e. Plume Monitoring) (j) (should) If a location is needed for monitoring at the perimeter of a facility or an operation; Note: Perimeter can refer to the legal property boundary or a defined area of interest within the site
j)	provide site characterization data to address gaps in the site CSM;	(g) (should) If a location is needed for the detection of COPC release from a distributed source; (h) (should) If a location is needed for detection of COPC releases from a region or site containing multiple potential sources;

		(i) (should) If a location is needed for periodic evaluation of ongoing COPC migration from a past or ongoing release to the subsurface; (i.e. Plume Monitoring) (j) (should) If a location is needed for monitoring at the perimeter of a facility or an operation; Note: Perimeter can refer to the legal property boundary or a defined area of interest within the site (c) (should) The parameters selected for groundwater monitoring should be integrated with the parameters utilized in the EMP to track the fate of COPC migration throughout different environmental media (i.e., integration of pathways monitoring).
k)	Demonstrate due diligence;	(e) (may) If monitoring (of an area) is required for other business reasons, (e.g. stakeholder concerns, due diligence).
l)	Meet a stakeholder commitment;	(e) (may) If monitoring (of an area) is required for other business reasons, (e.g. stakeholder concerns, due diligence).
m)	or other business reasons;	(e) (may) If monitoring (of an area) is required for other business reasons, (e.g. stakeholder concerns, due diligence).

5.2.4 Program Responsibilities & Training

Table 4 below outlines the positions responsible for all activities and responsibilities required in the EVMP and EMP, with a reference to the relevant training documentation for those positions. Note that program activities, and qualification and training requirements for staff with overall responsibility for the GWMP, are listed in the WL Groundwater Monitoring Program Specification document [35].

Table 4: Effluent Verification, Environmental and Groundwater Monitoring Program Activities and Positions Responsible

Activity/Role	Responsibilities	Dept.	Position(s) Responsible	Reference to Relevant Training Documentation
Environmental Risk Assessment (or equivalent)	Coordinate and assist with periodic updates to the WL Environmental Assessment Follow-up Program	EM and WLDP	• Decommissioning and Environmental Protection Program Staff	ENVP-509200-PLA-009 [25]
Monitoring Program Design & Implementation Oversight	Develop and maintain the design of the monitoring programs, and oversee their implementation.	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Monitoring Specialist	ENVP-509200-PLA-009 [25]

Activity/Role	Responsibilities	Dept.	Position(s) Responsible	Reference to Relevant Training Documentation
			• Contract Hydrologist/Hydrogeologist	Qualifications outlined in Statement of Work
Sampling & Analytical Procedures	Sample collection and sample analysis and field measurements.	EM and Licensing	• Technician/Technologist /Quality Assurance Staff • Section Head	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27] training sections in each analytical procedure
		RP	• RP Surveyor/RP Surveyor Assistant • Section Head	900-508740-STD-001[28] CW-508740-TNA-003 [29] 191-508740-OP-033 [31]
	Sampling and analysis techniques *(providing expert advice on the adequacy of sample and analysis techniques, and overseeing the development of new techniques as needed)*	EM	• Section Head • Laboratory Technologist	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		RP	• Technical Support Health Physicist	900-508740-STD-001[28] RADP-508740-TPL-006 [30]
Interpretation of Data	Interpret data generated by the monitoring programs.	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Monitoring Specialist • Contract Hydrologist/Hydrogeologist	ENVP-509200-PLA-009 [25] Qualifications outlined in Statement of Work
Quality Assurance and Quality Control	Sampling design, measurements, and QC *(design and oversee implementation of the sampling and measurement QC)*	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Specialist	ENVP-509200-PLA-009 [25]
		EM	• Technician/Technologist /Quality Assurance Staff • Section Head	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure

Activity/Role	Responsibilities	Dept.	Position(s) Responsible	Reference to Relevant Training Documentation
		Licensing	• Quality Assurance Representative	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		RP	• Technical Support Health Physicist	900-508740-STD-001[28] RADP-508740-TA-006 [30]
			• RP Surveyor/RP Surveyor Assistant • Section Head • Instrument Technologist	900-508740-STD-001[28] CW-508740-TNA-003 [29] 191-508740-OP-033 [31]
	Equipment maintenance	EM	• Section Head • Laboratory Technologist	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		Licensing	• Quality Assurance Representative	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		RP	• Instrument Technologist • RP Surveyor • Section Head	900-508740-STD-001[28] CW-508740-TNA-003 [29] Note: Every time a new piece of equipment is acquired, the manufacturer's training course is taken. 191-508740-OP-033 [31]
			• Technical Support Health Physicist	900-508740-STD-001[28] RADP-508740-TA-006 [30]
	Non-conformance management and performance verification *(managing non-conformances, schedu*	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Specialist	ENVP-509200-PLA-009 [25]

Activity/Role	Responsibilities	Dept.	Position(s) Responsible	Reference to Relevant Training Documentation
	ling checks for procedural compliance, intralaboratory and interlaboratory checks, etc.)	EM	• Technician/Technologist • Quality Assurance Representative • Section Head	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		RP	• RP Surveyor • Section Head • Instrument Technologist	900-508740-STD-001[28] CW-508740-TNA-003 [29] 191-508740-OP-033 [31]
	Procedures and sample verification *(developing and validating the sampling and analytical procedures)*	EM	• Section Head • Environmental Specialists • Environmental Chemist/Scientist • Contract Hydrologist/Hydrogeologist • Environmental Technologists	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure Qualifications outlined in Position Description Qualifications outlined in Statement of Work
		RP	• RP Surveyor • Section Head • Instrument Technologist	900-508740-STD-001[28] CW-508740-TNA-003 [29] 191-508740-OP-033 [31]
			• Technical Support Health Physicist	900-508740-STD-001[28] RADP-508740-TA-006 [30] 191-508740-OP-033 [31]
	Records and data management	EM	• Technician • Technologist • Section Head • Quality Assurance Representative	WL-514200-GDI-001 [26] and WL-514200-QAP-001 [27], and training sections in each analytical procedure
		RP	• RP Surveyor • Section Head	900-508740-STD-001[28] CW-508740-TNA-003 [29] 191-508740-OP-033 [31]

Activity/Role	Responsibilities	Dept.	Position(s) Responsible	Reference to Relevant Training Documentation
Program Reviews	Periodically review the adequacy of monitoring program design and effectiveness of programs.	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Specialist	ENVP-509200-PLA-009 [25]
Annual Report	Prepare annual reports summarizing the results of the monitoring programs.	EM	• Radiological Monitoring Specialist • Non-Radiological Monitoring Specialist • Groundwater Specialist • Contract Hydrologist	ENVP-509200-PLA-009 [25] Qualifications outlined in Statement of Work
Program Audits	Periodic audits of the monitoring programs.	External	• Contractor	Qualifications outlined in Statement of Work

6. REFERENCES

[1] *Management and Monitoring of Emissions*, 900-509200-STD-009.

[2] *Environmental Monitoring Programs*, 900-509200-STD-010.

[3] *Protection and Monitoring of Groundwater*, 900-509200-STD-015.

[4] *Environmental Assessment Follow-Up Program for Whiteshell Laboratories*, WLDP-03704-001-000, 2002 June.

[5] *Environmental Protection Program Radiological and Non-Radiological Monitoring Services Quality Assurance Plan*, EnvP-01913-QAP-001.

[6] *Environmental Protection Program Description Document*, 900-509200-PDD-001.

[7] Canadian Nuclear Safety Commission, *Nuclear Research and Test Establishment Decommissioning Licence – Whiteshell Laboratories*, Licence No. NRTEDL-W5-8.00/2024. Expiry Date: 2024 December 31.

[8] *Responsibility for Facilities and the Safety Of Operations At The Whiteshell Laboratories,* WL-508200-PRO-212.

[9] *Whiteshell Laboratories Decommissioning Project Comprehensive Study Report"*, Volumes 1, 2, and 3, 2001 March – Volumes 1 and 2 and 2001 November – Volume 3, WLDP-03702-041-000-0008 Rev. 2, WLDP-03702-041-000-0009 Rev. 2, WLDP-03702-041-000-0010 Rev. 0.

[10] *Derived Release Limits (DRLs) for AECL's Whiteshell Laboratories,* WL-509200-RRD-001, 2016.

[11] *2019 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories*, WL-509246-ACMR-2019, 2020 June.

[12] Whiteshell Laboratories Annual Compliance Report for 2019 under Licence NRTEDL-W5-8.00/2024, WL-514300-ACMR-2019, 2020 April.

[13] Canadian Standards Association, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CSA N288.5-11, 2011 April.

[14] Canadian Nuclear Laboratories, *Environmental Monitoring in 2019 at Whiteshell Laboratories*, WL-509243-ACMR-2019, 2020 June.

[15] Canadian Standards Association, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CSA N288.4-10, 2010 May.

[16] Canadian Standards Association, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills*, CAN/CSA-N288.7-15, 2015.

[17] Cotter Associates, CSA N288.4 and N288.5-11 *Gap Analysis Whiteshell Laboratories*, WL-01916-041-000-002, 2015 August.

[18] CRL-509200-REPT-004, Gap Analysis between CRL's Existing Environmental Monitoring Programs and the New CSA Standard N288.4-10, 2012 July.

[19] CRL-509200-REPT-005, Gap Analysis Between CRL's Effluent Monitoring Programs And The New CSA Standard N288.5-11 Effluent Monitoring Programs At Class 1 Nuclear Facilities And Uranium Mines And Mills, 2012 July.

[20] Actions to Close Gaps to N288 standards, WL-509200-062-000-000.

[21] Hydrogeological Assessment for Annual Safety Report, Dillon Consulting, WLDP-03704-041-000.

[22] W*L Effluent Verification Monitoring Plan*, WL-509200-PLA-001.

[23] *WL Environmental Monitoring Plan*, WL-509200-PLA-002.

[24] *Whiteshell Laboratories Groundwater Monitoring Plan*, WL-509200-PLA-003.

[25] Orientation and Training for ENVP Program Staff, ENVP-509200-PLA-009.

[26] Environmental Compliance Governing Documentation Index, WL-514200-GDI-001.

[27] Environmental Compliance *Quality Assurance Plan*, WL-514200-QAP-001.

[28] *Employee Designation and Training Requirements*, 900-508740-STD-001.

[29] *Radiation Protection Group 2 Worker – Training Needs Analysis and Training Requirements*, CW-508740-TNA-003.

[30] *Group 1 Health Physicist Task Analysis*, RADP-508740-TA-006.

[31] *Setup, Servicing, And Sample Changing For Tritium Bubblers and In-Line Air Samplers*, 191-508740-OP-033.

[32] Effluent Verification Monitoring and Environmental Monitoring Station Maintenance and Calibration Plan, WL-509200-TEP-001.

[33] Records Management, 900-511300-MCP-001.

[34] Document Control, 900-511300-STD-003.

[35] Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions, Dillon Consulting Limited, Revision 1, 2009 April, WLDP-03705-041-000-0022.

APPENDIX A RELATIONSHIPS BETWEEN CSA STANDARDS AND WL DOCUMENTATION

TABLE A-1 CSA STANDARD N288.4 – 10, ENVIRONMENTAL MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS

Contents of CSA N288.4	Applicable CNL Document(s) [Location of Requirement (R) & Location of Implementation Details (I)]
4 Objectives of an environmental monitoring program (EMP) 4.1 General objectives 4.2 Additional objectives	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Lists the EMP objectives. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* – Details the WL monitoring program's specific objectives pulled from those identified in 900-509200-STD-010. I: WL-509200-PLA-002 - *Environmental Monitoring Plan* – Details how these objectives are met through the monitoring performed at WL.
5 Criteria for establishing and revising an environmental monitoring program 5.1 General 5.2 Criteria for determining the need to establish an EMP 5.3 Criteria for determining the need to revise an EMP	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Lists both sets of criteria. I: WL-509200- PLA-002 - *Environmental Monitoring Plan* – Details which of these criteria were met thereby requiring WL to establish an EMP.
6 Design of an EMP 6.1 General 6.2 Systematic planning process for the development of an EMP	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Outlines the systematic process to be used when designing an EMP. I: WL-509200- PLA-002 - *Radiological Environmental Monitoring Plan*- Details the systematic process specifically used by WL to design the EMP.
7 Guidance for the design elements of an EMP 7.1 General 7.2 Contaminants and physical stressors to be monitored 7.3 Receptors of interest 7.4 Measures of biological effect 7.5 Media to be measured or sampled 7.6 Monitoring locations 7.7 Monitoring duration, frequency, intensity and magnitude 7.8 Supplementary studies 7.8.1 General 7.8.2 Entrainment and Impingement 7.8.3 Wildlife interactions with traffic and structures 7.8.4 Measurements of meteorological or hydrological data	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Outlines the monitoring which should be in place for a CNL EMP. I: WL-509200- PLA-002 - *Environmental Monitoring Plan*- Outlines the monitoring in place for WL's EMP.
8 Sampling and analytical procedures 8.1 General 8.2 Sampling collection 8.3 Sampling analysis and field measurements 8.4 Sampling and analysis techniques	R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* - Includes both requirements and guidance for sample collection and analysis. I: WL-509200-OV-001 - *WL's Integrated EMP Framework* - Provides a list of laboratory documents which cover the sample station design, sample collection and sample analysis in place for the WL EMP.

Contents of CSA N288.4	Applicable CNL Document(s) [Location of Requirement (R) & Location of Implementation Details (I)]
9 Interpretation of data 9.1 General 9.2 Statistical analysis 9.3 Uncertainty 9.3.1 General 9.3.2 Types and sources of uncertainty 9.3.3 Assessment, reduction, and reporting of uncertainties 9.3.4 Significant figures 9.4 Exposure and dose assessment	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – includes general requirements on the handling of uncertainty, significant figures and dose assessment for a CNL EMP. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Includes requirements and guidance on measurement uncertainty. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes a list of laboratory analytical procedures for data handled under the EMP as well as applicable procedures used when reporting lab results. I: WL-509253-PRO-001 - Estimating Measurement Uncertainty Arising From Measurement And Sampling. I: WL-509243-ASR-XXXX – *Annual Environmental Monitoring at WL* – Provides the interpretation of the data collected under the EMP. I: WL-509246-ASR-XXX – Annual Progress Report on the Environmental Assessment Follow-up Program for WL – provides additional interpretation of the data collected under the EMP.
10 Quality Assurance (QA) and Quality Control (QC) 10.1 General 10.2 Roles and responsibilities 10.3 Sampling design and QC 10.4 Measurements and QC 10.4.1 Equipment maintenance 10.4.2 Non-conformance 10.4.3 Performance verification 10.4.4 Procedures and sample verification 10.5 Records	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Outlines requirement to have a QA/QC program. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* - Details the required design of an EMP QA/QC program. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* - Provides a list of laboratory documents which detail procedural steps to execute QA/QC as well as a list of laboratory QA plans and Maintenance and Calibration requirements for associated equipment. I: WL-509200-PLA-002 - *Environmental Monitoring Plan* – Provides details on the field QA/QC in place and points to EnvP-01913-QAP-001 and lab procedures containing specific QA information.
11 Reporting, review and audit 11.1 General 11.2 Reporting 11.3 Annual assessment of the EMP 11.4 Periodic review of the EMP 11.5 Audits	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Provides requirements for reporting, reviews and audits. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes details on WL's reporting and program reviews (but not audits) in place to meet these requirements.
12 Staff qualification and training 12.1 Personnel qualifications 12.2 Training 12.3 Maintenance of training records	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Outlines that staff involved in the monitoring programs must be qualified and trained. R: EnvP-01913-QAP-001 – *EnvP Program Radiological and Non-radiological Monitoring Services Quality Assurance Plan* – Outlines that staff involved in the monitoring programs must be qualified and trained. I: WL-509200-OV-001 - W*L Integrated EMP Framework* – Includes the list of training documents for staff involved in the EMPs including training needs and qualifications (Note: Many of these are company-wide processes). I: 900-510200-STD-001 – Training Analysis I: 900-510200-FM-003 – Personnel Qualifications and Training Needs
13 Documentation	R: 900-509200-STD-010 – *Environmental Monitoring Programs* – Outlines which documents are required to be kept. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Outlines the documents associated with QA/QC which must be kept, including details such as retention time. I: WL-509200-OV-001 – WL*'s Integrated EMP Framework* – Includes details on WL's reports and program reviews (but not audits) in place to meet these requirements.

TABLE A-2
CSA STANDARD N288.5-11, EFFLUENT MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS

Contents of CSA N288.5	Applicable CNL Document(s) [Location of Requirement (R) & Location of Implementation Details (I)]
4 Objectives of an effluent monitoring program 4.1 General objectives 4.2 Additional objectives	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* – Lists the EVMP objectives. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* – Details the WL monitoring program's specific objectives pulled from those identified in 900-509200-STD-009. I: WL-509200-PLA-001 – *WL Effluent Verification Monitoring Plan* – Details how these objectives are met through the monitoring performed at WL.
5 Criteria for establishing an effluent monitoring program	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* – Lists EVMP establishment criteria. I: WL-509200-PLA-001 – WL *Effluent Verification Monitoring Plan* – Details which of these criteria were met thereby requiring WL to establish an EVMP.
6 Design of an Effluent Monitoring Program 6.1 General 6.2 Systematic planning process for the development of an Effluent Monitoring Program	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* - Outlines this systematic process to be used by any CNL site when designing an effluent monitoring program. I: WL-509200-PLA-001 – *WL Effluent Verification Monitoring Plan* – Details the systematic process specifically used by WL to design the EVMP.
7 Guidance for the design elements of an Effluent Monitoring Program 7.1 General 7.2 Nuclear and Hazardous Substances to be monitored 7.3 Selecting Effluent Streams to be Monitored 7.4 Initial Characterization of an Effluent Stream 7.5 Choice of Monitoring Strategy (air and water) 7.6 Sampling locations (air and water) 7.7 Sampling frequency (air and water) 7.8 Sampling Volume 7.9 Supplementary Studies and Other Monitoring Activities	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* - Outlines what the design of an CNL EVMP should include. I: WL-509200-PLA-001 – WL *Effluent Verification Monitoring Plan* – Outlines the monitoring in place for WL's EVMP.
8 Sampling and analytical procedures 8.1 General 8.2 Representative Sampling 8.3 Sampling of waterborne effluents 8.4 Sampling of airborne effluents 8.4 Sampling and analytical techniques	R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* - Includes both requirements and guidance for sample collection and analysis. I: WL-509200-OV-001 – WL*'s Integrated EMP Framework* - Provides a list of laboratory documents which cover the sample station design, sample collection and sample analysis in place for the WL EVMP.
9 Interpretation of data 9.1 General 9.2 Statistical analysis 9.3 Uncertainty 9.3.1 General 9.3.2 Assessment, reduction, and reporting of uncertainties 9.3.3 Significant Figures	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* – includes general requirements on the handling of uncertainty, significant figures and interpretation of data for an CNL EVMP. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Includes requirements and guidance on measurement uncertainty. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes a list of laboratory analytical procedures for data handled under the EVMP as well as applicable procedures used when reporting lab results. I: WL-00583-ASR-XXXX, *Effluent Verification Monitoring at Chalk River Laboratories in YYYY*– Provides the interpretation of the annual data collected under the WL EVMP.

Contents of CSA N288.5	**Applicable CNL Document(s)** **[Location of Requirement (R) & Location of Implementation Details (I)]**
10 Quality assurance (QA) and quality control (QC) 10.1 General 10.2 Roles and responsibilities 10.3 Measurements and QC 10.3.1 Equipment maintenance 10.3.2 Non-conformance 10.3.3 Performance verification 10.3.4 Procedures and sample verification 10.4 Records	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* - Outlines requirement to have a QA/QC Program. R: EnvP-01913-QAP-001 – Details the required design of an EVMP QA/QC program. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* - Provides a list of laboratory documents which detail procedural steps to execute QA/QC as well as a list of laboratory QA plans and Maintenance and Calibration requirements for associated equipment.
11 Reporting, review and audit 11.1 General 11.2 Reporting 11.3 Periodic review of the Effluent monitoring program 11.4 Annual assessment of the Effluent Monitoring program 11.5 Audits	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* - Provides requirements for program reporting, reviews and audits. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes details on WL's program reporting and reviews (but not audits) in place to meet these requirements.
12 Staff qualification and training 12.1 Personnel qualifications 12.2 Training 12.3 Maintenance of training records	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* – Provides requirement for staff involved in the monitoring programs to be qualified and trained. R: EnvP-01913-QAP-001 – *EnvP Program Radiological and Non-radiological Monitoring Services Quality Assurance Plan* – Outlines that staff who work with the monitoring programs must be qualified and trained. I: WL-509200-OV-001 - W*L Integrated EMP Framework* – Includes the list of training documents for staff involved in the EVMPs including training needs and qualifications (Note: Many of these are company-wide processes). I: 900-510200-STD-001 – Training Analysis I: 900-510200-FM-003 – Personnel Qualifications and Training Needs
13 Documentation	R: 900-509200-STD-009 – *Management and Monitoring of Emissions* – Outlines which documents are required to be kept. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Outlines the documents associated with QA/QC which must be kept, including details such as retention time. R: 900-511300-MCP-001 Rev. 0 RECORDS MANAGEMENT and 900-511300-STD-003, Document Control – details the process to define which documents are required to be kept under EVMPs Company-wide including the type of record, the regulatory requirement for keeping it, the retention period and the Locations of the records to be kept. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes details on WL's program reports, reviews and audits in place to meet these requirements.

TABLE A-3
CSA STANDARD N288.7-15, GROUNDWATER MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS

Contents of CSA N288.7	Applicable CNL Document(s) [Location of Requirement (R) & Location of Implementation Details (I)]
4 Goals and Objectives of Groundwater Protection and Groundwater Monitoring program (GWMP) 4.1.1 Overall Goal 4.1.2 General Goals 4.2 General Objectives	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater R: WLDP-03704-001-000 – Environmental Assessment Follow-Up Program for Whiteshell Laboratories. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* – Details the WL monitoring program's specific objectives pulled from those identified in 900-509200-STD-015. I: WL-509200-PLA-003 – *Groundwater Monitoring Plan* – Details how these objectives are met through the monitoring performed at WL.
5 Criteria for establishing groundwater protection and groundwater monitoring programs. 5.1 Criteria for the need for establishing Groundwater Protection Programs (GWPP) 5.2 Criteria for determining the need to establish a Groundwater Monitoring Program (GWMP)	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater. R: WLDP-03702-041-000-0008 Rev. 2, WLDP-03702-041-000-0009 Rev. 2, WLDP-03702-041-000-0010 Rev. 0, *"Whiteshell Laboratories Decommissioning Project Comprehensive Study Report"*, Volumes 1, 2, and 3, 2001 March – Volumes 1 and 2 and 2001 November – Volume 3. R: WLDP-03704-001-000 – Environmental Assessment Follow-Up Program for Whiteshell Laboratories. I: WLDP-03705-041-000-0022– *Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions* –discusses the criteria for establishing groundwater protection and groundwater monitoring programs. I: WL-509200-PLA-003 – *Groundwater Monitoring Plan* – Details which of these criteria were met thereby requiring WL to establish a GWMP.
6 Design of a GWPP 6.1 General 6.2 Establishing a Conceptual Site Model 6.3 Prevention and Minimization of Potential Releases to Groundwater 6.4 Development of Specific Groundwater Protection Goals 6.5 Development of a Groundwater Monitoring Program 6.6 Development of Other Programs Associated with Groundwater Protection	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater R: and I: WLDP-03705-041-000-0022– Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions –discusses the groundwater flow system and migration. R: WLDP-03704-001-000 – Environmental Assessment Follow-Up Program for Whiteshell Laboratories. R: 900-509200-STD-009 – *Management and Monitoring of Emissions* R: and I: 900-509200-PRD-001 Program Requirements Document, Groundwater Protection is assured through adherence to the Environmental Program Protection requirements. In particular, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations, PCB regulations, Wastewater Effluent Systems Regulations, Management of Designated Toxic Substances and Waste Management Facilities Regulation. I: WLDP-03704-ENA-004 – EAFP: Enhanced Monitoring Program, Hydrogeology Plan – Whiteshell Laboratories Waste Management Area, Landfill and Lagoon I: WL-509200-PLA-003 – *Groundwater Monitoring Plan* – Details which of these criteria were met thereby requiring WL to establish a GWMP. I: 900-509200-STD-005 – Environmental Incident Reporting, Investigation, and Mitigation. I: WL-508600-PRO-723 – Waste Management and Effluent Control I: WL-509200-PLA-001 – WL Effluent Verification Monitoring Plan I: WL Environmental Aspect Assessment and Operational Control Assessment Reports I: Environmental Protection Category 1 to 4 training as well as subject specific training.

Contents of CSA N288.7	Applicable CNL Document(s) [Location of Requirement (R) & Location of Implementation Details (I)]
7. Design of a GWMP 7.1 General 7.2 Systematic planning process for the development of a Groundwater Monitoring Program 7.3 Selection of Monitoring Strategy 7.4 Nuclear and hazardous substances to be monitored 7.5 Boreholes and Monitoring wells 7.6 Sampling Locations 7.7 Sampling Frequency 7.8 Supplementary Studies and other Monitoring Activities 7.8.2 Refinement of conceptual site model 7.8.3 Characterization of potential effects from plume discharge	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater I: WL-509200-PLA-003 – *Groundwater Monitoring Plan*
8 Sampling and analytical procedures 8.1 General 8.2 Sampling equipment 8.3 Sample collection 8.4 Sample volume, containers, and preservatives 8.5 Field measurements and sample analysis	R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* - Includes both requirements and guidance for sample collection and analysis. I: WL-509200-OV-001 - *WL's Integrated EMP Framework* - Provides a list of laboratory documents which cover the sample station design, sample collection and sample analysis in place for the WL EMP.
9 Interpretation of data 9.1 Objectives of data 9.2 Data evaluation 9.3 Parameters 9.4 Comparison to groundwater evaluation criteria 9.5 Statistical Analysis 9.6 Contextual considerations when interpreting results 9.7 Data management 9.8 Significant Figures	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater – includes requirements for data interpretation, evaluation, management and significant figures R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Includes requirements and guidance on measurement uncertainty. I: WL-509200-OV-001 – W*L's Integrated EMP Framework* – Includes a list of laboratory analytical procedures for data handled under the GWMP as well as applicable procedures used when reporting lab results. I: WL-509253-PRO-001 - Estimating Measurement Uncertainty Arising From Measurement And Sampling. Includes a discussion on Significant Figures. I: WL-509243-ASR-XXXX – *Annual Environmental Monitoring at WL* – Provides the interpretation of the data collected under the GWMP. I: WL-509246-ASR-XXX – Annual Progress Report on the Environmental Assessment Follow-up Program for WL – provides additional interpretation of the data collected under the GWMP. I: WLDP-03704-041-000 – Annual Hydrogeological Assessment prepared by Contract Hydrogeologist provides interpretation of groundwater flow and conditions.

Contents of CSA N288.7	**Applicable CNL Document(s)** **[Location of Requirement (R) & Location of Implementation Details (I)]**
10 Quality Assurance (QA) and Quality Control (QC) 10.1 General 10.2 Roles and responsibilities 10.3 Measurements and QC 10.3.1 Equipment maintenance 10.3.2 Non-conformance 10.3.3 Performance verification 10.4.4 Procedures verification 10.4 Records	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater – Outlines requirement to have a QA/QC program. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* - Details the required design of a GWMP QA/QC program. I: WL-509200-OV-001 - W*L's Integrated EMP Framework* - Provides a list of laboratory documents which detail procedural steps to execute QA/QC as well as a list of laboratory QA plans and Maintenance and Calibration requirements for associated equipment. I: 900-509200-STD-015 – Protection and Monitoring of Groundwater Provides details on the field QA/QC in place and points to EnvP-01913-QAP-001 and lab procedures containing specific QA information.
11 Reporting, review and audit 11.1 Preparation of monitoring reports documenting the GWMP 11.2 Periodic review of the groundwater protection program and groundwater monitoring program 11.3 Annual assessment of the GWMP 11.4 Audits	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater – Provides requirements for reporting, reviews and audits. I: WL-509200-OV-001 – W*L's Integrated GWMP Framework* – Includes details on WL's reporting and program reviews (but not audits) in place to meet these requirements.
12 Staff qualification and training 12.1 Personnel qualifications 12.2 Training 12.3 Maintenance of training records	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater – Outlines that staff involved in the monitoring programs must be qualified and trained. R: EnvP-01913-QAP-001 – *EnvP Program Radiological and Non-radiological Monitoring Services Quality Assurance Plan* – Outlines that staff involved in the monitoring programs must be qualified and trained. I: WL-509200-OV-001 - W*L Integrated EMP Framework* – Includes the list of training documents for staff involved in the GWMPs including training needs and qualifications (Note: Many of these are company-wide processes). I: 900-510200-STD-001 – Training Analysis I: 900-510200-FM-003 – Personnel Qualifications and Training Needs I: Environmental Protection Category 1 to 4 training as well as subject specific training.
13 Documentation 13.1 Groundwater protection program documentation 13.2 Groundwater monitoring program documentation	R: 900-509200-STD-015 – Protection and Monitoring of Groundwater Outlines which documents are required to be kept. R: EnvP-01913-QAP-001 – *EnvP Program Quality Assurance Plan* – Outlines the documents associated with QA/QC which must be kept, including details such as retention time. I: WL-509200-OV-001 – WL*'s Integrated EMP Framework* – Includes details on WL's reports and program reviews (but not audits) in place to meet these requirements.

APPENDIX B PROGRAM DOCUMENTATION

TABLE B-1
SUMMARY OF PROGRAM DOCUMENTATION

Document Name	Document Number	Description	Owner
1 Integrated Environmental Monitoring Program			
1(a) Requirements Documents and Procedures			
Management and Monitoring of Emissions	900-509200-STD-009	Defines the key requirements, responsibilities and processes for the management of radiological and non-radiological emissions which includes: a) identification and assessment of emission routes, b) Control and treatment of emissions, c) Operational control monitoring, and d) Effluent verification monitoring.	EnvP
Environmental Monitoring Programs	900-509200-STD-010	Defines the key requirements, responsibilities and processes for the establishment, design, and conduct of an Environmental Monitoring Program covering both radiological and non-radiological contaminants.	EnvP
Protection and Monitoring of Groundwater	900-509200-STD-015	Defines the key requirements, responsibilities and processes for the establishment, design, and conduct of a Groundwater Protection and Monitoring Program covering both radiological and non-radiological contaminants.	
WL Environmental Assessment Follow-Up Program	WLDP-03704-001-000	Defines the key requirements, responsibilities and process for the execution of the Environmental Assessment Follow-up Program. Defines the overall objectives of the GWMP and the ways these objectives are met. Defines the general working level requirements and management processes for the WL GWMP and is intended to establish a formalized administrative framework for the program and is primarily intended to be used in guiding the ongoing operation of the program and for training and quality assurance purposes.	EM
EnvP Program Radiological and Non-radiological Monitoring Services Quality Assurance Plan	EnvP-01913-QAP-001	Specifies general requirements for the competence to carry out Radiological and Non-Radiological monitoring services provided to the	EnvP

Document Name	Document Number	Description	Owner
		EnvP Program and provides a framework for planning, documenting, executing and verifying work conducted by Monitoring Services. This plan is used by EM.	
Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions	WLDP-03705-041-000-0022	Discusses the groundwater flow system and migration.	EnvP
Program Requirements Document	900-509200-PRD-001	Groundwater Protection is assured through adherence to the Environmental Program Protection requirements. In particular, Storage Tank Systems for Petroleum Products and Allied Petroleum Products Regulations, PCB regulations, Wastewater Effluent Systems Regulations, Management of Designated Toxic Substances and Waste Management Facilities Regulation	EnvP
Records Management	900-511300-MCP-001	Details the process to define which documents are required to be kept under EVMPs Company-wide including the type of record, the regulatory requirement for keeping it, the retention period and the Locations of the records to be kept.	IT
Document Control	900-511300-STD-003		IT
1 (b) WL Monitoring Plans			
WL's Environmental Monitoring Plan	WL-509200-PLA-002	Provides reasoning behind the design and implementation of WL's Environmental Monitoring Program.	EnvP
WL Effluent Monitoring Plan	WL-509200-PLA-001	Provides reasoning behind the design and implementation of WL's Effluent Monitoring Program.	EnvP
WL Groundwater Monitoring Plan	WL-509200-PLA-003	Provides working level guidelines and responsibilities for WL's Groundwater Monitoring Program.	EnvP
EAFP: Enhanced Monitoring Program – Hydrogeology Plan	WLDP-03704-ENA-004	Discusses the design and installation of the more recent WL Groundwater Monitoring wells.	EnvP
Monitoring Plan for the Ongoing Assessment of the WMA, Lagoon and Landfill Physical and Chemical Hydrogeological Conditions	WLDP-03705-041-000-0022	Discusses the groundwater flow system and basis for the new Groundwater Monitoring Plan WL-509200-PLA-003.	EnvP

Document Name	Document Number	Description	Owner
WL Biodiversity Management Plan	WL-509213-410-000	Identifies Canadian Nuclear Laboratories (CNL) legal obligations towards the management of Species at Risk areas and provide mitigation measures to reduce any potential adverse impacts.	EnvP
2 Quality Assurance Plans			
EnvP Program Radiological and Non-radiological Monitoring Services Quality Assurance Plan	EnvP-01913-QAP-001	Specifies general requirements for the competence to carry out Radiological and Non-Radiological monitoring services provided to the EnvP Program and provides a framework for planning, documenting, executing and verifying work conducted by Monitoring Services. This plan is used by EM.	EnvP
Environmental Protection and Monitoring Quality Assurance Plan	WL-514200-QAP-001	Describes the QA Program for the Environmental Management Branch. This Plan is in line with EnvP-01913-QAP-001.	WL
3 Maintenance and Calibration			
Effluent Verification Monitoring and Environmental Monitoring Station Maintenance and Calibration Plan	WL-509200-TEP-001	Applies to equipment stationed in situ that are essential for effluent verification monitoring and environmental monitoring at and around the WL site.	EnvP
RP Instrument Shop Overview	191-508237-OP-009	Describes the current RP Instrument Shop Instrument Calibration and Maintenance Program.	RP
Measuring and Sampling Equipment	WL-514200-GDI-001	List procedures that describe the requirements, responsibilities and process for the acquisition, control, and calibration of measuring and sampling equipment (EM) used in the EM Labs.	WL
4 Staff Qualification and Training			
4(a) EnvP Program Staff			
Orientation and Training for ENVP Program Staff	ENVP-509200-PLA-009	Outlines the training requirements for all Environmental Protection Program staff and environmental analysts, including those working on the Monitoring Programs.	EnvP
4(b) Laboratory Staff Training (WL and RP)			

Document Name	Document Number	Description	Owner
Training Analysis	900-510200-STD-001	Describes the process for analyzing training needs for all personnel performing technical work as CNL employees on the EMP (RP, WL).	Training and Development
Training Design and Development Standard	900-510200-STD-001	Describes the process for determining training requirements, incorporating these requirements into training program plans, and developing the associated training and assessment materials for all positions performing technical work as CNL employees on the EMP (RP, WL).	Lab Manager
Accountability Statements and Position Descriptions	900-510000-MCP-014	Described the process for preparing Accountability Statements for management positions and Position Descriptions for non-management positions.	Human Resources
Position Description	900-510000-FM-008	A position description form is filled out for each position involved in the WL EMP, including laboratory staffing RP and WL.	Lab Manager
Personnel Qualification and Training Needs	900-510200-FM-003	A personnel qualification and training need form is filled out for each staff member performing work on the WL EMP (i.e. laboratory staffing RP and WL).	Lab Manager
5 Sample Station Design Standards			
Nuclear Facility Ventilation System Design	145-508120-REQ-002	Describes the requirements for nuclear ventilation system design.	Engineering
Radioactive Air Effluent Monitoring Standard for Sampling Stations	118-61300-STD-001	Describes the requirements for radioactive air effluent releases sampling stations (devices and systems) that are used for regulatory compliance purposes.	AEML
RP Instrument Shop Overview	191-508237-OP-009	Describes the current RP Instrument Shop Instrument Calibration and Maintenance Program.	RP
6 Field Sampling Procedures			
6(a) EM			
Animal: Tissue Sampling Procedure	WL-509251-PRO-001	Details the collection and preparation of animal samples for analysis.	EM
Fish: Tissue Sampling Procedure	WL-509251-PRO-002	Details the collection and preparation of fish samples for analysis.	EM

Document Name	Document Number	Description	Owner
Inactive Landfill Site: Water Sampling Procedure	WL-509251-PRO-003	Details the collection and preparation of Landfill Dug out water samples for analysis.	EM
Lagoon: Discharge Sampling Procedure	WL-509251-PRO-004	Details the collection and preparation of lagoon discharge water samples for analysis.	EM
Outfall: Water Sampling Procedure	WL-509251-PRO-005	Details the collection and preparation of outfall process water samples for analysis.	EM
Precipitation: Fallout Sampling Procedure	WL-509251-PRO-006	Details the collection and preparation of deposition samples for analysis.	EM
Vegetation: Sampling, Drying And Ashing Procedure	WL-509251-PRO-007	Details the collection and preparation of vegetation (native and garden crop) samples for analysis.	EM
Waste Management Area: Soil Sampling Procedure	WL-509251-PRO-008	Details the collection and preparation of soil samples for analysis.	EM
Waste Management Area: Surface Water Sampling Procedure	WL-509251-PRO-009	Details the collection and preparation of ditch water samples for analysis.	EM
Waste Management Area: Tray Water Sampling Procedure	WL-509251-PRO-010	Details the collection and preparation of amine tank containment tray water samples for analysis.	EM
Waste Management Area: Well Water Level Measurement And Water Sampling Procedure	WL-509251-PRO-011	Details the collection and preparation of groundwater water samples for analysis.	EM
Winnipeg River: Sediment Sampling And Sample Preparation Procedure	WL-509251-PRO-012	Details the collection and preparation of river sediment samples for analysis.	EM
Winnipeg River: Water Sampling Procedure	WL-509251-PRO-013	Details the collection and preparation of river water samples for analysis.	EM
Air Quality Testing: Sample Collection Procedure	WL-509251-PRO-014	Details the collection and preparation of air quality testing samples for analysis.	EM
6(b) RP			

Document Name	Document Number	Description	Owner
Setup, Servicing, And Sample Changing For Tritium Bubblers And In-Line Air Samplers, CNL	191-508740-OP-033	Describes the process for sampling for air effluent monitoring stations.	RP
Concrete Canister Storage Facility (CCSF) Air Sampling	191-508740-OP-035	Describes the process for air sampling of the Concrete Canister Storage Facility	RP
7 Laboratory Analysis Procedures			
7 (a) EM Laboratory Operating Procedures			
Sample Handling and Control	WL-514200-OP-001 (in preparation) WL-127610-OP-001	Describes the sample handling and control processes	EM
WL Sample Management Office Chain of Custody Form	WL-514200-OP-002	Describes the use of Chain of Custody form	EM
Interfacing with Whiteshell Sample Management Office	WL-514200-OP-003	Describes the process for interfacing with the WL Sample Management Office	EM
WL Sample Management Office Operations	WL-514200-OP-004	Describes the operational processes with WL Sample Management Office	EM
Measurement of pH in Aqueous Solutions	WL-127610-OP-009	Identifies all steps necessary to measure pH	EM
Measurement of Electrical Conductivity in Aqueous Solutions	WL-127610-OP-010	Identifies all steps necessary to measure conductivity	EM
Determination of Total Suspended Solids in Water	WL-127610-OP-011	ATG 8 – Total Suspended Solids and Volatile Suspended Solids	EM
The Measurement of Total Organic Content (HB-40) in Aqueous Solutions	WL-127610-OP-014	Identifies all steps necessary to measure total organic (as HB40)	EM
Measurement of Total Beta Activity in Aqueous Samples Using an AECL Beta Counter	WL-127610-OP-017	Identifies all steps necessary to measure total beta	EM
Gamma Spectrometry (in-situ Gamma Spec)	WL-127610-OP-018	Describes step by step instructions for the operation of the in-situ gamma spectrometry system	WM
Lab-ware Cleaning Procedures	WL-127610-OP-019	Identifies all steps necessary to clean lab-ware	EM

Document Name	Document Number	Description	Owner
ISOCS (in-situ Object Counting System) Gamma Spectrometry	WL-508600-OI-001	Describes step by step instructions for the operation of the in-situ gamma spectrometry system	WM
Gross Alpha And Gross Beta: Source Preparation Procedure	WL-509252-OP-001	Describes step by step instructions for the preparation of Gross Alpha and Gross Beta counting sources for various matrix.	EM
Gross Alpha And Gross Beta: Sample Counting Procedure	WL-509252-OP-002	Provides instruction to EM staff for Alpha and Beta counter calibration, counter operations and sample counting instructions.	EM
Gamma Spectroscopy: Source Preparation Procedure	WL-509252-OP-003	Describes step by step instructions for the preparation of Gamma Sources for various matrices.	EM
Gamma Spectroscopy: Sample Counting Procedure	WL-509252-OP-004	Provides step by step instructions for Gamma Spectroscopy counter calibration and counting of samples.	EM
Water Evaporation Procedure	WL-509252-OP-005	Describes the procedure for the evaporation and ashing of water samples in preparation for Alpha, Beta, Gamma and Strontium analysis.	EM
Strontium: Emergency (Tank) Analysis Procedure	WL-509252-OP-006	Describes the process for analysis of Sr-90 in liquid samples that are either known to contain strontium or suspected to contain Sr-90 based on an imbalance in the gross beta activity compared to the gamma spectroscopy results.	EM
Tritium: Analysis Procedure	WL-509252-OP-007	Provides step by step instructions for the analysis of aqueous samples for tritium.	EM
Tritium: Counting Procedure	WL-509252-OP-008	Provides step by step instructions for the operation of the Quantalus 1220 beta counter for the purpose of counting samples.	EM
Carrier Standardization Procedure	WL-509252-OP-009	Describes step by step instructions for the preparation and standardization of Strontium carrier which is used in the WL-509252-OP-006, Strontium: Emergency (Tank) Analysis Procedure.	EM
7 (b) EM Field Operating Procedures			
Field Measurement Procedure	WL-509251-OP-015	Describes the field pH and conductivity measurements	EM
Thermoluminescent Dosimeter: Array Placement Procedure	WL-509251-OP-016	Describes the placement of the Environmental TLDs	EM
Land Gamma Measurement Procedure	WL-509251-OP-017	Describes the measurement of Land Gamma	EM
Groundwater Work Instruction Procedures And Revision History:	WL-509249-003-000-0001 Rev. 0	Listing of work instructions for groundwater work	EM
Work Instruction - Groundwater Sample Collection	WL-509249-003-000-0002 Rev. 0	Describes how to collect groundwater	EM

Document Name	Document Number	Description	Owner
Work Instruction -Groundwater Level Monitoring:	WL-509249-003-000-0003 Rev. 0	Describes how to measure groundwater levels	EM
Work Instruction- Monitoring Well Inspection And Maintenance	WL-509249-003-000-0004 Rev. 0	Describes how to perform well inspections and maintenance	EM
Work Instruction- Well Installation Methodology	WL-509249-003-000-0005 Rev. 0	Describes well installation methodology	EM
Work Instruction- Data Logger Installation:	WL-509249-003-000-0006 Rev. 0	Describes data logger installation	EM
Field Sample Preservation And Holding Time	WL-509249-003-000-0007 Rev. 0	Describes field sample preservation and holding times	EM
Drawings For Hydrogeological Interpretation	WL-509249-003-000-0008 Rev. 0	Describes the key drawings required for interpreting the following key types of hydrogeologic data.	EM
Data Management	WL-509249-003-000-0009 Rev. 0	Describes the preferred process for implementing the use of, and maintaining, field log books as part of the groundwater monitoring program	EM
Field Equipment Cleaning And Storage Requirement	WL-509249-003-000-0011 Rev. 0	Describes the equipment and technique used for the cleaning and storage of field equipment	EM
Field Equipment Inventory And Maintenance Schedule	WL-509249-003-000-0012 Rev. 0	Describes how to document and implement a field equipment inventory and maintenance schedule.	EM
7 (c) EM Verification and Equipment Performance Procedures			
Check of Balance Performance	WL-127610-OP-020	Describes the steps necessary to check a balance's performance	EM
Check of Auto-Pipette Performance	WL-127610-OP-021	Describes the steps necessary to check a pipette's performance	EM
Check of Thermometer/ATC Probe Performance	WL-127610-OP-022	Describes the steps necessary to check a thermometer's performance	EM
7 (d) EM Quality Verification and Equipment Control Procedures			
Gross Alpha Counting	WL-509253-OP-001	Describes the verification activities associated with gross alpha counting.	EM

Document Name	Document Number	Description	Owner
Gross Beta Counting	WL-509253-OP-002	Describes the verification activities associated with gross beta counting.	EM
Gamma Spectroscopy	WL-509253-OP-003	Describes the verification activities associated with gamma counting.	EM
Strontium Analysis	WL-509253-OP-004	Describes the verification activities associated with strontium analysis.	EM
Tritium Analysis	WL-509253-OP-001	Describes the verification activities associated with tritium analysis.	EM
Estimation of Uncertainty Arising from Sampling and Measurement	WL-509253-PRO-001	Details the requirements, responsibilities and the process for Environmental Management staff to calculate an estimate of measurement uncertainty (MU) using Quality Control (QC) data for current analytical methods. It is based on the approach used by Dickson et al	EM
7 (e) Control Maintainer Verification Activities			
RIS Instrument Shop Overview	191-508237-OP-009	Describes the current Instrument Shop Instrument Calibration and Maintenance Program	RP
Instrumentation Services Calibration Procedures	WL-508237-OP-002	Describes defines the organization, processes, and controls in place at Whiteshell Laboratories for the calibration of measurement and test equipment by the WL Instrumentation Group personnel.	RP
7 (f) EM Administrative Procedures			
The Sample Code System	ENVP-01900-PRO-006 LAP-01	Describes the sample coding system in use for WL samples for entry into an electronic database. Will be updated to included EMDS naming system.	EM
Archiving: Samples, Sample Data And Analytical Documentation	ENVP-01900-PRO-006 LAP-02	Identifies all steps necessary to archive samples, and data. Will be updated to include EMDS importing processes.	EM

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

REGULATORY REQUIREMENT DOCUMENT

DERIVED RELEASE LIMITS FOR CNL'S WHITESHELL LABORATORIES

WHITESHELL SITE DOCUMENTATION

WL-509211-RRD-001

Revision 6

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REVISION HISTORY

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6	2020/12/17	Issued as "Approved for Use".	S. Chouhan	K. Ross R. Bilinsky R. Swartz	P. Neal G. Dolinar
6D1	2020/11/26	Addressed CNSC review. DRLs for release of seven more radionuclides (i.e., Ac-227, Eu-155, Kr-85, Ra-226, Sm-151, Th-228 and U-233) from WMA systems were added. Issued for "Review and Comment".	S. Chouhan	K. Ross R. Bilinsky R. Swartz	
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3	2016/08/31	Accepted by CNSC for implementation. Issued as "Approved for Use".	S. Chouhan	M. Klukas	K. Ross G. Dolinar
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EXECUTIVE SUMMARY

This report provides revised Derived Release Limits (DRLs) for the operation of Canadian Nuclear Laboratories' (CNL's) Whiteshell Laboratories (WL). These DRLs supersede the values established in 2016 [1].

The DRLs were calculated using the same methodology as in 2016 [1], which is based on Canadian Standards Association (CSA) Guideline N288.1-08, which was developed with Canadian Nuclear Safety Commission (CNSC) involvement. The DRL calculations were performed using the Integrated Model for Probabilistic Assessment of Contaminant Transport (IMPACT) computer code, which embodies the recommended methodology. Previous versions of this code have been validated against experimental data and have been confirmed to be compliant with CSA Standard N286.7, which addresses the quality assurance of computer programs. The results of the DRL assessment were extensively verified to ensure the accuracy of the calculations.

The assumptions regarding the locations and characteristics of population groups located around the WL site are documented and justified. In following the current DRL modelling guidance, conservative assumptions and parameter values were adopted for exposures and intakes, and best-estimate values were used for many environmental transfer parameters and contaminated food source fractions. To the extent possible, site-specific values were used for parameters describing environmental conditions at the WL site, adding to the accuracy of the assessment.

In 2016, DRL's were calculated for one stack location, two roof vent locations and one Waste Management Area (WMA) location for airborne effluents, and for one liquid effluent release location. However, based on the introduction of three new systems in the WMA and the release of tritiated water (HTO) from one or more of these systems, the airborne DRLs had to be recalculated. DRLs for potential releases of seven more radionuclides (i.e., Ac-227, Eu-155, Kr-85, Ra-226, Sm-151, Th-228 and U-233) from WMA systems were added.

The potential critical groups considered in the assessment were the same as in 2016 [1], which include three farm groups having full-time occupancy and a farm group that has limited occupancy. Within these groups, six different age classes were considered, and for the two infant age classes, three milk sources were assessed (cow milk, breast milk and formula milk). Considering the number of release locations, potential critical groups and age classes included in the modelling, the WL DRL study is deemed comprehensive.

For airborne effluents, DRLs for 12 radionuclides are approximately 2% lower than the 2016 DRLs [1]. For one radionuclide (Zn-65), the bounding release location changed from B200 to the WMA and the magnitude of the DRL was lowered by 1%. A new DRL was added for HTO released from the WMA (5.61E+14 Bq week^{-1}) and the previous DRL for HTO released from B100 (1.65E+15 Bq week $^{-1}$) [1] is still valid. The DRL tables have been expanded to include seven additional radionuclides.

There is no change to the liquid effluent from the 2016 DRLs [1].

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1. INTRODUCTION

1.1 Revision of WL DRLs

This report provides revised Derived Release Limits (DRLs) for emissions of radioactive materials in both airborne and liquid effluents from Canadian Nuclear Laboratories' (CNL) Whiteshell Laboratories (WL) site during normal operation. The WL DRLs have been revised because of the introduction of three new systems in the Waste Management Area (WMA) and the potential releases of tritiated water (HTO) and seven more radionuclides (i.e., Ac-227, Eu-155, Kr-85, Ra-226, Sm-151, Th-228 and U-233) from one or more of these systems. As a result of these changes, the airborne effluent DRLs had to be recalculated. The airborne effluent DRLs in this report supersede those established in 2016 [1], with no change to the liquid effluent DRLs.

The methodology used in the recalculation of the DRLs is identical to that used in 2016 [1]. It is the recommended DRL calculation methodology that is documented in the Canadian Standards Association (CSA) Guideline N288.1-08 [2] (hereafter referred to as N288.1), which is based on the earlier CANDU Owner's Group (COG) DRL Guidance (hereafter referred to as the CDG) [3]. The Canadian Nuclear Safety Commission (CNSC) participated in the preparation of N288.1 [2].

In following N288.1 [2], only values associated with critical group exposure factors, occupancy factors and intake rates are treated conservatively. Other parameters such as the fractions of food and water intakes drawn from contaminated sources have been assigned realistic values. This is intended to reduce the degree of conservatism in the DRLs, as it is broadly recognized that multiple conservatisms yield dose projections that are not representative of the critical group concept (i.e., the projections are representative of extreme individuals). On the same basis, best-estimate values were used for environmental transfer parameters to provide better agreement between model predictions and actual measured environmental concentrations.

1.2 The IMPACT Computer Code

Integrated Model for Probabilistic Assessment of Contaminant Transport (IMPACT) [4], the modelling software used to calculate the DRLs, implements almost all aspects of the methodology recommended in the N288.1 [2]. It includes a database of parameter values, as well as user-friendly interfaces to facilitate the input of scenario-specific information. It outputs compartmental radionuclide concentrations and dose rates as well as DRLs.

The DRL calculations reported here were carried out using the same version (Version 5.4.0) of the IMPACT [4] code and database that was used in 2016 [1]. This version of the code incorporates all the sub-models required for application at WL, including methods for calculating dispersion in a river and air immersion dose rates from three-dimensional plumes of contaminated airborne material. The default database has been updated with error corrections as of 2010 July 9 [5] to make it consistent with N288.1 [2]. The software has been subject to validation and verification testing as discussed in [6] and [7]. The development of the previous version of the code (Version 5.2.2) was analyzed and found to be consistent [8] with the requirements of CSA Standard N286.7 [9], which relates to software quality assurance. The development of Version 5.4.0 was also guided by, and is expected to meet the requirements of, that standard.

1.3 The Whiteshell Laboratories Site

The 4,375-hectare WL site is located in the Local Government District of Pinawa in southeastern Manitoba, about 100 km northeast of Winnipeg. Most of the site and all the facilities are located on the east bank of the Winnipeg River (Figure 1), which in this area, flows from south to north.

The WL site is in the zone of transition between farmland to the west and the exposed part of the Precambrian Shield to the east, and is overlain by glacial till and sediments. The surrounding terrain is relatively flat, except for the small hills on both sides of the river. Part of the surrounding land is used for farming, with the rest being wooded. Sport fishing is carried out in the Winnipeg River, but there is no commercial fishing in the area.

The area surrounding WL is sparsely populated. The nearest population centres are Lac du Bonnet (population approximately 1,000, located 8.6 km north), Pinawa (population approximately 1,500, located 13.4 km east-southeast), River Hills (population less than 100, located 11.8 km south) and Seven Sisters (population less than 100, located 8.9 km south-southeast) (Figure 1). Of greater interest for this study are farms which are much closer to WL.

A near-field map of the WL site is shown in Figure 2. There are four main sources of airborne radioactive effluents at WL: Building 100 (B100) (reactor building), Building 200 (B200) (Active – Liquid Waste Treatment Centre) and Building 300 (B300) (shielded facilities and other laboratories), which are located in the complex of buildings in the main part of the site (WL-Main), and the WMA. In the previous DRL [1], the only sources of airborne effluents in the WMA were from the compactor/baler and incinerator. However, three new systems in the WMA will be introduced; the Standpipe Waste Retrieval System (SWRS), the Bunker Waste Retrieval System/Sorting and Conditioning Unit (BWRS/SCU), and the Intermediate Level Liquid Treatment System (ILLTS), which will also contribute to airborne effluents. The compactor/baler and incinerator are no longer in service, but they are discussed in this report to clarify the changes between the 2016 DRL [1] report and this assessment. The only significant source of liquid radioactive effluents from the site is the process outfall from the new Low Level Liquid Waste (LLLW) processing systems in B100 and B300. All of the B100 LLLW is now being tested, treated and released in a controlled manner to the river in the B100 LLLW system and likewise in B300. All of the collection tanks in B200 were then isolated and taken out of service. The B200 sumps have also been taken out of service, and any water collected from the sumps and associated piping was put into drums for processing.

The WL site is currently being decommissioned by CNL. There are no longer tenant businesses on site. There are farm workers on land leased from CNL on the west bank of the Winnipeg River (Farm E). They are not classified as Nuclear Energy Workers and their radiation exposure is not required to be monitored.

Farm E is the farming location which is closest to a source of WL effluents. However, farm workers are present at this location for only a limited duration each year. The closest farming property with year-round occupancy (Farm F) is also on the west bank of the Winnipeg River, but it is further downriver.

The DRLs presented in this report were calculated assuming the current WL site boundary and the supervised area, as shown by a black line in Figure 2. If the site boundary and/or the supervised area are to be reduced as a result of ongoing decommissioning of the WL site, and there are changes in the use of affected land, then the impact on DRLs will need to be evaluated.

Figure 1: Location of WL site.

Figure 2: Near-field map of WL site showing effluent release locations and potential critical group locations.

1.4 Acronyms and Abbreviations

B100	Building 100
B200	Building 200
B300	Building 300
B401	Building 401
B402	Building 402
BWRS/SCU	Bunker Waste Retrieval System/Sorting and Conditioning Unit
CDG	COG DRL Guidance
CNL	Canadian Nuclear Laboratories

CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owner's Group
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DCFs	Dose Coefficients
DRL	Derived Release Limits
HTO	Tritiated Water
ICRP	International Commission on Radiological Protection
ILLTS	Intermediate Level Liquid Treatment System
IMPACT	Integrated Model for Probabilistic Assessment of Contaminant Transport
LLLW	Low Level Liquid Waste
N288.1	CSA Standard N288.1-08
OBT	Organically Bound Tritium
SA	Specific Activity
SWRS	Standpipe Waste Retrieval System
WL	Whiteshell Laboratories
WMA	Waste Management Area

2. DERIVED RELEASE LIMITS

CNL's nuclear facilities are required to operate in such a way that radionuclide releases to the environment are well below their DRLs. These limits represent release rates that correspond to critical group exposures at the public dose limit. They are calculated by the licensee from the combined radiation dose that a member of the public receives through all pathways of exposure to a radionuclide that is routinely released to the environment. The DRLs are based on individual doses to average members of a critical group. The critical group is defined so as to represent a group of individuals likely to receive the highest exposures to radionuclides released from a particular source.

Where two or more potential critical groups exist and it is not obvious which would receive the greatest dose, separate calculations are made for each group. Similarly, separate calculations are performed for each age class within a group. The DRL for the radionuclide in question is set equal to the smallest DRL across the age classes and potential critical groups.

N288.1 considers only three age classes (adult, 10-year-old child and 1-year-old infant). However, in the current assessment, the six age classes defined in the International Commission on Radiological Protection (ICRP)-72 [10] and the CDG were considered. These are adult, 15-year-old teenager, 10-year-old child, 5-year-old child, 1-year-old infant and 3-month-old infant. The transfer parameters from nursing mother to infant are also from CDG.

A separate DRL is calculated for each radionuclide released. However, in order to simplify compliance monitoring some radionuclides can be grouped. For example, the gross beta/gamma-emitting radionuclides released to air (and similarly to water) can be grouped together and the DRL for the most restrictive radionuclide can be applied to that group.

Since the DRL for a given radionuclide (or radionuclide group) is calculated as though only that radionuclide was present in the effluent, facilities must operate to satisfy the following additional condition:

$$\sum \frac{R_i}{DRL_i} < 1.0 \qquad (1)$$

where: R_i is the release rate of the ith radionuclide (or group), DRL_i is the derived release limit for that radionuclide, and the summation takes place over all n radionuclides for releases to both air and water from all effluents.

This condition ensures that all releases combined will not cause a member of the public to receive a dose in excess of the public dose limit.

In order to ensure that this condition is met, and in order to keep public doses as low as reasonably achievable, WL facilities operate with releases at a small fraction of the DRL.

DRLs are calculated assuming that releases from the facility are reasonably continuous and that long-term steady-state is reached in the environment. Consequently, the doses and DRLs calculated in this report are not likely to be indicative of doses that would result from short-term incidents involving abnormal radioactive releases.

Since DRLs reflect the annual dose limit, they can be calculated as annual releases. However, for operational control purposes, airborne release limits are expressed in terms of a period of one week and liquid limits are expressed in terms of a period of one month. Therefore, the DRLs calculated in this assessment are also expressed in these terms.

3. DOSE LIMITS FOR MEMBERS OF THE PUBLIC

The dose limits for members of the public, as set out in the CNSC Radiation Protection Regulations [11], are given in Table 1. These limits are based on the 1991 recommendations of the ICRP [12], and are intended to prevent deterministic effects and to limit the occurrence of stochastic effects to an acceptable level.

Table 1: Dose limits for members of the public.

Application		Annual Dose Limits (mSv a^{-1})
Effective Dose ($D_{effective}$)		1
Equivalent Dose	Skin (D_{skin})	50
	Lens of the Eye (D_L)	15
	Hands and Feet	50

Paragraph S29 of ICRP Publication 60 [12] recommends that restrictions on effective dose are sufficient to ensure the avoidance of deterministic effects in all body tissues and organs except possibly the lens of the eye and the skin, which may be subject to localized exposures. Hence, there is no equivalent dose limit for other body tissues and organs.

Section 2.1.2 of the CDG [3] states "It has been shown that the equivalent dose to the lens of the eye will not be limiting for the purpose of setting Derived Release Limits [13]. For the lens dose (D_L) to be limiting, it must be true that D_L >15* ($D_{effective}$) and D_L >0.3* (D_{skin}). This condition is met only for Kr-83m, and the dose from this radionuclide is insignificant in comparison to other noble gases. Thus, calculations of effective dose and skin dose are sufficient for determining facility DRLs." Accordingly, only the effective and the skin doses were calculated in this WL analysis.

The possibility of the release of some energetic beta-emitting radionuclides being limited by skin dose was checked. Skin dose calculations were made for all external dose situations (air immersion, groundshine, beachshine and water immersion) for all radionuclides. In no case was the DRL based on skin dose lower than the DRL based on effective dose; hence, only the results for effective doses are discussed further.

4. CALCULATION OF DERIVED RELEASE LIMITS

The steps taken in this assessment to recalculate the DRLs for WL were identical to those used in 2016 [1], which are as follows:

1. Identify the potentially most affected members of the public, determine their characteristics with respect to exposure to radionuclides released from WL to the environment, and select a set of potential critical groups that will form the basis for the DRLs. Determine the parameter values for these groups (Section 5).
2. Identify and characterize the sources of airborne and liquid effluents, the factors influencing atmospheric and aquatic dispersion, and the specific radionuclides to be included (Sections 6 and 7).
3. Identify the environmental pathways models to be used in calculating the DRLs and any assumptions to be made in applying them (Sections 5 and 8).
4. Specify values for the transfer parameters and other data used in the model calculations and any assumptions to be made in applying them (Sections 5, 6 and 7).
5. Set up the model scenarios with the appropriate modelling software (IMPACT) (Section 9).
6. Perform a screening analysis to reduce the number of potential critical groups and release locations for which detailed dose calculations are required (Section 10).
7. Execute the final DRL calculations for each combination of effluent type, radionuclide, critical group, age class and potentially bounding release location (Section 8.4.8.1).
8. Determine the most restrictive DRLs for each radionuclide for airborne and liquid effluents from the DRLs based on the different age classes of the critical group and potentially bounding release locations (Section 11).
9. Confirm the results (Section 12).

Site-specific data were used in the calculations, where possible.

5. CRITICAL GROUPS

5.1 General Discussion

A critical group is a relatively homogeneous group of members of the public who represent the people most highly exposed to radionuclides released from a facility. This may be by virtue of their location or characteristics. DRLs are calculated from the mean dose in the critical group per unit radionuclide release. Recently, N288.1 has replaced the term "average member of the critical group" with the term "representative person". This is a purely cosmetic change. N288.1 states that the representative person "is the equivalent of … the average member of the critical group". The term "critical group" will be used here.

The critical groups considered in the recalculation of the DRLs for WL are identical to those used in 2016 [1]. Potential critical groups have been characterized based on site-specific information rather than by making hypothetical worst-case assumptions. Assumptions related to exposure pathways, occupancy factors, and fractions of the diet that consisted of local food and water were confirmed by interviewing some WL employees residing in surrounding communities. The local fractions applied in this DRL assessment were checked against the default recommendations in Table G.9c of N288.1 in 2016 [1] and were found to be conservative. Assumptions related to newly added pathways in IMPACT were consistent with the recent 2007 Chalk River Laboratories (CRL) DRL calculations [6] and 2010 Nuclear Power Demonstration Site DRL calculations [14].

5.2 Potential Critical Groups

In applying the critical group concept discussed above, a range of types of potential critical groups were identified as being representative of different locations and characteristics of population groups residing in the vicinity of WL.

5.2.1 Potential Critical Groups for Airborne Effluents

For airborne effluents, two types of potential critical groups were considered: farms that have year-round occupants and raise livestock (Farms A, D and F in Figure 2), and a farm that has limited occupancy and grows canola (Farm E). Table 2 gives the distances and directions of these groups from B200 at WL (more details in Table 20). The livestock farms are located adjacent to the WL site boundary and lie in high-frequency wind-direction sectors (N, S and NNW) from the effluent sources. A potential critical group location closer to the WMA than Farm A was not selected because the terrain to the east of Farm A is not suitable for farming.

Table 2: Distance and direction of airborne effluent potential critical groups from Building 200.

Potential Critical Group	Location Relative to Building 200		
	Distance (m)	Direction	
		Degrees from North	Sector
Farm A (livestock)	2,993	353	N
Farm D (livestock and honey)	2,913	177	S
Farm E (canola)	1,313	258	WSW
Farm F (livestock)	2,708	335	NNW

A wide range of types and scales of farming exists on both sides of the Winnipeg River from Seven Sisters Falls to Lac du Bonnet. While it is more common for a particular farm to specialize in one animal product, in this assessment it was conservatively assumed that the livestock farm groups grow most of the animal products that they consume. All the livestock farms were assumed to be identical, except that honey is only produced at Farm D and is supplied to all others.

The canola farm (Farm E) was conservatively assumed to be occupied for only 16 hours per day, for two weeks for planting, two weeks for fertilizing and two weeks for harvesting (total of 672 hours per year; this occupancy factor of 0.08 is referred to in Sections 5.4.4 and 10.1).

Individual members of the public who occasionally carry out recreational activities (e.g., boating, fishing and swimming) on the Winnipeg River, closer to the WL site than the locations of the above mentioned potential critical groups, are not explicitly considered in the DRL assessment. This is because these activities are not typical for population groups in the area, but are done by a few extreme individuals. In the recent CRL DRL calculations [6], a scoping analysis was carried out to show that the radiological risk from short-term, occasional occupancy of the river close to CRL is not significantly higher than that from the chronic exposure received by the more remote critical groups over extended periods of time. There is no reason to suspect that the risk for similar extreme individuals at WL would be significantly higher.

In view of the nature of the potential critical groups, screening calculations were performed to reduce the number of combinations of potential critical groups and release location for which detailed dose calculations were required. The screening calculations identified Farm A as the critical group for all nuclides except HTO (see Section 10.1 for details). For an HTO release from B100, Farm F was identified as the critical group. The characteristics of these two groups are the same and only the characteristics of these groups are discussed further in subsequent sections.

5.2.2 Critical Group for Liquid Effluents

Dilution and dispersion studies by Merritt ([15]and [16]) have shown that effluents released from the process outfall move downstream along the east bank of the Winnipeg River and do not reach the west bank in the vicinity of WL. Therefore, the critical group for liquid effluents is obvious, being Farm A on the east bank of the Winnipeg River, adjacent to the site boundary and 2,810 m downstream of the release point (Figure 2).

5.3 Characteristics of the Critical Groups

5.3.1 Critical Groups for Airborne Effluents (Farm A or F)

The group members:

- reside on a full-time basis at their assumed locations,
- maintain a large garden from which they obtain a significant fraction of their fruit and vegetable needs (see Section 5.4.2 for information on food sources),
- are self-sufficient in meeting their milk, poultry and egg requirements, and semi self-sufficient in beef and pork,
- feed their animals entirely on forage grown on their farm,
- meet their honey requirements by acquiring it from another local farm,
- partake in hunting on their own property to fulfill their game (deer) meat requirement,
- obtain their water from a well located on the property, and
- use a backyard swimming pool filled with well water during four months of the year.

The exposure pathways applicable to the critical groups are summarized in Table 3.

Table 3: Airborne exposure pathways applicable to the critical groups (Farm A or F).

Pathway	Comments
Air Inhalation	✔
Air Immersion	✔
Water Immersion	✔ (well)
Groundshine (airborne deposition)	✔
Incidental Soil Ingestion	✔
Water Ingestion	✔ (well)
Plant Ingestion	✔
a) Plant Uptake via Roots	✔
b) Plant Uptake via Foliar Deposition	✔
Animal Product Ingestion	✔ Beef (on site) Pork (on site) Poultry (on site) Eggs (on site) Game (on site) Milk (on site) Honey (from Farm D)
a) Animal Uptake via Forage Ingestion	✔
b) Animal Uptake via Water Ingestion	✔ Livestock – well Game – pond
c) Animal Uptake via Inhalation	✔
d) Animal Uptake via Soil Ingestion	✔

5.3.2 Critical Group for Liquid Effluents (Farm A)

The group members:

- reside on a full-time basis at their assumed location,
- obtain their water for domestic needs (drinking, washing) from the river,
- maintain a large garden from which they supply a significant fraction of their fruit and vegetable needs,
- irrigate their lawns and gardens (a total area of 2,500 m^2) with river water,
- do not irrigate forage crops (hay, grain, corn),
- are self-sufficient in meeting their milk, poultry and egg requirements, and semi self-sufficient for beef and pork,
- water their animals with river water,
- swim in the river during the summer months and in a pool filled with river water during the remainder of the year,
- spend a fraction of the time occupying the shoreline for recreational purposes, and
- fish in the Winnipeg River, from which they obtain a fraction of their fish ingestion needs.

The exposure pathways applicable to the critical group are summarized in Table 4.

Table 4: Liquid exposure pathways applicable to the critical group (Farm A).

Pathway	Comments
Air Inhalation (from volatilized radionuclides following irrigation)	✔
Air Immersion (from volatilized radionuclides following irrigation)	✔
Water Immersion	✔
Groundshine (irrigation)	✔
Incidental Soil Ingestion	✔
Beach Shine	✔
Incidental Sediment Ingestion	✔
Water Ingestion	✔
Fish Ingestion	✔
Fruit/Vegetable Ingestion	✔
a) Plant Uptake via Roots (irrigation)	✔
b) Plant Uptake via Foliar Deposition (irrigation)	✔
Animal Produce Ingestion	✔ Beef (on site) Pork (on site) Poultry (on site) Eggs (on site) Milk (on site)
a) Animal Uptake via Water Ingestion	✔

5.4 Critical Group Parameters

5.4.1 Water Sources

The water source assumptions for the critical groups are summarized in Table 5 and are justified in the discussions below.

Table 5: Water source assumptions.

Critical Group	Drinking		Washing and Bathing		Swimming		Irrigation		Animals	
	Source	Percentage	Source	Percentage	Source	Percentage	Source	Percentage	Source	Percentage
Airborne Effluents	Well	100	Well	100	Pool filled with well water	100*	Well**	100	Well for livestock, Pond for deer	100
Liquid Effluents	Winnipeg River	100	Winnipeg River	100	Winnipeg River beaches and swimming pools filled with Winnipeg River water	100	Winnipeg River	100	Winnipeg River for livestock Pond for deer	100

* An outdoor pool is assumed to be operated for only four summer months in a year.

** Grey shading indicates pathways and exposures that are not included in the calculations.

For the groups considered in this assessment, water was assumed to be used for the following applications:

- drinking by humans,
- showering, washing and other domestic uses,
- swimming,
- lawn and/or garden irrigation, and
- animal watering.

Some inhabitants of the banks of the Winnipeg River, in the vicinity of WL, use well water and some use river water. In the absence of detailed population survey information, average values for the usage of water that is radiologically contaminated by WL effluents could not be derived and applied. Instead, it was generally assumed that 100% of the water is obtained from sources that are radiologically contaminated by WL effluents.

In N288.1 [2], the only surface water bodies that are assumed to become contaminated by airborne effluents are small ponds. This distinction is made because larger bodies (lakes and rivers) provide significant dilution of activity deposited locally from the atmosphere. Moreover, natural removal processes are more effective for larger water bodies. As a result, concentrations are lower in large water bodies, reducing the significance of the water exposure pathways.

5.4.1.1 Drinking Water Assumptions

For liquid effluent modelling, the critical group was conservatively assumed to draw all their water from the Winnipeg River. Thus, 100% of the drinking water was assumed to be contaminated.

For modelling airborne effluents, the critical groups were assumed to obtain their drinking water from wells, which were assumed to be contaminated.

5.4.1.2 Immersion Assumptions (external exposures from washing, bathing and swimming)

For modelling airborne effluents, the critical groups were conservatively assumed to obtain all their water for washing and bathing from wells, which were assumed to be contaminated.

For liquid effluent modelling, 100% of the water for washing and bathing was assumed to be contaminated because it was conservatively assumed to come from the Winnipeg River.

Immersion exposure from swimming in the Winnipeg River during three summer months was assumed for the critical group for liquid effluents. Immersion exposures from swimming in a pool, supplied with water from the Winnipeg River, for the remainder of the year was also assumed. In reality, a pool at a hotel in Lac du Bonnet (filled with municipal water taken from the River) is accessible to the public. However, in this assessment, a community pool was conservatively assumed to be located at the location of the critical group, where river water concentrations are much higher than those at the Lac du Bonnet municipal water intake point.

For modelling airborne effluents, members of the critical groups were assumed to swim in a pool filled with well water during four months of the year.

5.4.1.3 Irrigation Assumptions

In N288.1 [2], lawn and garden irrigation with well water is not included in the modelling of airborne effluents. Inclusion is normally not warranted because the relative contribution of radioactivity to soil and plant tissue from irrigation is usually minor compared to the contribution from direct atmospheric deposition. On this basis, irrigation was not included in the modelling of the critical groups for airborne effluents.

In contrast, irrigation was included in the modelling of the critical group for liquid effluents. Lawn and garden watering was assumed to be done using water from the Winnipeg River.

5.4.1.4 Animal Watering Assumptions

It is discussed in the 2007 CRL DRL report [6] that a well (and not a river) is commonly used for watering of livestock. However, to be conservative, in this assessment it was assumed that livestock are watered from wells when modelling airborne effluents, and they receive water drawn from the Winnipeg River when modelling liquid effluents.

Deer are more likely to drink from small streams and ponds in forested areas than the exposed banks of the Winnipeg River. Therefore, it was assumed that game (deer) drink only from small contaminated ponds at the locations of the critical groups. Therefore, the ingestion of contaminated water by deer was modelled for airborne effluents only.

5.4.2 Food Sources

The percentages of the various food items in the diet of the critical groups that were assumed to come from contaminated sources are summarized in Table 6. The percentages are based upon site-specific information and judgement rather than statistical analysis, and are justified in the discussions in Sections 5.4.2.1 through 5.4.2.3 below. The sub-sections in this assessment remained identical to those in 2016 [1].

Table 6: Percentage of food from contaminated sources.

Critical Group	Terrestrial Animal Products							Plant Products				Fish
	Beef	Pork	Poultry	Venison	Eggs	Cow or Breast Milk	Honey	Fruit	Above-Ground Vegetables	Potatoes	Grain	
Airborne Effluents	50	50	100	100	100	100	100*	15	25	100	0**	0
Liquid Effluents	50	50	100	0	100	100	0	15	25	100	0	30

* Honey is produced on Farm D only and supplied to the critical group.

** Grey shading indicates pathways and exposures that are not included in the calculations.

In general, the percentages of food products from contaminated sources were assumed to be higher than those recommended in Table G9c of N288.1 [2]. The exceptions were: the contaminated fruit percentage was reduced from 20% to 15 %, the contaminated grain percentage was reduced from 1% to 0% and the contaminated fish percentage was reduced from 100% to 30%.

5.4.2.1 Plant Products

The critical groups were assumed to grow 15% of the fruit that they eat. N288.1 gives a default value of 20%, which is appropriate for climate conditions in southern Ontario, Quebec and New Brunswick. Since southern Manitoba has a harsher climate, a lower percentage is considered reasonable.

The critical groups were assumed to grow 25% of the above ground vegetables and 100% of the potatoes (including other root vegetables) in their diet.

As stated in the 2001 DRL report [17], there are some farms in the neighbourhood of WL that produce grain (wheat and oats), but these crops are sold to large companies and the contamination in the final food products is diluted to negligible levels. Therefore, consumption of contaminated grain was not included in the calculations.

The contaminated percentages discussed above apply for modelling both airborne and liquid effluents, for which crop contamination occurs through airborne deposition and irrigation, respectively.

5.4.2.2 Terrestrial Animal Products

Currently, no animal products are produced at the locations of the critical groups. However, within 10 km of WL there is a mix of beef and dairy farms, with some of their products are being consumed on the farms. At about 20 km south-southeast from WL, there are farmers who are self-sufficient in milk, chicken and eggs, and semi self-sufficient in beef and pork. It is possible that a farmer in the vicinity of WL could start producing beef, pork, poultry, eggs and milk, with some being for their own consumption. However, it is unlikely that they would be self-sufficient in beef and pork. Therefore, it was conservatively assumed that the critical groups are 50% self-sufficient in beef and pork, and 100% self-sufficient in poultry, eggs and milk, as was done in the 2001 DRL calculations [17].

The milk consumed by the 1-year-old infant was assumed to be either 100% cow milk or 100% formula milk. The formula milk was assumed to be prepared with local contaminated water. Either 100% formula milk or 100% breast milk was assumed to be the source of milk for the 3-month-old infant.

Deer is the main game animal in the area, and the critical groups were assumed to hunt and get all the venison required from their own property. As the deer are assumed to drink from small ponds on the property and not from the Winnipeg River, the venison is contaminated by airborne effluents from WL, but not by liquid effluents.

For modelling airborne effluents, it was assumed that 100% of the honey consumed is contaminated because it is available locally from Farm D. For modelling liquid effluents, the honey was assumed to be uncontaminated because the bees generally feed on forage crops, which are not contaminated by liquid effluents.

5.4.2.3 Fish

The critical group exposed to liquid effluents was assumed to eat fish caught nearby in the Winnipeg River. This is reasonable given that fishing is a popular activity in the area. It was assumed that 30% of the total fish consumed is contaminated. This was based on interviews with local sportsmen.

5.4.3 Intake Rates for Humans

The assumed intake rates for food, water, soil, sediment and air are shown in Table 7. Most of these values are the recommended default values provided in Tables 17, 18, 19 and G9c, and Clause 7.10.2 of N288.1 for three of the age classes; and Tables 4-15, 4-16, 4-17 and G20c, and Clause 5.11 of the CDG for all of the age classes. These are the 90^{th} or 95^{th} percentiles of their respective distributions, which is consistent with the philosophy of using conservative values for intake rates. The adult intake rates are those for a male.

Since beef offal, veal, lamb and rabbit are a small percentage of the diet in the WL area, they were combined into the "beef +" category in Table 7. Similarly, mushrooms were combined with above-ground vegetables.

The venison intake rates of the critical groups were assumed to be much higher than those recommended in N288.1 and the CDG because deer hunting is much more common among farmers in the WL area than in the general population. The intakes for the "beef +" category in Table 7 were assumed to be correspondingly lower, such that the total intake from these two categories is the same as in N288.1 and the CDG. This adjustment ensures a balanced energy intake for the receptors. Because of the abundance of deer in the area, it was assumed that the intakes from the venison and "beef +" categories were equal, which is similar to what was assumed in the 2007 CRL DRL calculations [6].

The DRLs were not calculated for a nursing mother, but her intake rates were required to estimate radionuclide concentrations in breast milk fed to infants. The nursing mother was modelled in the same way as a terrestrial animal, but with intake rates being at the 90^{th} percentiles rather than the median values that were used for other terrestrial animals. The higher values were used because of the increased energy requirements resulting from lactation. These intake rates are similar to those recommended by Wong [18].

Table 7: Intake rates of food, water, soil and air.

Food Categories and Items	3-Month-Old Nursing Infant	3-Month-Old Formula-Milk-Drinking Infant	1-Year-Old Cow-Milk-Drinking Infant	1-Year-Old Formula-Milk-Drinking Infant	5-Year-Old Child	10-Year-Old Child	15-Year-Old Teenager	Adult (Male)	Nursing Mother
Freshwater Fish(kg a^{-1})	0.31	0.31	0.91	0.91	2.69	3.1	3.48	7.41	4.75
Milk (mother's milk or cow's milk) (L a^{-1})	416	0*	371	0*	277	305	327	265	170
Beef + Beef Offal + Veal + Lamb + Rabbit (kg a^{-1})	6.1	6.1	5.4	5.4	9.6	15	20	34	22
Venison (kg a^{-1})	6.1	6.1	5.4	5.4	9.6	15	20	34	22
Pork (kg a^{-1})	0	0	3.2	3.2	7.3	11	15	29	19
Poultry (kg a^{-1})	0	0	4.6	4.6	7.7	9.8	11	20	13
Eggs (kg a^{-1})	2.9	2.9	8.4	8.4	9.6	11	15	30	19
Honey (kg a^{-1})	0.8	0.8	0.34	0.34	0.91	1.1	1.1	2	1.3
Fruit and Berries (kg a^{-1})	69	69	66	66	92	93	91	174	112
Above-Ground Vegetables + Mushrooms (kg a^{-1})	26	26	44	44	91	114	144	236	152
Potatoes (kg a^{-1})	4.6	4.6	23	23	47	63	80	104	67
Total Water Intake (L a^{-1})	0	347	0	358	365	511	657	840	840
Soil Intake (kg a^{-1})	0.044	0.044	0.044	0.044	0.12	0.12	0.12	0.12	0.12
Sediment Intake (kg a^{-1})	0.044	0.044	0.044	0.044	0.12	0.12	0.12	0.12	0.12
Inhalation Rates (m^3 a^{-1})	1,140	1,140	2,740	2,740	6,390	7,850	8,210	8,400	8,400

* Formula-milk-drinking infants (3-month-old and 1-year-old) have zero milk intake and proportionately higher water intake.

5.4.4 Occupancy Factors

The occupancy factors applied to the critical groups and the different age classes were in general the recommended default values in N288.1, which include full-time residential occupancy at the assumed receptor location.

First exception was with respect to swimming occupancy. For modelling liquid effluents, beach swimming was assumed to be based on a three-month period per year, rather than a four-month period, because the Winnipeg River water is colder than the average on which the N288.1 recommendations are based. N288.1 assumes that swimming takes place indoors during the period when beach swimming does not, so the pool occupancy is based on eight months per year. However, for the WL calculations, it was assumed that the critical group swims in an indoor pool during nine months per year.

Second exception was that an occupancy factor of 0.08 was applied to Farm E as discussed in Section 5.2.1, and referred to in Section 10.1.

6. SOURCE CHARACTERISTICS AND DISPERSION

6.1 Airborne Effluents

6.1.1 Sources

Airborne effluents are discharged at four locations: the B100 stack, the B200 roof vent, the B300 roof vent and the WMA. In the 2016 DRL [1], although the WMA had two sources (the incinerator and the compactor/baler), they were treated as one. This was reasonable because they were close to each other and had similar release heights, so that at the downwind distances of the potential critical groups, the differences had a marginal impact on radionuclide concentrations. However, now that three new systems (the SWRS, the BWRS/SCU and the ILLTS) will be introduced in the WMA, the sources of airborne effluents in the WMA were re-evaluated.

6.1.2 Atmospheric Dispersion Model

Atmospheric dispersion was modelled using the sector-averaged Gaussian model described in N288.1 and implemented in IMPACT 5.4.0.

The characteristics of the sources are shown in Table 8, together with the dimensions of the adjacent building.

Table 8: Source characteristics and building dimensions considered in the atmospheric dispersion model.

Parameter	B100	B200	B300	WMA			
				Compactor/ Baler**	SWRS	BWRS/ SCU	ILLTS
Physical Height of Release (m)	30.4	0	0	7.3	7.92	7.92	5.18
Stack Inside Diameter (m)	1.98	-	-	-	0.203	0.254	0.127
Stack Exit Velocity (m s^{-1})	4.6	-	-	-	15.24	15.24	0.00080
Stack Gas Temperature (°C)	25	-	-	-	28.06*	28.06*	10
Ambient Air Temperature (°C)	0.4	-	-	-	0.4	0.4	0.4
Height of Nearby Building (m)	18.5	7.6	12	5.5	5.5	5.5	5.5
Smallest Horizontal Dimension of Nearby Building (m)	55	12.8	35	12.5	12.5	12.5	12.5
Cross-Sectional Area of Nearby Building (m^2)	1,000	100	400	70	70	70	70

* An average of the winter and summer values.

** The compactor/baler is no longer in service, but it is discussed in this report to clarify the changes between 2016 DRL [1] and this assessment.

The B100 stack was treated as an elevated source with excess momentum and buoyancy, and accompanying plume rise. The release was assumed to be affected to some extent by the wake of the adjacent building. The B200 and B300 roof vents were treated as ground-level sources because of building entrainment occurring at them.

In the 2016 DRL [1], the WMA was treated as an elevated source, but without excess momentum and buoyancy. Even though the incinerator stack (12.2 m high) and the roof vent of the compactor/baler (7.3 m high) were both sources of airborne effluents, a conservative value of 7.3 m was used for the release height in the calculations. However, with the introduction of the three new systems (SWRS, BWRS/SCU and ILLTS), all the WMA parameter values need to be compared to determine which ones should be used in the new DRL calculations.

Effective release height is an important intermediate parameter when modelling releases from different geometries. When comparing the parameter values in Table 8, it is expected that the effective release heights corresponding to the SWRS and the BWRS/SCU will be higher than that of the compactor/baler, as modelled in the 2016 DRL [1]. On the other hand, the effective release height of the ILLTS will be lower to the ground than that of the compactor/baler, as modelled in the previous DRL [1], resulting in higher air concentrations from that source. This initially indicates that the doses will be the highest from the ILLTS, and the WMA DRLs should be calculated using its release geometry. However, effective release height is not only dependent on release geometry, but also on the stability class and the wind speed class (as defined in Table 10). To establish their overall effect, the effective release heights were extracted using a research and development (R&D) tool CSA-DRL [19]. The results (see Figure 3) demonstrate that the effective release height corresponding to the ILLTS geometry will be lowest in all cases compared to the other three release geometries. This also indicates that the doses will be the highest from the ILLTS and, thus, the DRL will be the lowest (and most conservative) for all radionuclides when calculated using the ILLTS geometry.

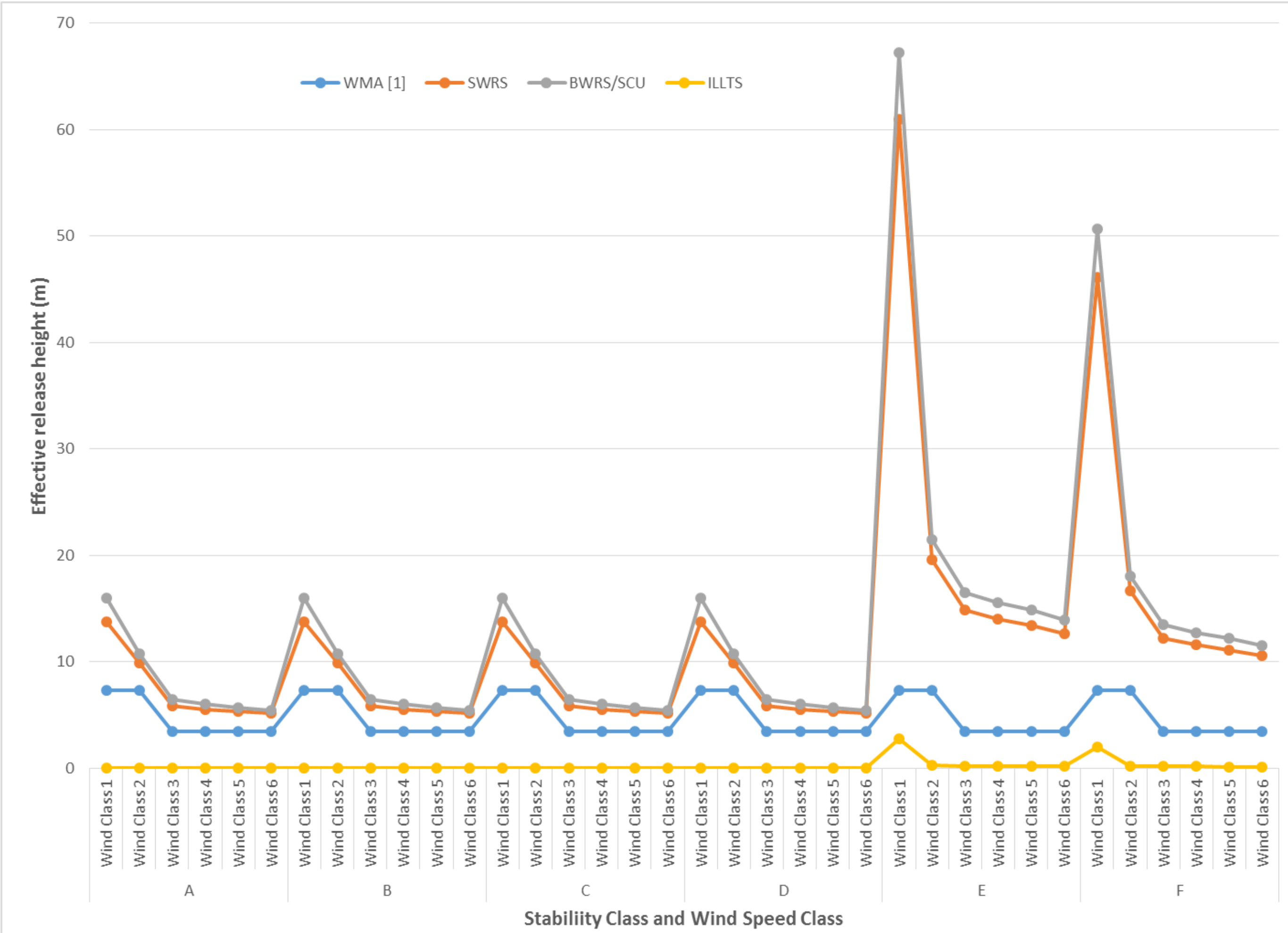

Figure 3: Comparison of the effective release heights corresponding to each stability class and each wind speed class for the WMA release location.

A sample calculation was then carried out in IMPACT [4] for a unit release (1 Bq s^{-1}) of Cs-137 from the SWRS, the BWRS/SCU and the ILLTS to compare the total dose to an adult at the critical group A location. The results from the 2016 DRL [1] and the current calculations are compared in Table 9. It can be seen that the highest dose was predicted using the ILLTS geometry and, therefore, all WMA DRLs calculated using this geometry will be conservative.

Table 9: Example dose from unit release of Cs-137 to show a combined effect of release geometry, stability classes and wind speed classes.

Release Location	Total Dose (Sv a^{-1})
Compactor/Baler	4.01E-08
SWRS	2.07E-08
BWRS/SCU	1.90E-08
ILLTS	4.08E-08

Site-specific meteorological data collected routinely by CNL at WL in the past were used in the dispersion calculations. Temperature, wind speed, wind direction and standard deviation of wind direction were measured at heights of 6, 25 and 61 m on the tower located within a 2-ha clearing about 300 m south-west of

B300. Quality-assured values for each of these variables are available every hour from 1988 to 1995. The data from the 6-year period (1990-1995, inclusive) were used for the present calculations. The 25-m level of the tower is at about the same height as the B100 stack. Meteorological conditions are, therefore, similar at the two locations and the 25-m data were used in calculations involving releases from B100. In contrast, B200 and B300 were treated as the ground-level sources and releases from the WMA occur from a short stack. The 6-m data represent best the meteorological conditions experienced by low-level releases and were used for these sources.

Limited, more recent meteorological data is available for the WL site. Environment Canada routinely measures temperature and wind data at a single level above the ground surface. However, the older CNL data is more suitable for the current DRL calculations for the following reasons:

- multi-level temperature measurements can be used to significantly improve estimates of the atmospheric stability class,
- higher-level data better represents the meteorological conditions experienced by the release from B100,
- the quality assurance of the selected CNL data is believed to be better than that of the Environment Canada data, and
- although there may have been some changes in meteorological conditions over the last 23 years, these are relatively small considering the uncertainties in the atmospheric dispersion modelling.

The CNL data from the period of 1990-1995 were also used in the 2001 DRL [17] calculations.

For each tower level, triple joint frequency distributions of wind speed, wind direction and stability class were calculated from the hourly data. The full triple joint frequency distributions are reported in Appendix A. Wind roses for the two measurement levels are shown in

Figure 4 and Figure 5. The average wind speeds in each wind speed class, which were also required by the model, are listed in Table 10.

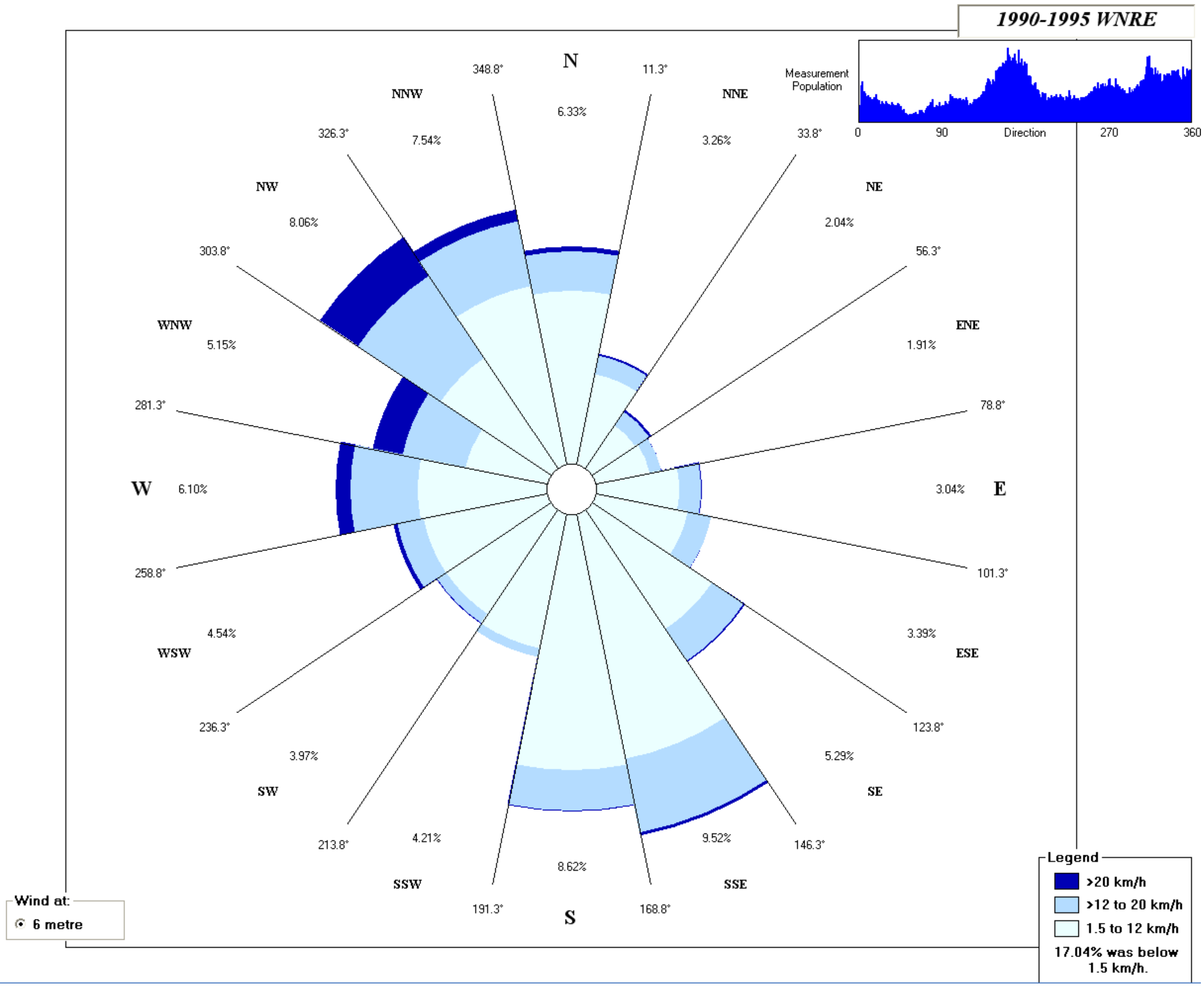

Figure 4: Wind rose diagram for the 6-m level.

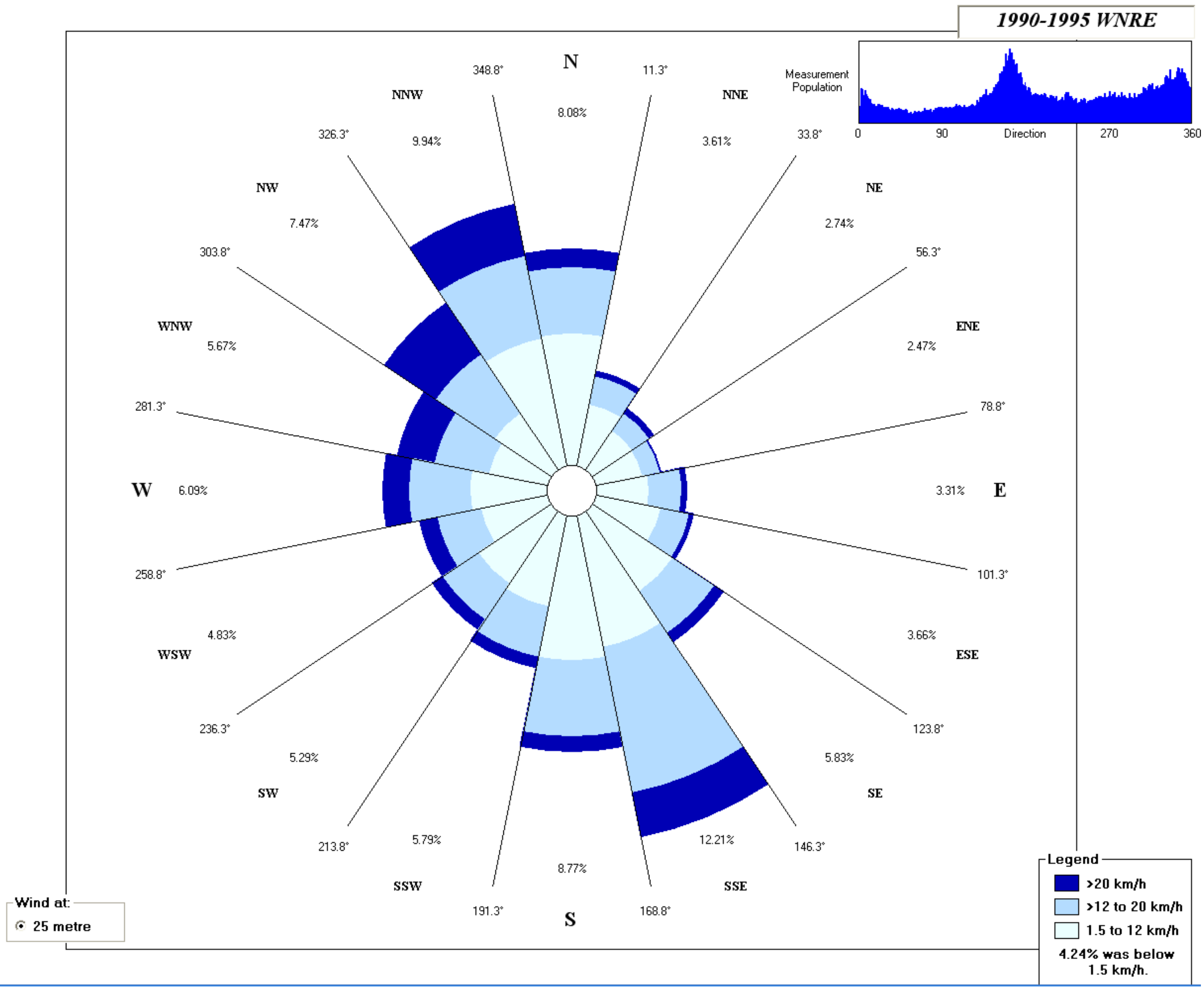

Figure 5: Wind rose diagram for the 25-m level.

Table 10: Mean wind speeds for each wind speed class.

Wind Speed Class	Wind Speed Range (m s^{-1})	Mean Speed (m s^{-1})	
		6-m Level	25-m Level
1	0-2	0.85	1.14
2	2-3	2.47	2.50
3	3-4	3.44	3.47
4	4-5	4.42	4.45
5	5-6	5.44	5.45
6	> 6	7.05	7.28

The land between the sources and the potential critical groups is partly wooded and partly farmland. Therefore, the meteorological roughness length was set equal to 0.4 m, as was done in the 2001 DRL [17] calculations.

All other parameters required to calculate atmospheric dispersion were assigned the values recommended in N288.1 [2].

6.2 Liquid Effluents

6.2.1 Sources

At the WL site, liquid effluents are discharged to the Winnipeg River continuously through the process outfall, twice a year from the sewage lagoon and intermittently through small natural streams. Of these sources, only the process outfall (shown as "Outfall" in Figure 2) is significant enough for explicit inclusion in the calculation of DRLs. As has been done in the past, the DRLs calculated for the process outfall can be applied to the sewage lagoons because the distance between the two sources is small compared to their distances from the critical group.

6.2.2 River Dispersion Model

The concentrations of radionuclides in the river water, at the location of the water intake for the critical group, have been calculated using the two-dimensional advection-dispersion model of N288.1 [2]. The model parameters include the river width, the river depth, the current velocity, the longitudinal and lateral dispersion coefficients, the offshore distance to the release point and the offshore distance to the point of water intake.

The river width was estimated from a topographic map to be 470 m. Based on the average river flow rate of 1.01E6 L s^{-1} for the period 2003-2008 [20] and Merritt's study [15], the current velocity was estimated to be 0.28 m s^{-1}. Based on this width, flow rate and velocity, the river depth was estimated to be 7.7 m. The release point is located 8 m offshore. The offshore distance to the point of water intake was conservatively assumed to be 8 m also.

N288.1 [2] recommends that values of longitudinal and lateral dispersion coefficients for the model are best determined from site-specific dispersion studies. In the 2001 DRL calculations [17], the dilution resulting at the location of the water intake was estimated based on the results of a short-term tracer test [15]. However, the radionuclide concentrations measured subsequently during routine monitoring of river water at a location 1,930 m downstream of the release point and 880 m upstream of the point of water intake were consistently much higher than estimates based on the measured release rates and the dilution estimated from the tracer test. This has led to doubts as to the applicability of the results of the tracer test in the DRL calculations.

Therefore, for the 2016 DRL [1] calculations, it was decided to calibrate the river model using Sr-90 and C-137 concentration data obtained from ten years (2003-2012) of routine monitoring of the river water at the location 1,930 m downstream of the release point, the river water upstream of the release point and the effluent in the process outfall ([20], [21], [22] and [23]). In this calibration, the longitudinal dispersion coefficient was set equal to 150 m^2 s^{-1}, the value recommended by N288.1 [2] for the Ottawa River downstream of the CRL site. This was done because data limitations made it impossible to estimate independent values of the longitudinal and lateral coefficients, and because the model predictions are very insensitive to the value of the longitudinal dispersion coefficient. The value for the Ottawa River was selected because the Ottawa River is similar in size to the Winnipeg River. The lateral dispersion coefficient was calibrated to be 7.4E-7 $m^2 s^{-1}$. The calibration done here (using the observed data) is equivalent to the validation of this sub-model.

7. RADIONUCLIDES

The DRLs have been calculated for all thirty-seven parent radionuclides that have been recently found or are reasonably expected to be found in WL's airborne and liquid effluents (see Table 11). In the 2016 DRL [1], an airborne effluent DRL was calculated for HTO released from B100 only. However, based on the introduction of three new systems in the WMA and the release of HTO from one or more of these systems, a separate airborne effluent DRL was calculated for HTO released from the WMA.

Table 11: Radionuclides considered for airborne and liquid effluents.

Ac-227#	HTO**	Ra-226#
Am-241	I-129	Sb-125 (Te-125md)
Am-243 (Np-239d, Pu-239dd)	Kr-85#	Sm-151#
C-14*	Mn-54	Sr-90 (Y-90d)
Ce-144 (Pr-144d)	Nb-94	Tc-99
Cm-244	Ni-63	Th-228 (Ra-224d)#
Co-60	Np-237 (Pa-233d)	U-233 (Th-229d, Ra-225dd)#
Cs-134	Pm-147	U-234
Cs-137 (Ba-137md)	Pu-238 (U-234d)	U-235 (Th-231d)
Eu-152	Pu-239	U-238 (Th-234d, Pa-234mdd)
Eu-154	Pu-240	Zn-65
Eu-155#	Pu-241 (Am-241d)	
Fe-55	Pu-242	

* For airborne effluents, C-14 was assumed to be released as CO_2.

** For airborne effluents, HTO was assumed to be released from B100 and the WMA.

Only for airborne effluents assumed to be released from the WMA.

In Table 11, radioactive daughters which are possibly significant (e.g., Np-239d, Pu-239dd) are given in parentheses after their parent (e.g., Am-243). They are not released directly, but the ingrowth of these daughters and their transfer through the environment were modelled explicitly in IMPACT [4], and were taken into account in determining the DRL for the parent. The letter 'd' following the radionuclide name indicates the first daughter, and the letters "dd" indicates the second daughter.

8. ENVIRONMENTAL PATHWAYS MODELS

8.1 General Discussion

The environmental pathways models described in N288.1 [2] were used in this analysis. These are illustrated in Figure 6 and Figure 7 as flowcharts, which provide a summary of the environmental compartments and transfer mechanisms applied in the current modelling for the critical groups. Each compartment treated in the model is numbered and the quantity in compartment i is denoted by X_i. Transfer from compartment i to compartment j is characterized by a transfer parameter P_{ij}, such that the amount present in compartment j under steady-state conditions due to transfer from compartment i is $P_{ij}X_i$. The various compartments, transfer parameters and their units are summarized in Table 12 and Table 13.

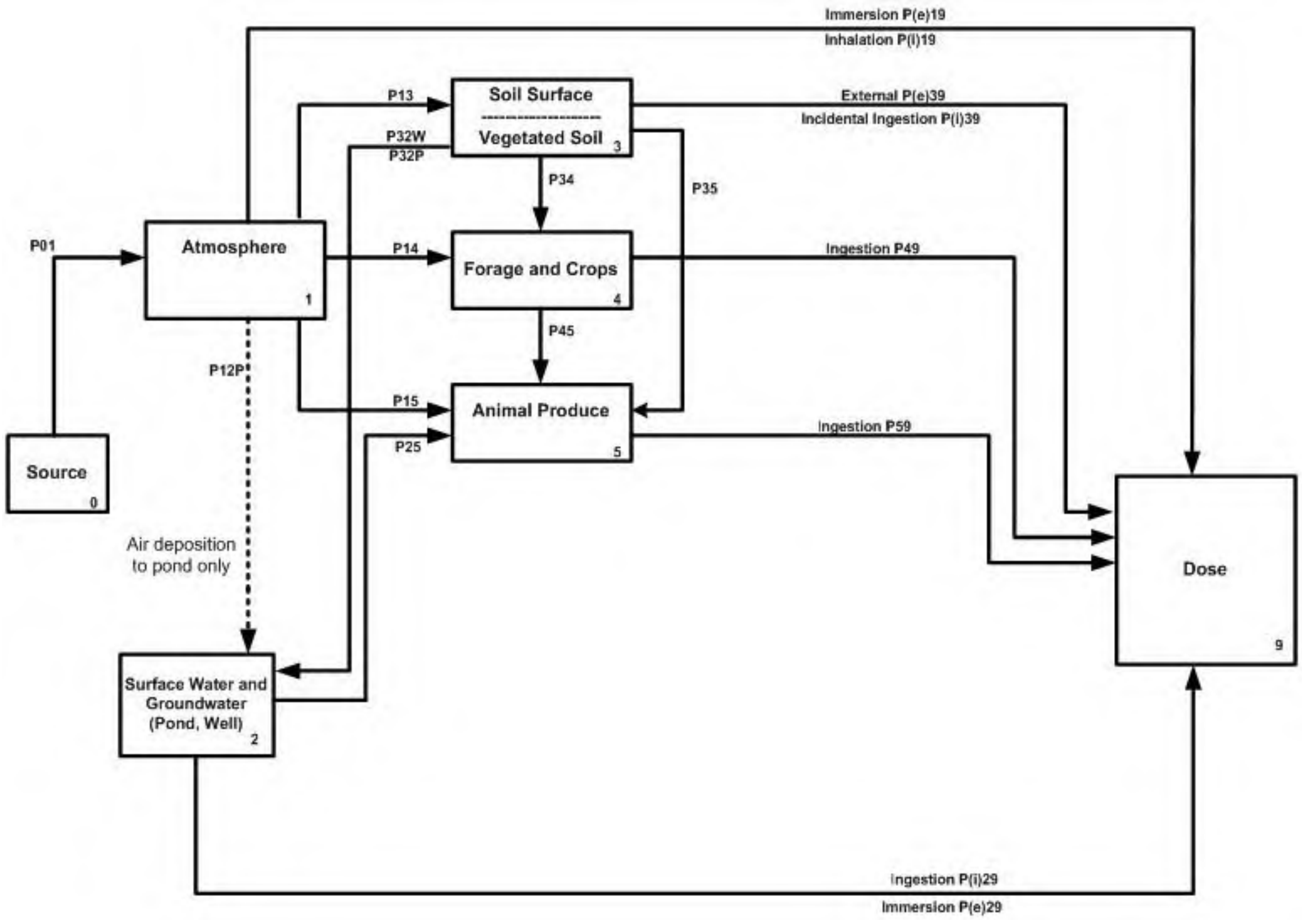

Figure 6: Environmental transfer model for airborne effluent modelling.

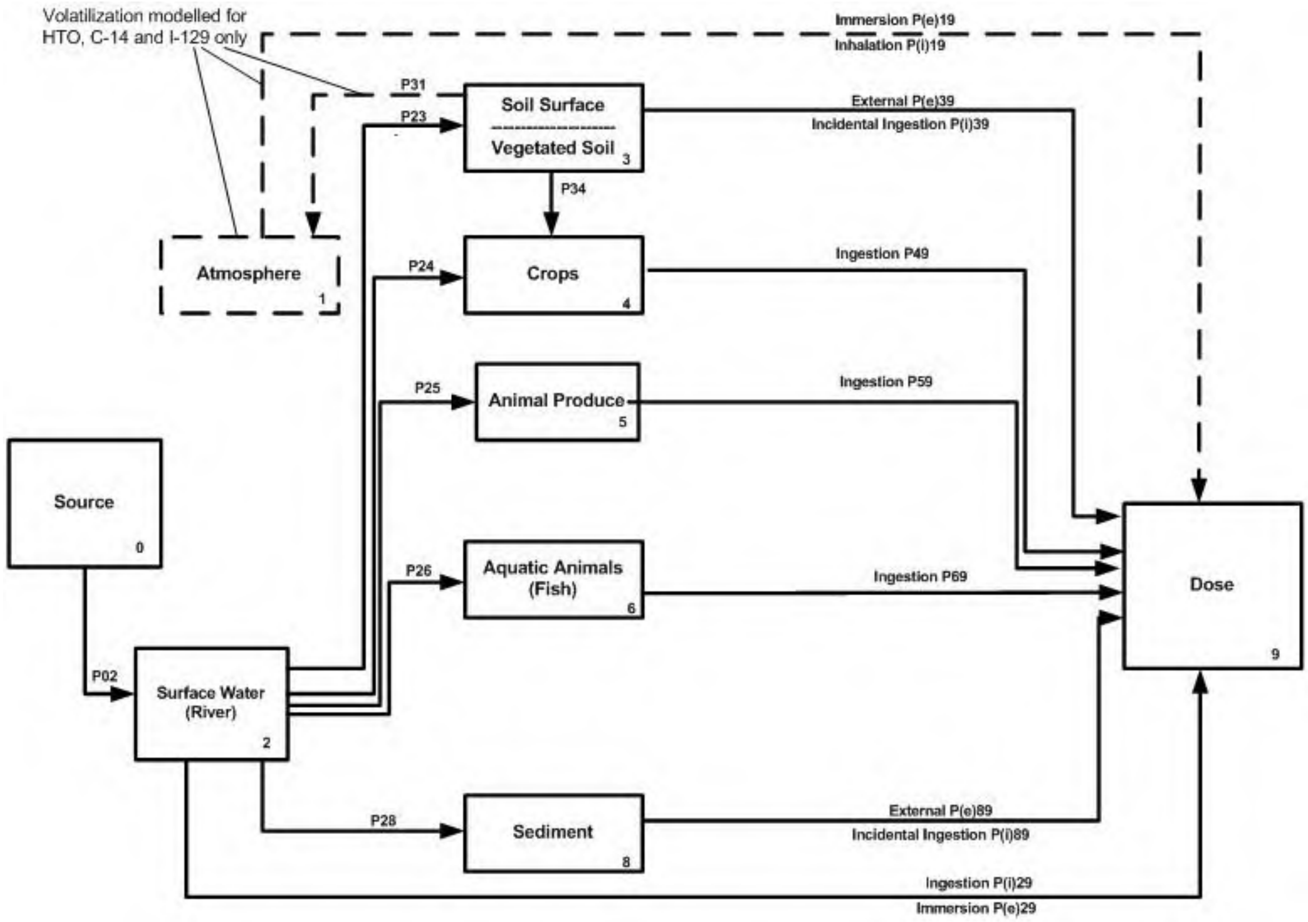

Figure 7: Environmental transfer model for liquid effluent modelling.

Table 12: Transfer compartments and their units.

Compartment Number	Compartment Name	Units
0	Source	$Bq \cdot s^{-1}$
1	Atmosphere	$Bq \cdot m^{-3}$
2	Surface Water (river)	$Bq \cdot L^{-1}$
2p	Surface Water (pond)	$Bq \cdot L^{-1}$
2w	Ground Water (well)	$Bq \cdot L^{-1}$
3area	Surface Soil	$Bq \cdot m^{-2}$
3mass	Bulk Soil	$Bq \cdot kg^{-1}$ dw*
3spw	Soil Pore Water	$Bq \cdot L^{-1}$
4	Forage and Crops	$Bq \cdot kg^{-1}$ fw†
5	Animal Produce	$Bq \cdot kg^{-1}$ fw
6	Aquatic Animals (fish)	$Bq \cdot kg^{-1}$ fw
8	Sediment	$Bq \cdot kg^{-1}$ dw
9	Dose	$Sv \cdot a^{-1}$

* Dry weight.

† Fresh weight

Table 13: Transfer parameters and their units.

Transfer Parameter	Compartments		Parameter Units
	From	To	
P_{01}	Source	Atmosphere	$s \bullet m^{-3}$
P_{3area1}	Surface Soil	Atmosphere	$m^2 \bullet m^{-3}$
P_{3mass1}*	Bulk Soil	Atmosphere	kg dw • m^{-3}
P_{12p}	Atmosphere	Surface Water (pond)	$m^3 \bullet L^{-1}$
P_{13area}	Atmosphere	Surface Soil	$m^3 \bullet m^{-2}$
P_{13mass}	Atmosphere	Bulk Soil	$m^3 \bullet kg^{-1}$ dw
P_{13spw}	Atmosphere	Soil Water	$m^3 \bullet L^{-1}$
P_{14}	Atmosphere	Forage and Crops	$m^3 \bullet kg^{-1}$ fw
P_{15}	Atmosphere	Animal Produce	$m^3 \bullet kg^{-1}$ fw
$P(i)_{19}$	Atmosphere	Dose (inhalation)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet m^3$
$P(e)_{19}$	Atmosphere	Dose (immersion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet m^3$
P_{02}	Source	Surface Water (river)	$s \bullet L^{-1}$
P_{3spw1}**	Soil Water	Atmosphere	L • m^{-3}
$P_{3area2p}$	Surface Soil	Surface Water (pond)	$m^2 \bullet L^{-1}$
$P_{3area2w}$	Surface Soil	Groundwater (well)	$m^2 \bullet L^{-1}$
$P_{3area3spw}$	Surface Soil	Soil Water	$m^2 \bullet L^{-1}$
P_{3spw2w}	Soil Water	Groundwater (well)	unitless
P_{3spw2p}	Soil Water	Surface Water (pond)	unitless
P_{23area}	Surface Water	Surface Soil	$L \bullet m^{-2}$
P_{23mass}	Surface Water	Bulk Soil	$L \bullet kg^{-1}$ dw
P_{23spw}**	Surface Water	Soil Water	unitless
P_{24}	Surface Water	Forage and Crops	$L \bullet kg^{-1}$ fw
P_{25}	Surface Water (lake, river)	Animal Produce	$L \bullet kg^{-1}$ fw
P_{2p5}	Surface Water (pond)	Animal Produce	$L \bullet kg^{-1}$ fw
P_{2w5}	Well Water	Animal Produce	$L \bullet kg^{-1}$ fw
P_{26}	Surface Water	Aquatic Animal	$L \bullet kg^{-1}$ fw
P_{28}	Surface Water	Sediment	$L \bullet kg^{-1}$ dw
$P(i)_{29}$	Surface Water	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet L$
$P(i)_{2w9}$	Well Water	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet L$
$P(e)_{29}$	Surface Water	Dose (immersion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet L$
$P(e)_{2w9}$	Well Water	Dose (immersion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet L$
P_{3mass4}	Bulk Soil	Forage and Crops	kg $dw \bullet kg^{-1}$ fw
P_{3mass5}	Bulk Soil	Animal Produce	kg $dw \bullet kg^{-1}$ fw
$P(i)_{3mass9}$	Bulk Soil	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ dw
$P(e)_{3area9}$	Surface Soil	Dose (groundshine)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet m^2$
P_{45}	Forage and Crops	Animal Produce	kg $fw \bullet kg^{-1}$ fw
P_{49}	Forage and Crops	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ fw
P_{59}	Animal Produce	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ fw
P_{69}	Aquatic Animals	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ fw
$P(i)_{89}$	Sediment	Dose (ingestion)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ dw
$P(e)_{89}$	Sediment	Dose (beachshine)	$Sv \bullet a^{-1} \bullet Bq^{-1} \bullet kg$ dw

* For C-14 and radioiodine only.

** For HTO only.

The application of the models from N288.1 [2] to the WL assessment is discussed briefly in the sections below, emphasizing the few cases where it was necessary to deviate from the recommended models and parameter values.

8.2 Special Radionuclides

8.2.1 Tritium and Carbon 14

As recommended in N288.1 [2], the models used to calculate the DRLs for HTO and C-14 were based mainly on specific activity (SA) concepts. For tritium, SA models were used for all pathways except for the final calculation of doses, where an uptake model was used instead. For C-14, SA models were used for all pathways except transfers to animals (where a transfer factor was used, which was still derived from SA consideration), and the calculation of dose (where an uptake model was used). HTO absorption by skin was taken into account by increasing the dose from HTO inhalation by 50%, as recommended in N288.1 [2].

HTO can form stable bonds with carbon in plants and animals, in which case it is known as organically bound tritium (OBT). The DRLs for HTO take into account OBT formed in the environment. As a unit release of HTO will result in doses from both HTO and OBT in the environment, the dose from these two sources of uptake were added together and used to back calculate the HTO DRL.

The default parameter values recommended in N288.1 [2] were used throughout the tritium and C-14 models.

8.2.2 I-129

I-129 was modelled in the same manner as other radionuclides except that, in the case of liquid effluents, its volatile nature was taken into account by including volatilization following irrigation. Resulting air inhalation and immersion doses were calculated from the air concentrations estimated by the model.

8.3 Special Receptors

In order to facilitate the modelling of infant dose from the consumption of mother's breast milk, the concentrations of radionuclides in the milk were calculated. This modelling was carried out in IMPACT by modelling the lactating mother in the same way as a terrestrial animal and considering breast milk to be an animal product. The animal transfer models in N288.1 [2] were used for the mother, as shown in Figure 8. The nursing mother's intakes of food, water and air were discussed and listed in Section 5.4.3 and Table 7. Values for all of the other parameters required by the model were left at the default values in the IMPACT database. Figure 8 is provided to demonstrate only the contribution from mother's milk to infant's ingestion dose. Infants receive additional doses from other pathways as shown in Figure 6 and Figure 7.

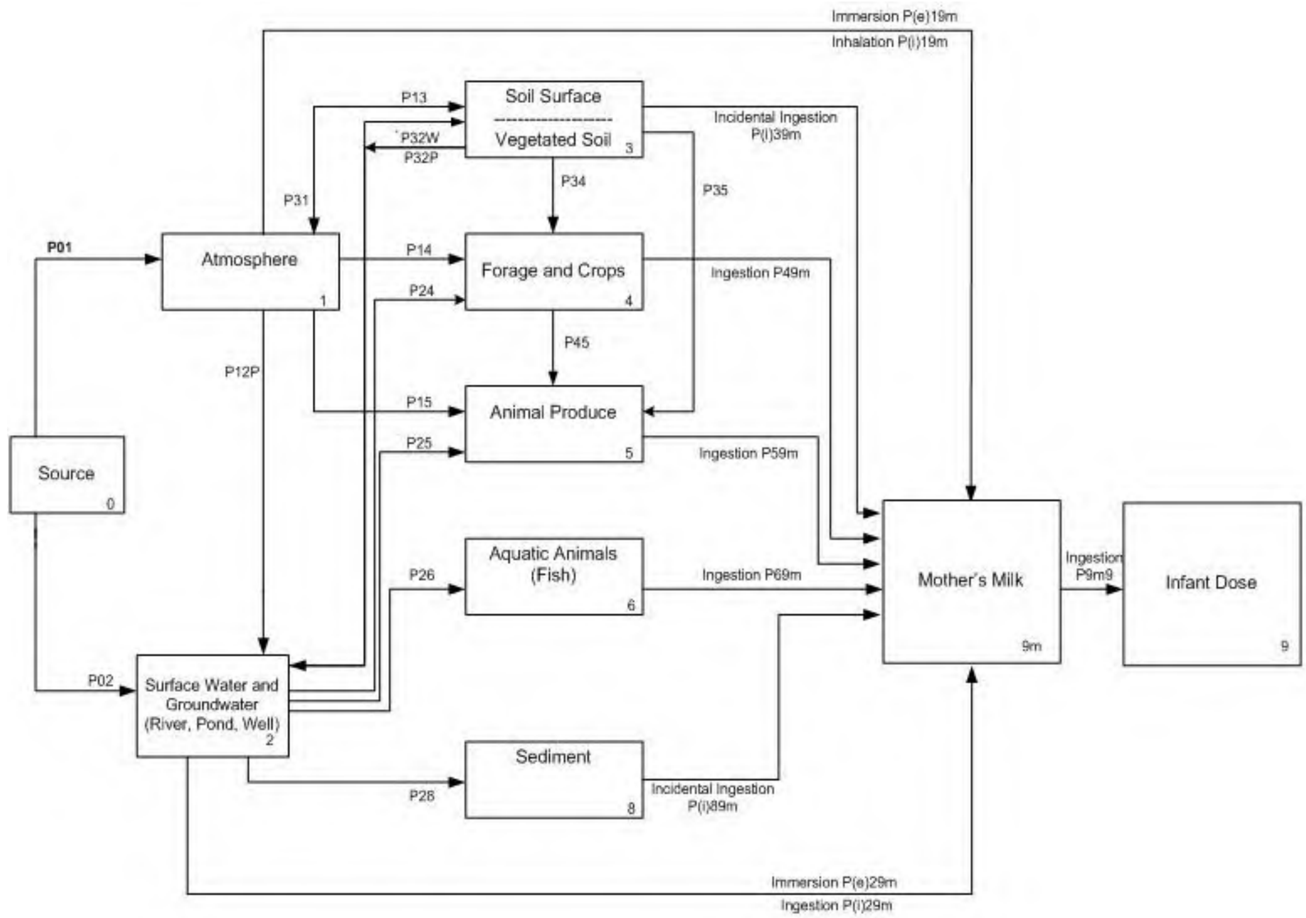

Figure 8: Supplemental model for mother's milk.

8.4 Other Parameter Values

8.4.1 Soil Types

The surface soil in the vicinity of WL was assumed to be clay, based on the recommendations of Killey [24]. The subsoil was conservatively assumed to be sand.

8.4.2 Well Depth

In areas having clay over bedrock, water supply wells are most likely to extend into the bedrock until some sufficiently permeable fracture zone is encountered, possibly at depths up to 100 m [22]. However, in some areas close to the WL site, sands and sandy till are present and it is possible to obtain a domestic water supply with a very shallow (5-10 m depth) dug well. Since the shallow supply well is conservative, a well depth of 6 m was assumed in this assessment.

The dose results generated from the DRL modelling demonstrate that the groundwater pathway is not of great importance for most radionuclides. However, for HTO, Tc-99 and Np-237, well water ingestion is one of the dominant pathways**.**

8.4.3 Pond Model

Although, in reality, ponds are fed by precipitation, groundwater and surface water inflows, only precipitation and groundwater inflow were included in the IMPACT pond model. This is conservative because uncontaminated surface water inflow flushes radioactivity from the pond.

The parameter values assumed for the small ponds that were assumed to provide drinking water for deer are listed in Table 14. These are the values suggested in N288.1 [2]. In the IMPACT default database, the value for the sediment dry bulk density was found to be incorrect and the database maintainers were notified of this error.

Table 14: Parameters values used in the pond model.

Parameter	Value
Effective Soil Porosity	0.2
Pond Surface Area (m^2)	5000
Pond Depth (m)	2
Horizontal Linear Groundwater Velocity ($m\ s^{-1}$)	1.58E-7
Groundwater Inflow Rate to Pond ($L\ s^{-1}$)	5.06E-3
Sediment Dry Bulk Density ($kg\ m^{-3}$)	400

8.4.4 Wet Deposition Velocity

The calculation of the wet deposition velocity involves a term f_{pj}, which is defined as the fraction of the time that precipitation occurs when the wind blows from sector j. Precipitation data routinely collected by CNL at WL, in the past, is incomplete in that it does not include the contribution from snow. Therefore, the f_{pj} values were created using Environment Canada's meteorological data for the WL site for the period of 2004 May to 2009 April, inclusive (see Table 15).

Table 15: Values of f_{pj}.

Sector	f_{pj} Value
N	0.087
NNE	0.114
NE	0.111
ENE	0.084
E	0.072
ESE	0.064
SE	0.061
SSE	0.04
S	0.047
SSW	0.047
SW	0.052
WSW	0.053
W	0.057
WNW	0.071
NW	0.065
NNW	0.061

The calculation of the wet deposition velocity also requires a value for the annual average precipitation (rain + snow). The value measured at WL for the period of 1971 to 2000 [25], 565 mm, was used.

8.4.5 Volatilization from Irrigation Water

The critical group associated with liquid releases was assumed to irrigate its backyard gardens and lawns with contaminated water. In the calculations, the size of the irrigated area was assumed to be 50 m by 50 m, which was intended to account for a front yard, a back yard and a large garden plot. In calculating air concentrations following volatilization of volatile radionuclides (HTO, C-14 and I-129), the receptor was placed on the contaminated field, implying continuous exposure to the re-emitted activity.

8.4.6 Absolute Humidity

Values of annual average absolute humidity, average absolute humidity over the snow-free period and average absolute humidity over the growing season are required for modelling HTO. For the WL area, the snow-free period is approximately from May 15 to November 15, and the growing season is estimated to be from June 1 to September 30. Based on Environment Canada data measured at the WL site between 2008 October 1 and 2009 September 30, the following humidity values were used: annual average absolute humidity 0.00541 L m^{-3}, average absolute humidity over the snow-free period 0.0085 L m^{-3}, and average absolute humidity over the growing season 0.0102 L m^{-3}.

8.4.7 External Dose Coefficients

There are two approaches to modelling the contributions of daughter radionuclides to the dose resulting from the release of a parent radionuclide to the environment. The preferred approach is to explicitly model the ingrowth of these daughters, their transfer through the environment and the resulting dose from them. A second approach which is simpler, but in certain cases less accurate, is to explicitly model the parent only and include the contributions to dose from the daughters in the dose coefficients (DCFs). IMPACT has been designed so that either approach can be used. For the current DRL calculations, the explicit approach was used. However, the external DCFs in the default IMPACT database include the contributions of daughters. Since there is a potential for errors when correcting the many external DCFs, and since the external doses are either much less than the ingestion doses or the contributions from the daughters to external doses are much less than those from the parent, the default external DCFs were used for the current calculations. This approach is slightly conservative.

8.4.8 Additional Changes to IMPACT Default Database

Table 16 shows changes to parameter values in the IMPACT default database that were made for the WL assessment and are not described elsewhere in this report.

8.4.8.1 Parameter Values for Additional Radionuclides Identified for Airborne Effluents from the WMA

DRLs were required for seven more radionuclides (i.e., Ac-227, Eu-155, Kr-85, Ra-226, Sm-151, Th-228 and U-233) for potential releases from WMA systems. For five radionuclides (Eu-155, Kr-85, Ra-226, Th-228 and U-233), the parameter values were already present in the IMPACT default database. For Ac-227 and Sm-151, IMPACT default database did not contain any parameter values. In fact, the parameter values for both elements (Ac and Sm) were completely missing and, therefore, it became necessary to add all the parameter values for them.

Sm-151 does not have any progeny, but Ac-227 decays into Fr-223 and Th-227. Both these radionuclides (Fr-223 and Th-227) were also missing in IMPACT database. Given that Ac-227 and the other six radionuclides are expected to be present at WL site very rarely, and to keep the calculations simple, Fr-223 and Th-227 progenies were ignored.

All the parameter values corresponding to Ac-227 and Sm-151 were estimated as shown in Table 17, Table 18 and Table 19, and entered into IMPACT database for performing the DRL calculations.

Table 16: Other parameter values in the IMPACT default database that were modified for the WL calculations.

Compartment	Parameter Name	Unit	IMPACT Default Database Value	Value Used in WL Model	Reference and Comment
Surface Water (River)	Partition coefficient for Np	$L\ kg^{-1}$	25	40	N288.1 Clause 7.8.2
Surface Water (Pond)	Partition coefficient for Np	$L\ kg^{-1}$	65	125	N288.1 Clause 6.6.2.2
Surface Water (Pond)	Net Precipitation Rate	$mm\ a^{-1}$	369	6	=WL precipitation rate – WL evapotranspiration rate [26]
Groundwater (Well)	Rate of Infiltration to Aquifer	$m^3\ m^{-2}\ s^{-1}$	4.757E-9	4.043E-9	Assumed same as soil infiltration rate below, although N288.1 Clause 6.5.2.2 suggests that it can be lower than soil.
Soil	Infiltration Rate	$m^3\ m^{-2}\ s^{-1}$	1.142E-8	4.043E-9	= 0.5 (WL precipitation rate – 0.31) m a^{-1}, N288.1 Clause 6.3.6.3
Soil (link from water via air)	Annual Average Irrigation Rate	$L\ m^{-2}\ s^{-1}$	Not available	1.1E-5	N288.1 Clause 7.2.3.2.2
Terrestrial Plants	Fraction of Plant Carbon Derived from Air (all sources other than irrigation water)	-	1	0.7 or 1.0*	N288.1 Clauses 6.4.9.3 and 7.3.4.3
Sediment (River)	Partition coefficient for Np	$L\ kg^{-1}$	25	40	N288.1 Clause 7.8.2
Sediment (Pond)	Partition coefficient for Np	$L\ kg^{-1}$	65	125	N288.1 Clause 6.6.2.2
Dose	Fraction of Year Spent Swimming in a Surface Water Body (Beach Swimming)	-	0.014	0.011	Based on 3 months per year
Dose	Fraction of Year Spent Swimming in a Pool Filled with River Water	-	0.028	0.032	Based on 9 months per year
Full Simulation	Facility Life	years	Not available	57	When the 2010 DRLs were calculated, WL site had been in existence for 47 years (opened in 1963) and the DRLs were expected to be used for another 10 years.

* This value is set at 0.7 when calculating liquid effluent DRLs, but is set at 1 when calculating airborne effluent DRLs.

Table 17: Radionuclide specific parameter values takes from different references.

Parameter	Radionuclide						Comment
	Sm-151			Ac-227			
Halflife (s)	2.84E+09			6.87E+08			RadDecay program [27]
Building shielding factor	0.5			0.5			The mean value of 0.5 is the recommended default CSA N288.1, 2020 [28], cls. 6.2.5.
Groundshine shielding factor	0.2			0.2			Both radionuclides are not pure beta emitters
	Infant-1 year old	**Child-10 year old**	**Adult**	**Infant-1 year old**	**Child-10 year old**	**Adult**	
Effective dose coefficients for inhalation (Sv•Bq–1)	1.08E-08	4.50E-09	4.00E-09	5.50E-04	2.60E-04	2.20E-04	ICRP-119 [29], and Health Canada [30].
Effective dose coefficients for ingestion (Sv•Bq–1)	6.40E-10	2.00E-10	9.80E-11	3.10E-06	1.50E-06	1.10E-06	ICRP-119 [29], and Health Canada [30].
Dose coefficients for immersion in a semi-infinite cloud of radioactive material, for effective as well as skin (Sv•a–1/Bq•m–3)	1.01E-12	7.76E-13		2.09E-10	1.61E-10		ICRP-119 [29], and Health Canada [30]. 1-year-old infant DCF = 1.3 adult DCFs because both radionuclides are not pure beta emitters. CSA N288.1 (2020) [28], cls. 6.2.3.1.
Dose coefficients for exposure 1 m above a contaminated plane ground source, same value for effective as well as skin (Sv•a–1/Bq•m–2)	1.42E-13	1.09E-13		5.79E-12	4.45E-12		ICRP-119 [29], and Health Canada [30]. 1-year-old infant DCF = 1.3 adult DCFs because both radionuclides are not pure beta emitters. CSA N288.1, 2020, [28], cls. 6.14.2.
Dose coefficients for immersion in contaminated water, effective as well as skin (Sv•a–1/Bq•L–1)	2.36E-12	1.82E-12		4.48E-10	3.60E-10		Eckerman and Leggett [31]. 1-year-old infant DCF = 1.3 adult DCFs because both radionuclides are not pure beta emitters. CSA N288.1, 2020, [28], cls. 6.16.1.2.
Dose coefficients for exposure to shoreline contaminated to a depth of 5 cm, effective as well as skin (Sv•a–1/Bq•kg–1 dw)	#N/A						It is not applicable to ground water well. It would have been applicable if there was any water body.

Table 18: Radionuclide gamma energy and probability data takes from RadDecay program [27].

Radionuclide			
Sm-151		**Ac-227**	
Probability per decay	**Energy (MeV)**	**Probability per decay**	**Energy (MeV)**
1.06E-03	5.85E-03	1.15E-02	1.30E-02
2.96E-04	2.15E-02	3.62E-04	1.74E-02
		9.82E-04	1.15E-01

Table 19: Parameter values estimated as an average of the values of two neighbouring elements from the periodic table, one on each side.

Parameter	Radionuclide					
	Pm-147	Eu-152	**Sm-151**	Ra-226	Th-228	**Ac-227**
Dry deposition velocity (m.s-1)	1.40E-03	1.40E-03	**1.40E-03**	1.40E-03	1.40E-03	**1.40E-03**
Washout ratio to soil and pond	5.50E+06	5.50E+06	**5.50E+06**	5.50E+06	5.50E+06	**5.50E+06**
Washout ratio to plant	6.30E+05	6.30E+05	**6.30E+05**	6.30E+05	6.30E+05	**6.30E+05**
Partition coefficient clay (L.kg-1), and clay pore water	653	653	**653**	9000	5400	**7200**
Partition coefficient loam (L.kg-1), and loam pore water	429	429	**429**	36000	3300	**19650**
Partition coefficient organic (L.kg-1), and organic pore water	1513	1513	**1513**	2400	89000	**45700**
Partition coefficient sand (L_kg-1), and sand pore water	123	123	**123**	490	3000	**1745**
Volatilization rate constant clay (s-1)	0	0	**0**	0	0	**0**
Volatilization rate constant loam (s-1)	0	0	**0**	0	0	**0**
Volatilization rate constant organic (s-1)	0	0	**0**	0	0	**0**
Volatilization rate constant sand (s-1)	0	0	**0**	0	0	**0**
Distribution coefficient groundwater (L.kg-1)	123	123	**123**	490	3000	**1745**
Distribution coefficient pond (L_kg-1)	2145	2145	**2145**	180000	16500	**98250**
Volatilization rate constant pond (s-1)	0	0	**0**	0	0	**0**
Removal factor for water treatment, pore water, groundwater and pond	1	1	**1**	1	1	**1**
Soil to plant transfer factor clay (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor loam (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor organic ((Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor sand (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor feed grain (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor forage (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor fruits (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor garden vegetables (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor grain (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Soil to plant transfer factor potatoes (Bq/kg)/(Bq/kg)	0.018	0.018	**0.018**	0.11	0.0033	**0.0567**
Food processing factor feed grain	1	1	**1**	1	1	**1**
Food processing factor forage	1	1	**1**	1	1	**1**
Food processing factor fruits	1	1	**1**	1	1	**1**
Food processing factor garden veg	1	1	**1**	1	1	**1**
Food processing factor grain	1	1	**1**	1	1	**1**
Food processing factor potatoes	1	1	**1**	1	1	**1**
Translocation factor feed grain	0.1	0.1	**0.1**	1	0.01	**0.505**
Translocation factor forage	1	1	**1**	1	1	**1**
Translocation factor fruits	0.1	0.1	**0.1**	1	0.01	**0.505**
Translocation factor garden vegetables	1	1	**1**	1	1	**1**
Translocation factor grain	0.1	0.1	**0.1**	1	0.01	**0.505**
Translocation factor potatoes	0.1	0.1	**0.1**	1	0.01	**0.505**
Bio-concentration aquatic plant (L.kg-1 fresh weight)	3000	3000	**3000**	1000	200	**600**
Bio-concentration freshwater fish (L.kg-1_fw)	30	50	**40**	50	100	**75**

Parameter	Radionuclide					
	Pm-147	Eu-152	**Sm-151**	Ra-226	Th-228	**Ac-227**
Bio-concentration marine fish (L.kg-1_fw)	300	300	**300**	100	600	**350**
Bio-concentration shellfish (L.kg-1_fw)	1000	1000	**1000**	100	1000	**550**
Distribution coefficient river sediment (L.kg-1_dw)	1230	1230	**1230**	4900	30000	**17450**
Ingestion transfer factor beef meat (day.kg-1)	0.0022	0.0022	**0.0022**	0.002	0.00012	**0.00106**
Ingestion transfer factor breast milk (day.kg-1)	0.00058	0.00058	**0.00058**	7.45E-03	2.87E-04	**3.87E-03**
Ingestion transfer factor cow milk (day.kg-1)	2.90E-05	2.90E-05	**2.90E-05**	6.00E-05	2.30E-05	**4.15E-05**
Ingestion transfer factor deer (day.kg-1)	0.017	0.017	**0.017**	0.0072	0.002	**0.0046**
Ingestion transfer factor honey (day.kg-1)	0.53	0.53	**0.53**	0.53	0.53	**0.53**
Ingestion transfer factor lamb (day.kg-1)	0.05	0.05	**0.05**	0.008633	0.013	**0.010817**
Ingestion transfer factor pig (day.kg-1)	0.005	9.80E-05	**2.55E-03**	0.0046	0.0046	**0.0046**
Ingestion transfer factor poultry eggs (day.kg-1)	0.02	0.0038	**0.0119**	0.005	0.01	**0.008**
Ingestion transfer factor poultry meat (day.kg-1)	0.002	0.0038	**0.0029**	0.03	0.01	**0.02**
Ingestion transfer factor rabbit (day.kg-1)	0.24	0.24	**0.24**	0.1	0.028	**0.064**
Inhalation transfer factor beef meat (day.kg-1)	0.529122	0.529122	**0.529122**	0.00222	0.01207	**0.00714**
Inhalation transfer factor breast milk (day.kg-1)	0.13978	0.13978	**1.40E-01**	2.93E-03	2.77E-04	**1.60E-03**
Inhalation transfer factor cow milk (day.kg-1)	0.006975	0.006975	**0.006975**	6.66E-05	0.002313	**1.19E-03**
Inhalation transfer factor deer (day.kg-1)	4.08867	4.08867	**4.08867**	0.007992	0.20116	**0.10458**
Inhalation transfer factor honey (day.kg-1)	0	0	**0**	0	0	**0**
Inhalation transfer factor lamb (day.kg-1)	12.0255	12.0255	**12.0255**	0.009583	1.30754	**0.658697**
Inhalation transfer factor pork (day.kg-1)	1.20255	0.02357	**0.61306**	0.005106	0.462668	**0.233887**
Inhalation transfer factor poultry eggs (day.kg-1)	4.8102	0.913938	**2.862069**	0.00555	1.0058	**0.50568**
Inhalation transfer factor poultry meat (day.kg-1)	0.48102	0.913938	**0.697479**	0.0333	1.0058	**0.5196**
Inhalation transfer factor rabbit (day.kg-1)	57.7224	57.7224	**57.7224**	0.111	2.81624	**1.46362**

9. MODELLING SCENARIOS

9.1 General Discussion

In the 2016 DRL [1], a scenario file was set up using IMPACT [4]. A map covering the region of interest was imported into the model and calibrated to ensure the UTM coordinates were properly aligned. All effluent release locations and potential critical group locations were then entered into the model. Links between compartments were set up, including transfers between adjacent environmental compartments, and between the potential critical groups and their food supply locations. All site-specific and scenario-specific parameters needed by the pathways models were then incorporated.

Once the scenario file was finalized, eight sub-scenario files were created. Four of these were for screening calculations for airborne effluents. Two were for detailed calculations for airborne releases of all radionuclides, except HTO, one for each potentially bounding release location. Another was for detailed calculations of the release of HTO from B100. The final one was for detailed calculations for liquid effluents. For each combination of effluent type, radionuclide, critical group, age class and potentially bounding release location, calculations of dose rate per unit release were carried out by running IMPACT. The results were searched to identify the highest dose rates per unit release for each combination of effluent type and radionuclide among all age classes and potentially bounding release locations. These dose rates per unit release were then used to calculate the DRLs for each combination of effluent type and radionuclide. For each of these combinations, the dominant exposure pathway and its percent contribution to the dose rate were also determined.

In the current assessment, from the scenario files described above, the file corresponding to the WMA airborne releases was modified to include the release of HTO and to replace the release geometry of the compactor/baler with that of the ILLTS. The results of the analysis are presented in Section 11.

9.2 Scenarios for Airborne Effluent Modelling

Table 20 lists the UTM coordinates of the release locations and potential critical group locations considered in the analysis of airborne effluents.

Table 20: Release and potential critical group locations for airborne effluent modelling.

Location	Easting (m)	Northing (m)
Release		
Building 100 Stack	709,909	5,562,658
Building 200	709,928	5,562,834
Building 300	709,714	5,562,668
WMA Gate	711,322	5,564,260
Potential Critical Group		
Farm A	709,547	5,565,803
Farm D	710,067	5,559,924
Farm E	708,642	5,562,571
Farm F	708,783	5,565,288

The exposure pathways for the critical groups for airborne effluents are air inhalation, air immersion, water immersion, groundshine, soil ingestion, water ingestion, plant ingestion and ingestion of terrestrial animal products.

9.3 Scenario for Liquid Effluent Modelling

Table 21 lists the UTM coordinates of the release and critical group locations considered in the analysis of liquid effluents.

Table 21: Release and critical group locations for liquid effluent modelling.

Location	Easting (m)	Northing (m)
Release		
WL Process Outfall	709,474	5,562,997
Critical Group		
Farm A	709,547	5,565,803

The exposure pathways for the critical group for liquid effluents are air inhalation, air immersion, water immersion, groundshine, soil and sediment ingestion, water ingestion, plant ingestion, ingestion of terrestrial animal products, fish ingestion and beach shine.

10. SCREENING CALCULATIONS FOR AIRBORNE EFFLUENTS

10.1 Potential Critical Groups and Release Locations

As in the 2016 DRL [1], screening calculations for airborne effluents were performed, which helped reduce combinations of potential critical groups and release locations (from 16 (4 releases X 4 receptors) to **3**) for which detailed dose calculations were required. The findings can be summarized as follows, with further details provided below:

1. Review of air concentrations indicated that releases from B300 would result in the highest predicted dose at the Farm E critical group. However, because Farm E has an occupancy factor of 0.08, it was not calculated to be the bounding case. The releases from **B200 result in the highest predicted dose at the Farm A critical group**, and thus emerged as a bounding case for about half of the radionuclides.
2. Consideration of the combined effect of the wind and precipitation frequencies on the predicted soil concentrations resulted in **WMA release point and Farm A critical group** emerging as a bounding case for the remaining radionuclides.
3. Consideration of different rates of decay of parent radionuclides and ingrowth of progenies during the plume travel time, as well as the predicted air and soil concentrations for logically selected radionuclides, did not result in any additional release location or critical group bounding cases.
4. Knowledge that tritium is not released from B200 resulted in **B100 as a release point and Farm F as critical group** as a bounding case.

In view of the similar nature of the potential critical groups, the screening was based on:

1. The predicted annual-average air concentrations at each group location, resulting from a unit release of each radionuclide at a release location. Concentrations at Farm E were multiplied by a factor of 0.08 to account for the fact that it has limited occupancy (672 hrs per year) (as clarified in Sections 5.2.1 and 5.4.4).
2. The predicted annual-average soil concentration at each group location, resulting from a unit release of each radionuclide at a release location, except for C-14 and HTO, for which doses do not depend on soil concentration. Concentrations at Farm E were multiplied by a factor of 0.08 to account for the limited occupancy.

Table 22 shows the predicted air concentrations for a subset of the radionuclides released, along with the predicted air concentrations of their daughters. Predictions for all released radionuclides having daughters are included to illustrate the differing effects of ingrowth for different combinations of potential critical groups and release locations. Also included in Table 22 are predictions for the slowest- and fastest-decaying released radionuclides that have no daughters, I-129 and Zn-65. Predictions for HTO, which was previously released from B100 only, now includes separate predictions for HTO released from the WMA. The highest concentrations for each radionuclide are indicated by yellow shading.

Even though the air concentrations in the WMA have increased by approximately 2% for all radionuclides, the release location and critical group corresponding to the highest concentration for each radionuclide remain the same as in the 2016 DRL [1]. For all radionuclides, except Pu-239dd (second daughter of released radionuclide Am-243) and HTO (released from both B100 and the WMA), the highest predicted air concentrations are for the combination of Farm A and release from B200. For Pu-239dd, the air concentration is also highest at Farm A, but in this case in combination with release from B300. However, the air concentrations of Pu-239dd are ten orders of magnitude lower than those of its parent, Am-243, so the dose contribution from Pu-239dd will be negligible compared to that of Am-243 and it need not be considered further. Although Farm E is the potential critical group closest to release locations B100, B200 and B300, it has limited occupancy and is not located in one of the high-frequency wind-direction sectors relative to them (Figure 2, Figure 4 and Figure 5). Therefore, the scaled predicted air concentrations at this group location are lower than the concentrations at other group locations. Although the WMA is closer to Farm A than B200 is, the WMA is not the bounding release location for air concentrations because Farm A is in a low-frequency wind-direction sector relative to the WMA (Figure 2 and Figure 4).

For HTO released from the WMA, the air concentration is also highest at Farm A, but in this case in combination with release from the WMA. This is because HTO is only released from B100 and the WMA, and each case was treated individually to allow for separate DRLs. For HTO released from the B100, the highest predicted air concentration is at Farm F, not at Farm A. This is because releases from B100 were assumed to be driven by the meteorological conditions typical of a height of 25 m, whereas releases from the other locations were assumed to be driven by the meteorological conditions typical of a height of 6 m. The meteorological conditions at these two heights differ significantly (Figure 2 and Figure 4).

Table 22: Predicted air concentrations (Bq m^{-3}) at potential critical group locations as a result of the unit release of radionuclide (1 Bq s^{-1}) to the atmosphere at a release location.

Radionuclide	Release from B100				Release from B200				Release from B300				Release from WMA**			
	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F
Am-243	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07***	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Np-239d	1.05E-09	9.85E-10	3.08E-11	1.03E-09	8.44E-09	4.06E-09	2.82E-10	7.21E-09	8.38E-09	4.10E-09	3.32E-10	7.35E-09	6.05E-09	1.88E-09	1.07E-10	3.74E-09
Pu-239dd	1.03E-18	8.64E-19	1.15E-20	8.20E-19	1.32E-17	6.14E-18	1.92E-19	1.01E-17	1.38E-17	5.88E-18	1.84E-19	1.05E-17	7.42E-18	4.39E-18	1.75E-19	5.36E-18
Ce-144	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Pr-144d	1.14E-07	1.12E-07	4.67E-09	1.24E-07	6.59E-07	3.26E-07	3.51E-08	6.14E-07	6.29E-07	3.42E-07	4.46E-08	6.13E-07	5.56E-07	1.08E-07	8.07E-09	3.11E-07
Cs-137	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Ba-137md	1.85E-07	1.86E-07	1.26E-08	2.30E-07	7.63E-07	3.87E-07	5.85E-08	7.53E-07	7.16E-07	4.13E-07	8.41E-08	7.45E-07	6.96E-07	1.16E-07	9.39E-09	3.69E-07
HTO	1.87E-07	1.90E-07	1.46E-08	2.37E-07†	-	-	-	-	-	-	-	-	6.99E-07†	1.16E-07	9.41E-09	3.70E-07
I-129	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Np-237	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Pa-233d	9.20E-11	8.60E-11	2.68E-12	8.99E-11	7.39E-10	3.56E-10	2.46E-11	6.31E-10	7.34E-10	3.59E-10	2.90E-11	6.43E-10	5.29E-10	1.65E-10	9.33E-12	3.28E-10
Pu-238	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
U-234d	2.78E-17	2.60E-17	8.10E-19	2.71E-17	2.23E-16	1.07E-16	7.44E-18	1.91E-16	2.22E-16	1.09E-16	8.75E-18	1.94E-16	1.60E-16	4.98E-17	2.82E-18	9.90E-17
Pu-241	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Am-241d	1.58E-14	1.47E-14	4.60E-16	1.54E-14	1.27E-13	6.10E-14	4.22E-15	1.08E-13	1.26E-13	6.16E-14	4.97E-15	1.10E-13	9.07E-14	2.82E-14	1.60E-15	5.62E-14
Sb-125	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Te-125md	4.28E-11	4.00E-11	1.25E-12	4.18E-11	3.44E-10	1.66E-10	1.15E-11	2.94E-10	3.41E-10	1.67E-10	1.35E-11	2.99E-10	2.46E-10	7.67E-11	4.34E-12	1.52E-10
Sr-90	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Y-90d	9.30E-10	8.69E-10	2.72E-11	9.09E-10	7.45E-09	3.59E-09	2.49E-10	6.37E-09	7.40E-09	3.62E-09	2.93E-10	6.49E-09	5.34E-09	1.66E-09	9.41E-11	3.31E-09
U-235	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Th-231d	2.32E-09	2.17E-09	6.78E-11	2.27E-09	1.85E-08	8.92E-09	6.21E-10	1.58E-08	1.84E-08	9.01E-09	7.32E-10	1.61E-08	1.33E-08	4.10E-09	2.34E-10	8.22E-09
U-238	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Th-234d	1.03E-10	9.64E-11	3.01E-12	1.01E-10	8.28E-10	3.99E-10	2.76E-11	7.07E-10	8.22E-10	4.03E-10	3.25E-11	7.21E-10	5.93E-10	1.85E-10	1.05E-11	3.67E-10
Pa-234mdd	9.68E-11	9.00E-11	2.53E-12	9.27E-11	8.02E-10	3.86E-10	2.56E-11	6.82E-10	7.98E-10	3.89E-10	2.95E-11	6.96E-10	5.69E-10	1.81E-10	1.01E-11	3.55E-10
Zn-65	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07

* The values listed for Farm E are the predicted concentrations multiplied by a factor of 0.08 to account for the limited occupancy.

** The predicted air concentrations for releases from the WMA are revised values from the 2016 DRL [1].

*** Yellow shading indicates the highest concentrations for each radionuclide.

† Separate HTO DRLs are required for B100 and the WMA, thus, both are shaded yellow.

Table 23 shows the predicted soil concentrations for a subset of the radionuclides released (except for C-14 and HTO), along with the predicted soil concentrations of their daughters. The highest concentrations for each radionuclide are indicated by yellow shading.

Even though the soil concentrations in the WMA have increased by approximately 2% for all radionuclides, the release location and critical group corresponding to the highest concentration for each radionuclide remain the same as in the 2016 DRL [1]. The highest predicted soil concentrations are for the combination of Farm A and release from the WMA for all parent radionuclides, except I-129. Farm A also has the highest predicted air concentrations, but the release location resulting in the highest air concentrations is different (B200). The difference is because precipitation occurs more frequently when the wind is blowing toward Farm A from the WMA than when it is blowing from B200 (see Figure 2 and Table 15), with the net result being more wet deposition and higher soil concentrations, even though the air concentrations are lower.

For I-129, the highest predicted soil concentration is for the same combination as the highest predicted air concentration (Farm A and B200). This is because, for I-129, wet deposition is less significant than dry deposition, whereas the opposite is true for the other radionuclides of interest. The washout ratio for I-129 is much lower than that for the other radionuclides (1.6e5 vs. 5.5e6), and the dry deposition velocity for I-129 is higher (7.5e-3 m s^{-1} vs. 1.4E-3 m s^{-1}).

For many of the daughter radionuclides, the highest predicted soil concentrations are for the combination of Farm A and release from B300. However, the soil concentrations of the daughters are several orders of magnitude lower than those of the parents, so they can be ignored.

In summary, based on the results of the screening calculations in the 2016 DRL [1], detailed dose calculations were required for only three combinations of potential critical group and release locations: Farm F and B100 for HTO, Farm A and B200 for radionuclides other than HTO, and Farm A and the WMA for radionuclides other than HTO. However, based on the results of the screening calculations, detailed dose calculations need to be revised for the combination of Farm A and the WMA (using the ILLTS geometry) for all radionuclides with the addition of HTO. Since Farm A has been determined previously to be the bounding critical group for all radionuclides released from the WMA, and since seven radionuclides introduced in 2020 are only releasing from WMA, further screening to determine the bounding critical group was not required.

Table 23: Predicted soil concentrations (Bq kg^{-1}dw) at potential critical group locations as a result of the unit release of radionuclide (1 Bq s^{-1}) to the atmosphere at a release location.

Radionuclide	Release from B100				Release from B200				Release from B300				Release from WMA			
	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F	Farm A	Farm D	Farm E*	Farm F
Am-243	5.97E-03	9.99E-03	6.93E-04	7.01E-03	2.43E-02	2.05E-02	2.97E-03	2.30E-02	2.33E-02	2.07E-02	4.17E-03	2.22E-02	**2.85E-02****	**7.56E-03**	**5.57E-04**	**1.56E-02**
Np-239d	6.42E-09	9.88E-09	2.80E-10	5.82E-09	5.12E-08	4.11E-08	2.69E-09	4.20E-08	5.20E-08	3.92E-08	3.04E-09	4.17E-08	**4.72E-08**	**2.33E-08**	**1.21E-09**	**3.02E-08**
Pu-239dd	3.27E-14	4.54E-14	5.48E-16	2.43E-14	4.20E-13	3.25E-13	9.55E-15	3.07E-13	4.48E-13	2.94E-13	8.82E-15	3.13E-13	**3.03E-13**	**2.85E-13**	**1.04E-14**	**2.27E-13**
Ce-144	1.37E-04	2.30E-04	1.60E-05	1.61E-04	5.59E-04	4.73E-04	6.84E-05	5.30E-04	5.36E-04	4.77E-04	9.61E-05	5.11E-04	**6.57E-04**	**1.74E-04**	**1.28E-05**	**3.60E-04**
Pr-144d	3.57E-09	5.75E-09	2.18E-10	3.58E-09	2.05E-08	1.69E-08	1.71E-09	1.83E-08	2.00E-08	1.67E-08	2.10E-09	1.78E-08	**2.22E-08**	**6.85E-09**	**4.68E-10**	**1.29E-08**
Cs-137	3.43E-03	5.74E-03	3.98E-04	4.03E-03	1.39E-02	1.18E-02	1.71E-03	1.32E-02	1.34E-02	1.19E-02	2.40E-03	1.27E-02	**1.64E-02**	**4.35E-03**	**3.20E-04**	**8.98E-03**
Ba-137md	8.48E-10	1.41E-09	8.64E-11	9.80E-10	3.49E-09	2.95E-09	4.20E-10	3.31E-09	3.35E-09	2.98E-09	5.81E-10	3.19E-09	**4.10E-09**	**1.09E-09**	**8.02E-11**	**2.25E-09**
I-129	2.45E-03	2.53E-03	1.93E-04	3.10E-03	1.00E-02	5.16E-03	7.91E-04	9.88E-03	9.38E-03	5.49E-03	1.15E-03	9.76E-03	**9.20E-03**	**1.56E-03**	**1.25E-04**	**4.88E-03**
Np-237	4.85E-03	8.10E-03	5.62E-04	5.69E-03	1.97E-02	1.67E-02	2.41E-03	1.87E-02	1.89E-02	1.68E-02	3.39E-03	1.80E-02	**2.31E-02**	**6.14E-03**	**4.52E-04**	**1.27E-02**
Pa-233d	6.44E-09	9.91E-09	2.80E-10	5.83E-09	5.15E-08	4.13E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.74E-08**	**2.35E-08**	**1.21E-09**	**3.04E-08**
Pu-238	4.87E-03	8.15E-03	5.66E-04	5.72E-03	1.98E-02	1.68E-02	2.43E-03	1.88E-02	1.90E-02	1.69E-02	3.41E-03	1.81E-02	**2.33E-02**	**6.18E-03**	**4.55E-04**	**1.28E-02**
U-234d	8.82E-13	1.36E-12	3.84E-14	7.99E-13	7.06E-12	5.66E-12	3.69E-13	5.79E-12	7.17E-12	5.40E-12	4.18E-13	5.75E-12	**6.49E-12**	**3.22E-12**	**1.66E-13**	**4.16E-12**
Pu-241	2.17E-03	3.63E-03	2.52E-04	2.55E-03	8.84E-03	7.47E-03	1.08E-03	8.38E-03	8.47E-03	7.54E-03	1.52E-03	8.07E-03	**1.04E-02**	**2.75E-03**	**2.03E-04**	**5.69E-03**
Am-241d	4.83E-10	7.43E-10	2.10E-11	4.37E-10	3.86E-09	3.10E-09	2.02E-10	3.17E-09	3.92E-09	2.96E-09	2.29E-10	3.15E-09	**3.55E-09**	**1.76E-09**	**9.10E-11**	**2.28E-09**
Sb-125	4.77E-04	7.98E-04	5.54E-05	5.60E-04	1.94E-03	1.64E-03	2.37E-04	1.84E-03	1.86E-03	1.66E-03	3.34E-04	1.77E-03	**2.28E-03**	**6.05E-04**	**4.45E-05**	**1.25E-03**
Te-125md	6.43E-09	9.90E-09	2.80E-10	5.83E-09	5.15E-08	4.12E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.73E-08**	**2.35E-08**	**1.21E-09**	**3.03E-08**
Sr-90	3.12E-03	5.22E-03	3.62E-04	3.66E-03	1.27E-02	1.07E-02	1.55E-03	1.20E-02	1.22E-02	1.08E-02	2.18E-03	1.16E-02	**1.49E-02**	**3.95E-03**	**2.91E-04**	**8.17E-03**
Y-90d	6.42E-09	9.89E-09	2.80E-10	5.82E-09	5.13E-08	4.11E-08	2.69E-09	4.21E-08	5.21E-08	3.93E-08	3.04E-09	4.18E-08	**4.72E-08**	**2.33E-08**	**1.21E-09**	**3.03E-08**
U-235	5.95E-03	9.94E-03	6.90E-04	6.98E-03	2.42E-02	2.04E-02	2.96E-03	2.29E-02	2.32E-02	2.06E-02	4.16E-03	2.21E-02	**2.84E-02**	**7.53E-03**	**5.55E-04**	**1.56E-02**
Th-231d	6.39E-09	9.84E-09	2.79E-10	5.80E-09	5.09E-08	4.08E-08	2.68E-09	4.18E-08	5.16E-08	3.90E-08	3.04E-09	4.15E-08	**4.69E-08**	**2.31E-08**	**1.20E-09**	**3.00E-08**
U-238	5.95E-03	9.94E-03	6.90E-04	6.98E-03	2.42E-02	2.04E-02	2.96E-03	2.29E-02	2.32E-02	2.06E-02	4.16E-03	2.21E-02	**2.84E-02**	**7.53E-03**	**5.55E-04**	**1.56E-02**
Th-234d	6.44E-09	9.91E-09	2.80E-10	5.83E-09	5.15E-08	4.13E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.74E-08**	**2.35E-08**	**1.21E-09**	**3.04E-08**
Pa-234mdd	2.04E-13	3.12E-13	7.95E-15	1.81E-13	1.68E-12	1.35E-12	8.43E-14	1.37E-12	1.71E-12	1.28E-12	9.37E-14	1.37E-12	**1.54E-12**	**7.76E-13**	**3.97E-14**	**9.91E-13**
Zn-65	1.18E-04	1.97E-04	1.37E-05	1.38E-04	4.80E-04	4.06E-04	5.87E-05	4.55E-04	4.60E-04	4.09E-04	8.25E-05	4.38E-04	**5.64E-04**	**1.49E-04**	**1.10E-05**	**3.09E-04**

* The values listed for Farm E are the predicted concentrations multiplied by a factor of 0.08 to account for the limited occupancy.

** Yellow shading indicates the highest concentrations for each radionuclide.

11. DRL RESULTS

11.1 Summary of Results

For each effluent type, the DRL for a given radionuclide was calculated from:

$$DRL_i = \frac{DL_{eff}}{D_i} \tag{2}$$

where: DRL_i is the derived release limit for radionuclide i (Bq s^{-1}), DL_{eff} is the annual effective dose limit for members of the public (0.001 Sv a^{-1}), D_i is the dose rate per unit release rate ((Sv a^{-1})/(Bq s^{-1})) for radionuclide i, summed over all applicable exposure pathways, for the age class leading to the highest dose.

The calculated DRLs for each radionuclide are summarized in Table 24 and Table 25 for airborne and liquid effluents, respectively. For airborne effluents, the DRLs are expressed on a weekly basis and for liquid effluents they are expressed on a monthly basis. The tables also provide information on the bounding age classes, the dominant exposure pathways and the percent contributions from the dominant pathways to the total dose rates.

Table 24: DRLs for airborne effluents released from WL.

Radionuclide (and daughters)	DRL (Bq week^{-1})	Bounding Release Location	Bounding Critical Group	Bounding Age Class*	Dominant Pathway**	Percent Contribution from Dominant Pathway to Total Dose Rate
Ac-227#	3.80E+08	WMA	Farm A	Child-10y	AI	90
Am-241	2.07E+09	B200	Farm A	Adult	AI	92
Am-243 (Np-239d, Pu-239dd)	2.04E+09	B200	Farm A	Adult	AI	89
C-14 (CO_2)	8.61E+11	B200	Farm A	1y CMDI	TAMM	97
Ce-144 (Pr-144d)	3.52E+11	B200	Farm A	1y CMDI	TP	45
Cm-244	3.20E+09	B200	Farm A	Child-5y	AI	96
Co-60	1.78E+10	WMA	Farm A	1y CMDI	SLE	83
Cs-134	1.36E+10	WMA	Farm A	Adult	TAMM	78
Cs-137 (Ba-137md)	1.48E+10	WMA	Farm A	Adult	TAMM	65
Eu-152	1.96E+10	WMA	Farm A	3mo NI	SLE	98
Eu-154	2.53E+10	WMA	Farm A	3mo NI	SLE	97
Eu-155#	8.13E+11	WMA	Farm A	3mo NI	SLE	84
Fe-55	1.74E+12	B200	Farm A	3mo NI	TAMM	74
HTO †	1.65E+15	B100	Farm F	Adult	WI	39
HTO †	5.61E+14	WMA	Farm A	Adult	WI	39
I-129	4.71E+08	B200	Farm A	1y CMDI	TAMM	98
Kr-85#	3.83E+15	WMA	Farm A	Skin	AE	100
Mn-54	3.05E+11	WMA	Farm A	1y CMDI	SLE	83
Nb-94	4.95E+09	WMA	Farm A	1y CMDI	SLE	100
Ni-63	1.50E+11	WMA	Farm A	1y CMDI	TAMM	97
Np-237 (Pa-233d)	1.63E+09	WMA	Farm A	3mo FMDI	WI	78
Pm-147	5.18E+12	B200	Farm A	3mo NI	TAMM	47
Pu-238 (U-234d)	1.89E+09	B200	Farm A	Adult	AI	92
Pu-239	1.73E+09	B200	Farm A	Adult	AI	92
Pu-240	1.74E+09	B200	Farm A	Adult	AI	92
Pu-241 (Am-241d)	9.60E+10	B200	Farm A	Adult	AI	92
Pu-242	1.80E+09	B200	Farm A	Adult	AI	92
Ra-226#	1.02E+09	WMA	Farm A	Skin	SLE	100
Sb-125 (Te-125md)	2.03E+11	WMA	Farm A	1y CMDI	SLE	92
Sm-151#	1.34E+13	WMA	Farm A	1y CMDI	AI	46
Sr-90 (Y-90d)	6.79E+09	WMA	Farm A	3mo NI	TAMM	81
Tc-99	1.18E+11	WMA	Farm A	3mo FMDI	WI	86
Th-228(Ra-224d)#	1.59E+09	WMA	Farm A	Child-5y	AI	96
U-233(Th-229d, Ra-225dd)#	4.85E+09	WMA	Farm A	3mo FMDI	TAMM	84
U-234	4.78E+09	B200	Farm A	3mo FMDI	TAMM	84
U-235 (Th-231d)	4.67E+09	B200	Farm A	3mo FMDI	TAMM	78
U-238 (Th-234d, Pa-234mdd)	4.92E+09	B200	Farm A	3mo FMDI	TAMM	80
Zn-65	1.97E+10	WMA	Farm A	1y CMDI	TAMM	94

† For all radionuclides, except HTO, there is only one DRL. For HTO, there are two separate DRLs, one for releases from B100 and one for the WMA.

For these radionuclides, DRLs are for releases from WMA only.

*** Acronyms for Age Class:**

1y CMDI: 1-year-old cow-milk-drinking infant

3mo NI: 3-month-old nursing infant

3mo FMDI: 3-month-old formula-milk-drinking infant

**** Acronyms for Pathway:**

AI: air (inhalation)

AE: air (external)

TAMM: terrestrial animals + mother's milk (ingestion)

TP: terrestrial plants (ingestion)

SLE: soil external (groundshine)

WI: water (ingestion)

Table 25: DRLs for liquid effluents released from WL.

Radionuclide (and daughters)	DRL (Bq month^{-1})	Bounding Critical Group	Bounding Age Class*	Dominant Pathway**	Percent Contribution from Dominant Pathway to Total Dose Rate
Am-241	1.04E+09	Farm A	3mo FMDI	WI	74
Am-243 (Np-239d, Pu-239dd)	1.04E+09	Farm A	3mo FMDI	WI	72
C-14	7.67E+10	Farm A	3mo NI	TAMM	89
Ce-144 (Pr-144d)	6.50E+10	Farm A	3mo FMDI	WI	82
Cm-244	1.08E+09	Farm A	3mo FMDI	WI	60
Co-60	2.09E+10	Farm A	3mo FMDI	SLE	69
Cs-134	8.94E+09	Farm A	Adult	FI	73
Cs-137 (Ba-137md)	1.16E+10	Farm A	Adult	FI	65
Eu-152	2.37E+10	Farm A	3mo FMDI	SLE	84
Eu-154	2.78E+10	Farm A	3mo FMDI	SLE	75
Fe-55	6.05E+11	Farm A	3mo FMDI	WI	88
HTO	6.80E+13	Farm A	3mo FMDI	WI	91
I-129	8.94E+09	Farm A	Child-10y	WI	48
Mn-54	2.41E+11	Farm A	3mo FMDI	SLE	46
Nb-94	6.59E+09	Farm A	3mo FMDI	SLE	94
Ni-63	1.09E+12	Farm A	1y CMDI	TAMM	87
Np-237 (Pa-233d)	2.40E+09	Farm A	3mo FMDI	WI	92
Pm-147	1.37E+12	Farm A	3mo FMDI	WI	94
Pu-238 (U-234d)	1.16E+09	Farm A	3mo FMDI	WI	89
Pu-239	1.11E+09	Farm A	3mo FMDI	WI	89
Pu-240	1.11E+09	Farm A	3mo FMDI	WI	89
Pu-241 (Am-241d)	8.32E+10	Farm A	3mo FMDI	WI	89
Pu-242	1.16E+09	Farm A	3mo FMDI	WI	89
Sb-125 (Te-125md)	1.71E+11	Farm A	3mo FMDI	SLE	54
Sr-90 (Y-90d)	1.30E+10	Farm A	3mo NI	TAMM	80
Tc-99	4.38E+11	Farm A	3mo FMDI	WI	84
U-234	1.34E+10	Farm A	3mo FMDI	WI	95
U-235 (Th-231d)	1.17E+10	Farm A	3mo FMDI	WI	78
U-238 (Th-234d, Pa-234mdd)	1.25E+10	Farm A	3mo FMDI	WI	82
Zn-65	3.29E+10	Farm A	Adult	FI	79

*** Acronyms for Age Class:**

3mo FMDI: 3-month-old formula-milk-drinking infant

3mo NI: 3-month-old nursing infant

1y CMDI: 1-year-old cow-milk-drinking infant

**** Acronyms for Pathway:**

WI: water (ingestion)

TAMM: terrestrial animals + mother's milk (ingestion)

SLE: soil external (groundshine)

FI: fish (ingestion)

11.2 Evaluation of Results

For airborne effluents, B200 is the bounding release location for sixteen of the thirty radionuclides. The WMA is the bounding release location for all others, except for HTO, released from B100. The adult is the bounding age class for eleven radionuclides, with air inhalation being the dominant pathway for seven of these. For all other radionuclides, except one, infant age classes are bounding with ingestion of terrestrial animal products and mother's milk being the dominant pathway for half of these.

For liquid effluents, there are no changes from the 2016 DRLs [1]. The 3-month-old formula-milk-drinking infant is the bounding age class for twenty-three radionuclides, with water ingestion being the dominant pathway for seventeen of these and groundshine being the dominant pathway for the remainder.

11.3 Facility DRLs

The DRL values calculated in Table 24and Table 25 are intended to be applied directly to all nuclear facilities at WL. For air effluents, staff should use the DRLs in Table 24. For liquid effluents, facilities that release activity to the Winnipeg River should use the DRLs in the liquid effluent table (Table 25). These liquid effluent DRLs can also be used in assessing releases from other liquid discharge points (storm water runoff, internal effluent discharges to the process drain) that discharge into the Winnipeg River.

Where effluent monitoring is carried out using gross parameters (i.e., gross beta and gross alpha activity), the DRL (Table 26) for the most limiting, and likely to be present, radionuclide in the mixture should be applied to the gross parameter. The radionuclide for gross alpha for airborne emissions is Pu-239 and for gross beta is Sr-90. For liquid emissions the isotope for gross alpha activity is Pu-238 (most limiting and occasionally detected) and for gross beta is Sr-90.

Table 26: DRL values for gross parameters.

Release Type	Gross Parameter	Limiting Nuclide	Release Limit
Airborne – Stack Emissions	Gross Beta	Sr-90	6.79E+09 Bq/wk
	Gross Alpha	Pu-239/240	1.73E+09 Bq/wk
Liquid – Process Outfall and Sewage Lagoon	Gross Beta	Sr-90	1.30E+10 Bq/mo
	Gross Alpha	Pu-238	1.16E+09 Bq/mo

12. VERIFICATION

In the 2016 DRL [1], the analysis assumptions, the selection of input parameter values, the contents of IMPACT code input files and the determination of DRLs were verified in several ways. Draft assumptions and the selection of some key input parameter values were reviewed by appropriate CNL staff prior to the start of calculations. As the DRL results were generated, those for selected radionuclides (C-14, Co-60, Cs-134, Cs-137 (Ba-137m), HTO (OBT), I-129, Pu-239, Sr-90 (Y-90) and Ce-144 (Pr-144)) were checked using the independent code CSA-DRL. Finally, the assumptions, input files and calculated DRLs were independently verified through a comprehensive internal CNL review [32].

The initial checking using the CSA-DRL code did not identify any problems with the results generated using the IMPACT code. The final CNL verification identified two errors with the selection of input parameter values, one of which was significant. This review also identified one minor transcription error in the input files. These errors were subsequently corrected.

Subsequently, it was realized by the authors that there was an error in the screening calculations. This was corrected, although it did not significantly change the results.

In the current assessment, all the changes relating to the airborne effluent DRL calculations were made by Sohan Chouhan and independently verified by Bruce Reavie and Lisa Campagna [33] to ensure that they were successfully transcribed into the IMPACT code [4]. Compilations of the IMPACT results into the summary DRLs were also verified.

The DRLs for seven additional radionuclides introduced in 2020 were calculated by Sohan Chouhan and independently verified by Karen Ross [34].

12.1 Sample Calculations

These DRLs were additionally verified by performing sample calculations (details in Appendix B) for the most limiting, and likely to be present, radionuclide for airborne (Sr-90) and liquid (Pu-238) releases.

13. COMPARISON OF REVISED DRLS WITH PREVIOUS VALUES

The revised DRLs have been compared with those established in 2016 [1]. Reasons for the differences were mentioned briefly in Section 1 and Section 6 of this report.

In summary, for 12 radionuclides from airborne effluents, the revised DRLs are approximately 2% lower than the 2016 DRLs [1]. For one radionuclide (Zn-65), the bounding release location changed from B200 to the WMA and the magnitude of the DRL was lowered by 1%. The main reason for the decreases in the DRLs is the introduction of the three new systems (SWRS, BWRS/SCU and ILLTS) in the WMA, which resulted in lowering the effective release height. A new DRL was added for HTO released from the WMA (5.61E+14 Bq week^{-1}) and the previous DRL for HTO released from B100 (1.65E+15 Bq week $^{-1}$) [1] is still valid. DRLs were calculated for seven additional potential radionuclides in airborne effluent released from WMA.

There is no change to the liquid effluent DRLs.

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APPENDIX A TRIPLE JOINT FREQUENCY DISTRIBUTION OF WIND SPEED, WIND DIRECTION AND STABILITY CLASS

Table 27: Triple joint frequency distribution data obtained at the 6-m level.

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
N	A	0.00536	0.002556	0.000887	0.000103	0.000062	0
NNE	A	0.002948	0.001237	0.000371	0.000041	0.000021	0
NE	A	0.001649	0.000598	0.000392	0.000082	0	0
ENE	A	0.001567	0.00066	0.00033	0.000021	0	0
ENE	A	0.001835	0.000845	0.00035	0.000021	0	0
ESE	A	0.002165	0.000474	0.000186	0.000041	0	0
SE	A	0.002783	0.000763	0.000247	0	0.000021	0
SSE	A	0.003381	0.000825	0.000206	0.000041	0.000021	0
S	A	0.004371	0.001134	0.000206	0.000021	0	0
SSW	A	0.004165	0.001299	0.000227	0.000041	0	0
SW	A	0.004494	0.001567	0.000515	0.000062	0	0
WSW	A	0.00369	0.001587	0.000763	0.000103	0.000021	0.000021
W	A	0.003525	0.001814	0.000969	0.000227	0.000062	0.000103
WNW	A	0.002618	0.001237	0.00099	0.000309	0.000206	0.000124
NW	A	0.004247	0.002433	0.001587	0.000536	0.000268	0.000165
NNW	A	0.005298	0.002783	0.001258	0.000412	0.000082	0.000041
N	B	0.005855	0.004865	0.004	0.001567	0.000618	0.000309
NNE	B	0.002082	0.001794	0.001051	0.000371	0.000103	0
NE	B	0.001319	0.00099	0.000515	0.000309	0.000041	0.000021
ENE	B	0.001031	0.000433	0.000412	0.000103	0.000041	0
ENE	B	0.000825	0.000639	0.000598	0.000206	0.000062	0
ESE	B	0.001464	0.000866	0.000618	0.000247	0.000041	0
SE	B	0.002515	0.001752	0.001072	0.000206	0.000041	0.000021
SSE	B	0.002598	0.001876	0.001051	0.000268	0.000021	0
S	B	0.005195	0.003567	0.001855	0.000907	0.000247	0.000021
SSW	B	0.004927	0.00503	0.002103	0.000639	0.000062	0
SW	B	0.004639	0.003484	0.001464	0.00033	0.000062	0
WSW	B	0.003381	0.002453	0.00134	0.000515	0.000082	0.000041
W	B	0.002247	0.001443	0.001361	0.001113	0.000289	0.000082
WNW	B	0.001732	0.001691	0.00202	0.001505	0.000742	0.00033
NW	B	0.004247	0.00367	0.004391	0.003072	0.002185	0.001443
NNW	B	0.007236	0.006989	0.006721	0.004783	0.002144	0.00099
N	C	0.010721	0.006948	0.004762	0.002082	0.000536	0.000392
NNE	C	0.005484	0.004618	0.002783	0.001319	0.000474	0.000206
NE	C	0.002041	0.002371	0.001402	0.000928	0.000289	0.000021
ENE	C	0.002474	0.001278	0.000804	0.000495	0.000186	0
ENE	C	0.00167	0.001773	0.00202	0.000928	0.000227	0.000041
ESE	C	0.003257	0.002433	0.002474	0.001134	0.000289	0.000021

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	**2 to 3 m/s**	**3 to 4 m/s**	**4 to 5 m/s**	**5 to 6 m/s**	**>6 m/s**
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
SE	C	0.005505	0.00501	0.00402	0.002144	0.000825	0.000144
SSE	C	0.008638	0.009648	0.007855	0.004206	0.001113	0.00035
S	C	0.013009	0.009669	0.007628	0.002928	0.000763	0.000021
SSW	C	0.012906	0.004371	0.001402	0.000144	0.000021	0
SW	C	0.009917	0.003958	0.002206	0.000536	0.00033	0.000041
WSW	C	0.005546	0.004783	0.002866	0.001464	0.000701	0.00035
W	C	0.003773	0.003567	0.004288	0.002763	0.001691	0.001175
WNW	C	0.003299	0.002886	0.003628	0.003938	0.003051	0.004288
NW	C	0.00703	0.005422	0.006164	0.00635	0.005546	0.005999
NNW	C	0.010473	0.007463	0.005298	0.003134	0.001361	0.000742
N	D	0.005752	0.001216	0.000495	0.000309	0.000124	0.000041
NNE	D	0.004268	0.002185	0.000763	0.000371	0.000227	0.000021
NE	D	0.001608	0.002123	0.001464	0.000866	0.000763	0.00035
ENE	D	0.003154	0.002206	0.001196	0.000577	0.000103	0.000082
ENE	D	0.004577	0.00468	0.00369	0.001072	0.00035	0.000289
ESE	D	0.006391	0.004103	0.002845	0.001155	0.00033	0.000041
SE	D	0.008494	0.006577	0.003938	0.001587	0.000371	0
SSE	D	0.015174	0.015091	0.009071	0.004082	0.000969	0.000165
S	D	0.017751	0.006494	0.003505	0.000598	0.000082	0.000021
SSW	D	0.005999	0.000186	0	0	0	0
SW	D	0.006577	0.000577	0.000227	0.000041	0	0
WSW	D	0.007628	0.003814	0.001423	0.000928	0.000289	0.000433
W	D	0.006102	0.007175	0.006206	0.003649	0.002082	0.001402
WNW	D	0.002742	0.003051	0.003381	0.002783	0.001484	0.001711
NW	D	0.004144	0.002144	0.002845	0.003031	0.002288	0.002206
NNW	D	0.005608	0.001587	0.000845	0.000392	0.000247	0.000227
N	E	0.003196	0.000495	0.000845	0.000639	0.000433	0.000103
NNE	E	0.001051	0.000082	0.000021	0	0	0
NE	E	0.000866	0.000186	0.000124	0	0	0
ENE	E	0.002474	0.000309	0.000041	0	0	0
ENE	E	0.004103	0.000804	0.000041	0	0	0
ESE	E	0.004618	0.000577	0.000082	0.000021	0	0
SE	E	0.005731	0.000887	0.000268	0.000082	0.000021	0
SSE	E	0.008329	0.001484	0.000412	0.000041	0	0
S	E	0.010741	0.000227	0	0	0	0
SSW	E	0.005237	0.000021	0	0	0	0
SW	E	0.004845	0.000021	0	0	0	0
WSW	E	0.004927	0.00035	0.000124	0.000041	0.000021	0
W	E	0.003587	0.001299	0.00101	0.000144	0.000103	0.000021
WNW	E	0.001876	0.000454	0.000144	0.000103	0.000082	0.000144
NW	E	0.001876	0.000041	0	0	0	0
NNW	E	0.002618	0.000124	0	0	0	0.000021

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
N	F	0.005711	0.000309	0.000186	0.000082	0	0.000021
NNE	F	0.002227	0	0	0	0	0
NE	F	0.001464	0	0	0	0	0
ENE	F	0.002206	0	0	0	0	0
ENE	F	0.003628	0.000021	0	0	0	0
ESE	F	0.005855	0.000021	0	0	0	0
SE	F	0.010143	0	0.000062	0	0	0
SSE	F	0.01004	0.000062	0.000062	0.000041	0.000021	0.000021
S	F	0.014514	0.000124	0.000021	0	0	0
SSW	F	0.013792	0	0	0	0	0
SW	F	0.014225	0.000124	0	0	0	0
WSW	F	0.011772	0	0	0	0	0
W	F	0.009875	0	0.000021	0.000021	0.000041	0.000021
WNW	F	0.007257	0.000041	0.000041	0.000082	0.000062	0.000021
NW	F	0.00635	0	0	0	0	0
NNW	F	0.006123	0.000021	0	0	0	0

Table 28: Triple joint frequency distribution data obtained at the 25-m level.

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
N	A	0.002515	0.001718	0.000736	0.000245	0.000082	0.000102
NNE	A	0.001411	0.000634	0.000368	0.000143	0.000102	0
NE	A	0.001043	0.000409	0.000286	0.000123	0.000061	0
ENE	A	0.001043	0.000491	0.000225	0.000061	0.000061	0
ENE	A	0.001268	0.000757	0.000348	0.000164	0.00002	0
ESE	A	0.001043	0.000573	0.000389	0.000061	0	0
SE	A	0.001636	0.000634	0.000123	0.000041	0.000061	0.00002
SSE	A	0.001902	0.00092	0.000429	0.000143	0.000041	0
S	A	0.001984	0.000838	0.000348	0.000164	0.000061	0.000041
SSW	A	0.002413	0.000777	0.000348	0.000184	0.000041	0.000041
SW	A	0.002208	0.001043	0.000348	0.000204	0.000041	0.000123
WSW	A	0.0018	0.000716	0.000716	0.000123	0.000061	0.000102
W	A	0.002147	0.001084	0.000941	0.000368	0.000164	0.000204
WNW	A	0.00182	0.000757	0.000838	0.00047	0.000184	0.000225
NW	A	0.002249	0.001104	0.000798	0.000491	0.000184	0.000143
NNW	A	0.002945	0.001431	0.000675	0.000245	0.000164	0.000204
N	B	0.001963	0.002597	0.001145	0.000777	0.000204	0.00002
NNE	B	0.000941	0.000982	0.000654	0.000164	0.000082	0
NE	B	0.000859	0.000695	0.000654	0.000184	0.000061	0.00002
ENE	B	0.000838	0.000552	0.000389	0.000225	0	0
ENE	B	0.000552	0.00047	0.000429	0.000245	0.00002	0
ESE	B	0.000654	0.000573	0.000327	0.000184	0.000082	0.00002
SE	B	0.001288	0.000777	0.000552	0.000204	0.000102	0
SSE	B	0.00135	0.000982	0.000491	0.000286	0.000143	0.00002
S	B	0.002024	0.001063	0.000634	0.000511	0.000266	0.000143
SSW	B	0.001922	0.001247	0.001125	0.000818	0.000348	0.000184
SW	B	0.001636	0.001247	0.001534	0.000777	0.000286	0.000123
WSW	B	0.00137	0.001329	0.001043	0.000757	0.000348	0.000348
W	B	0.001309	0.000961	0.001043	0.000798	0.000327	0.000245
WNW	B	0.001513	0.000818	0.001104	0.0009	0.00045	0.000348
NW	B	0.001615	0.001125	0.001309	0.001206	0.000941	0.000613
NNW	B	0.002086	0.002352	0.001575	0.000818	0.000593	0.000511
N	C	0.003619	0.00638	0.005726	0.00499	0.003026	0.002699
NNE	C	0.001615	0.002536	0.001963	0.00135	0.000695	0.00047
NE	C	0.00182	0.001636	0.001309	0.0009	0.000348	0.000204
ENE	C	0.001493	0.001022	0.000777	0.000654	0.000348	0.000041
ENE	C	0.001288	0.000982	0.001268	0.000941	0.000368	0.000245
ESE	C	0.001575	0.001677	0.001043	0.000859	0.000654	0.000266
SE	C	0.003006	0.002372	0.002045	0.001738	0.000695	0.000409
SSE	C	0.003047	0.003517	0.003619	0.003026	0.002311	0.001227
S	C	0.00454	0.004315	0.004499	0.003742	0.002454	0.001922

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	**2 to 3 m/s**	**3 to 4 m/s**	**4 to 5 m/s**	**5 to 6 m/s**	**>6 m/s**
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
SSW	C	0.003844	0.003742	0.004744	0.003824	0.002842	0.002045
SW	C	0.003865	0.003415	0.003354	0.00272	0.002045	0.001411
WSW	C	0.002393	0.002352	0.002208	0.001902	0.000859	0.00135
W	C	0.003026	0.001881	0.00272	0.002127	0.001227	0.002127
WNW	C	0.002699	0.002147	0.001963	0.00227	0.001984	0.003211
NW	C	0.003497	0.003129	0.004253	0.003804	0.003988	0.006441
NNW	C	0.005419	0.007014	0.007341	0.008364	0.007341	0.010265
N	D	0.006973	0.009141	0.006728	0.004887	0.002311	0.002086
NNE	D	0.002495	0.00503	0.005071	0.002147	0.001452	0.001125
NE	D	0.002924	0.003599	0.003354	0.002147	0.001247	0.001431
ENE	D	0.002904	0.004253	0.00274	0.001595	0.0009	0.000389
ENE	D	0.002433	0.003456	0.00411	0.003476	0.001902	0.001145
ESE	D	0.003988	0.005337	0.004785	0.003149	0.00135	0.000757
SE	D	0.005174	0.006666	0.008282	0.005705	0.003558	0.002045
SSE	D	0.004744	0.01094	0.018261	0.018241	0.013374	0.009325
S	D	0.007178	0.011922	0.009611	0.006891	0.003231	0.001697
SSW	D	0.00499	0.005992	0.005726	0.003395	0.001206	0.000675
SW	D	0.00499	0.005705	0.00454	0.002945	0.001922	0.001677
WSW	D	0.004642	0.004213	0.005071	0.003538	0.002249	0.003088
W	D	0.004192	0.004417	0.00548	0.005215	0.003517	0.005092
WNW	D	0.003333	0.003108	0.004335	0.004785	0.003313	0.006687
NW	D	0.003211	0.004458	0.004785	0.005726	0.005808	0.011615
NNW	D	0.006585	0.008814	0.006421	0.004785	0.003906	0.004233
N	E	0.003865	0.003517	0.002208	0.000777	0.000184	0.000143
NNE	E	0.002536	0.002106	0.000941	0.000061	0.00002	0
NE	E	0.001022	0.001022	0.000634	0.000061	0.000061	0.000041
ENE	E	0.001738	0.001452	0.000941	0.000225	0.000041	0
ENE	E	0.002352	0.002413	0.00182	0.000757	0.000061	0
ESE	E	0.002495	0.003067	0.00137	0.000409	0.000041	0
SE	E	0.003967	0.004172	0.001227	0.000204	0.000041	0.000041
SSE	E	0.004213	0.00638	0.006176	0.003088	0.001063	0.000225
S	E	0.004621	0.007239	0.003517	0.000716	0.000286	0.000082
SSW	E	0.002515	0.002699	0.001166	0.000286	0.000061	0
SW	E	0.002474	0.001534	0.001186	0.000204	0	0
WSW	E	0.002168	0.001186	0.001247	0.000634	0.000204	0.000204
W	E	0.00274	0.002372	0.002842	0.001493	0.000695	0.000327
WNW	E	0.001513	0.001472	0.001718	0.001513	0.000757	0.000777
NW	E	0.001922	0.000654	0.000573	0.000409	0.000327	0.000164
NNW	E	0.00364	0.003006	0.00092	0.000286	0.000061	0.000061
N	F	0.002536	0.000879	0.00047	0	0	0
NNE	F	0.001166	0.000204	0.00002	0	0	0
NE	F	0.001227	0.00002	0.00002	0	0	0

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	**2 to 3 m/s**	**3 to 4 m/s**	**4 to 5 m/s**	**5 to 6 m/s**	**>6 m/s**
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
ENE	F	0.001125	0.000082	0.000061	0	0	0
ENE	F	0.001329	0.00045	0.000368	0	0	0
ESE	F	0.001391	0.000389	0.000102	0	0	0
SE	F	0.002413	0.000593	0	0	0	0
SSE	F	0.002352	0.000961	0.000532	0.00002	0	0
S	F	0.002045	0.001002	0.000368	0.000041	0	0
SSW	F	0.001452	0.000204	0.00002	0	0	0
SW	F	0.002208	0.000123	0.00002	0	0	0
WSW	F	0.001738	0.000082	0.000082	0	0	0
W	F	0.002188	0.000164	0.000061	0.00002	0	0
WNW	F	0.00184	0.000102	0.000184	0.00002	0	0
NW	F	0.00182	0.00002	0	0	0	0
NNW	F	0.002393	0.000307	0.000266	0	0	0

APPENDIX B SAMPLE CALCULATIONS FOR THE MOST LIMITING, AND LIKELY TO BE PRESENT, RADIONUCLIDE FOR AIRBORNE AND LIQUID RELEASES

This appendix demonstrates the accuracy of WL DRL calculation via sample calculation done for the most limiting, and likely to be present, radionuclide for airborne (Sr-90) and liquid releases (Pu-238).

This sample calculation scenarios are consistent with all the information discussed in the report and the results given in Table 24and Table 25; therefore, only illustrative points are mentioned below.

Most of the acronyms used in Table 29and Table 30 are same as those defined in Table 12 and Table 13, but some additional ones are: **w** well, **p** pond, **frg** forage, **frt** fruits, **grd** garden vegetables, **ptt** potatoes, **cmlk** cow milk, **bmlk** breast milk, **chkn** chicken, **fwf** freshwater fish, **ar** air, **ih** inhalation, **ig** ingestion, **ex** external, **ef** effective, **wt** Winnipeg River water, **g** ground, **tr** terrestrial, **pl** plant, **an** animal, and **aq** aquatic.

B.1 SAMPLE CALCULATIONS BEHIND THE DRL FOR AIRBORNE EFFLUENT (SR-90) RELEASE FROM WL

When calculating DRLs for Sr-90 (nuclide **A**), the dose contribution from its progeny Y-90 (nuclide **B**) was calculated explicitly in this scenario (Table 29). Any compartment showing negligible concentration or dose (e.g., groundwater well concentration for Y-90) were omitted (along with the corresponding transfer parameter values) from Table 29.

In this scenario, only the bounding release location (WMA), the bounding critical group (Farm A), and the bounding age class (3-month-old nursing infant) were modelled. Full detail of the dominant pathway (terrestrial animal and mother's milk) are available in Table 29, which also contains details of nursing mother's milk calculations.

As shown in the Table 6, for airborne effluents, Farm-A critical group was self-sufficient in all food product except honey, which is produced on Farm D only and supplied to Farm-A critical group. This was accounted by doing separate compartmental concentration and dose calculations at Farm D corresponding to all pathways related to honey, and to the nursing mother's milk, and to dose to a 3-month-old nursing infant.

IMPACT code version 5.4.0 used in the calculation does not provide transfer parameter values, which were obtained using an R&D tool CSA-DRL [19]. This DRL was calculated in both codes (IMPACT and CSA-DRL), both gave the same final DRL value of 6.79E+09 Bq/week. Then the relevant compartmental values and transfer parameter values were outputted from CSA-DRL and populated in Table 29.

Some compartmental concentrations values are intentionally repeated in some rows in Table 29 (and similarly also in Table 30) to make it very intuitive. The dependency between all compartments can be best understood by going from left to right for each compartment and then move sequentially from top to bottom in this table.

The resulting DRL value from this sample calculation table matched exactly with the result of Table 24, and hence verified the accuracy of DRL calculation corresponding to airborne effluents.

Table 29: Airborne release scenario.

Sample calculations for airborne releases shown for parent radionuclide Sr-90 marked as "a" and a progeny radionuclide Y-90 marked as "b"																					
Starting or the first intermediate:				**Second intermediate:**				**Third intermediate:**				**Fourth intermediate:**				**Fifth intermediate:**				**Final:**	
Compartment:		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**	
Name	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**
Compartmental calculations: Critical group A, and food from that location only																					
c_0_a (Bq/s)	**1**	p_01_a	6.99E-07																	c_1_a	6.99E-07
		p_01_b	5.34E-09																	c_1_b	5.34E-09
c_1_a	6.99E-07	p_13_mass_a	2.13E+04																	c_3_mass_a	1.49E-02
c_1_b	5.34E-09	p_13_mass_b	8.84E+00																	c_3_mass_b	4.72E-08
c_1_a	6.99E-07	p_13_area_a	5.98E+06																	c_3_area_a	4.17E+00
c_1_b	5.34E-09	p_13_area_b	2.48E+03																	c_3_area_b	1.32E-05
c_3_area_a	4.17E+00	p_32w_a*	5.23E-13																	c_2w_a	2.18E-12
c_3_area_a	4.17E+00	p_32w_for_pond_a*	3.24E-05																	c_2w_for_pond_a	1.35E-04
c_3_area_b	1.32E-05	p_32w_for_pond_b*	3.57E-06																	c_2w_for_pond_b	4.72E-11
c_1_a	6.99E-07	p_12p_a	4.85E+02	c_2w_for_pond_a	1.35E-04	p_g2p_a**	6.57E-02													c_2p_a	3.48E-04
c_1_b	5.34E-09	p_12p_b	1.15E+00	c_2w_for_pond_b	4.72E-11	p_g2p_b**	1.56E-04													c_2p_b	6.15E-09
c_1_a	6.99E-07	p_14_frg_a	5.89E+03	c_3_mass_a	1.49E-02	p_34_frg_a	1.65E-01													c_4_frg_a	6.58E-03
		p_14_frt_a	2.22E+03			p_34_frt_a	8.70E-02													c_4_frt_a	2.85E-03
		p_14_grd_a	2.22E+03			p_34_grd_a	8.70E-02													c_4_grd_a	2.85E-03
		p_14_ptt_a	1.06E+03			p_34_ptt_a	1.83E-01													c_4_ptt_a	3.46E-03
c_1_b	5.34E-09	p_14_frg_b	1.22E+03	c_3_mass_b	4.72E-08	p_34_frg_b	4.18E-03													c_4_frg_b	6.50E-06
		p_14_frt_b	3.74E+01			p_34_frt_b	2.20E-03													c_4_frt_b	2.00E-07
		p_14_grd_b	3.74E+02			p_34_grd_b	2.20E-03													c_4_grd_b	2.00E-06
		p_14_ptt_b	1.78E+01			p_34_ptt_b	4.62E-03													c_4_ptt_b	9.53E-08
c_1_a	6.99E-07	p_15_CMlk_a	1.58E-01	c_2w_a	2.18E-12	p_25_CMlk_a	3.02E-01	c_3_mass_a	1.49E-02	p_35_CMlk_a	4.36E-03	c_4_frg_a	6.58E-03	p_45_CMlk_a	2.08E-01					c_5_CMlk_a	1.44E-03
		p_15_beef_a	1.66E-01			p_25_beef_a	6.51E-02			p_35_beef_a	2.98E-03			p_45_beef_a	1.46E-01					c_5_beef_a	1.00E-03
		p_15_pork_a	3.14E-01			p_25_pork_a	1.02E-01			p_35_pork_a	5.40E-03			p_45_pork_a	2.61E-01					c_5_pork_a	1.79E-03
		p_15_chkn_a	6.92E-02			p_25_chkn_a	7.60E-03			p_35_chkn_a	1.14E-03			p_45_chkn_a	4.00E-02					c_5_chkn_a	2.80E-04
		p_15_eggs_a	2.46E-01			p_25_eggs_a	2.70E-02			p_35_eggs_a	4.05E-03			p_45_eggs_a	1.42E-01					c_5_eggs_a	9.95E-04
		p_15_deer_a	6.55E-01	c_2p_a	3.48E-04	p_25_deer_a	2.04E-01			p_35_deer_a	1.40E-03			p_45_deer_a	5.26E-01					c_5_deer_a	3.55E-03
c_1_b	5.34E-09	p_15_CMlk_b	3.03E+00					c_3_mass_b	4.72E-08	p_35_CMlk_b	6.32E-05	c_4_frg_b	6.50E-06	p_45_CMlk_b	2.33E-03					c_5_CMlk_b	3.13E-08
		p_15_beef_b	1.25E+02							p_35_beef_b	1.70E-03			p_45_beef_b	6.43E-02					c_5_beef_b	1.09E-06
		p_15_pork_b	5.52E+00							p_35_pork_b	7.20E-05			p_45_pork_b	2.68E-03					c_5_pork_b	4.69E-08
		p_15_chkn_b	1.56E+01							p_35_chkn_b	1.95E-04			p_45_chkn_b	5.28E-03					c_5_chkn_b	1.18E-07
		p_15_eggs_b	4.68E+00							p_35_eggs_b	5.85E-05			p_45_eggs_b	1.58E-03					c_5_eggs_b	3.53E-08
		p_15_deer_b	1.21E+02	c_2p_b	6.15E-09	p_25_deer_b	2.86E-02			p_35_deer_b	1.96E-04			p_45_deer_b	5.69E-02					c_5_deer_b	1.02E-06
c_1_a	6.99E-07	p_15_BMlk_a	4.88E-01	c_2w_a	2.18E-12	p_25_BMlk_a	1.87E-01	c_3_mass_a	1.49E-02	p_35_BMlk_a	2.69E-05	c_4_frt_a	2.85E-03	p_45_frt_BMlk_a	3.76E-02	c_5_CMlk_a	1.44E-03	p_55_CMlk_BMlk_a	3.81E-02	c_5_BMlk_a	6.78E-04
												c_4_grd_a	2.85E-03	p_45_grd_BMlk_a	8.47E-02	c_5_beef_a	1.00E-03	p_55_beef_BMlk_a	2.43E-03		
												c_4_ptt_a	3.46E-03	p_45_ptt_BMlk_a	7.11E-02	c_5_pork_a	1.79E-03	p_55_pork_BMlk_a	2.09E-03		
																c_5_chkn_a	2.80E-04	p_55_chkn_BMlk_a	2.83E-03		
																c_5_eggs_a	9.95E-04	p_55_eggs_BMlk_a	4.31E-03		
																c_5_deer_a	3.55E-03	p_55_deer_BMlk_a	4.87E-03		
c_1_b	5.34E-09	p_15_BMlk_b	1.60E+01					c_3_mass_b	4.72E-08	p_35_BMlk_b	1.91E-07	c_4_frt_b	2.00E-07	p_45_frt_BMlk_b	2.68E-04	c_5_CMlk_b	3.13E-08	p_55_CMlk_BMlk_b	2.71E-04	c_5_BMlk_b	8.69E-08
												c_4_grd_b	2.00E-06	p_45_grd_BMlk_b	6.03E-04	c_5_beef_b	1.09E-06	p_55_beef_BMlk_b	1.73E-05		
												c_4_ptt_b	9.53E-08	p_45_ptt_BMlk_b	5.06E-04	c_5_pork_b	4.69E-08	p_55_pork_BMlk_b	1.48E-05		
																c_5_chkn_b	1.18E-07	p_55_chkn_BMlk_b	2.01E-05		
																c_5_eggs_b	3.53E-08	p_55_eggs_BMlk_b	3.07E-05		
																c_5_deer_b	1.02E-06	p_55_deer_BMlk_b	3.46E-05		
Compartmental calculations: CG_D (honey source for CG A) location																					
		p_01_a	1.16E-07																	c_1_a	1.16E-07
c_0_a	**1**	p_01_b	1.66E-09																	c_1_b	1.66E-09
c_1_a	1.16E-07	p_13_mass_a	3.40E+04																	c_3_mass_a	3.95E-03
c_1_b	1.66E-09	p_13_mass_b	1.41E+01																	c_3_mass_b	2.33E-08
c_1_a	1.16E-07	p_13_area_a	9.51E+06																	c_3_area_a	1.11E+00
c_1_b	1.66E-09	p_13_area_b	3.94E+03																	c_3_area_b	6.53E-06
c_1_a	1.16E-07	p_14_frg_a	7.31E+03	c_3_mass_a	3.95E-03	p_34_frg_a	1.65E-01													c_4_frg_a	1.50E-03
c_1_b	1.66E-09	p_14_frg_b	1.51E+03	c_3_mass_b	2.33E-08	p_34_frg_b	4.18E-03													c_4_frg_b	2.50E-06

Sample calculations for airborne releases shown for parent radionuclide Sr-90 marked as "a" and a progeny radionuclide Y-90 marked as "b"																					
Starting or the first intermediate:				**Second intermediate:**				**Third intermediate:**				**Fourth intermediate:**				**Fifth intermediate:**				**Final:**	
Compartment:		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**	
Name	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**
c_4_frg_a	1.50E-03	p_45_honey_a	2.79E+00																	c_5_honey_a	4.20E-03
c_4_frg_b	2.50E-06	p_45_honey_b	2.15E+00																	c_5_honey_b	5.39E-06
c_5_honey_a	4.20E-03	p_55_honey_BMlk_a	2.91E-04																	c_5_BMlk_a	1.22E-06
c_5_honey_b	5.39E-06	p_55_honey_BMlk_b	2.07E-06																	c_5_BMlk_b	1.12E-11
Dose calculations: Critical group A, and food from that location only																					
c_1_a	6.99E-07	pe_19_ef_a	3.10E-09																	c_9_ar_ex_ef_a	2.17E-15
c_1_b	5.34E-09	pe_19_ef_b	2.50E-08																	c_9_ar_ex_ef_b	1.34E-16
c_1_a	6.99E-07	pi_19_ad_ef_a	1.71E-04																	c_9_ar_ih_ad_ef_a	1.19E-10
c_2w_a	2.18E-12	pe_2well9_ef_a	8.19E-11																	c_9_well_ex_ef_a	1.79E-22
c_3_area_a	4.17E+00	pe_39_ef_a	4.93E-10																	c_9_g_ex_ef_a	2.06E-09
c_3_area_b	1.32E-05	pe_39_ef_b	4.86E-10																	c_9_g_ex_ef_b	6.42E-15
c_3_mass_a	1.49E-02	pi_39_a	3.73E-09																	c_9_soil_ig_a	5.56E-11
c_3_mass_b	4.72E-08	pi_39_b	5.02E-10																	c_9_soil_ig_b	2.37E-17
c_4_frt_a	2.85E-03	p_49_frt_a	2.39E-06																		
c_4_grd_a	2.85E-03	p_49_grd_a	1.49E-06																	c_9_tr_pl_ig_a	1.47E-08
c_4_ptt_a	3.46E-03	p_49_ptt_a	1.07E-06																		
c_4_frt_b	2.00E-07	p_49_frt_b	3.22E-07																		
c_4_grd_b	2.00E-06	p_49_grd_b	2.01E-07																	c_9_tr_pl_ig_b	4.80E-13
c_4_ptt_b	9.53E-08	p_49_ptt_b	1.44E-07																		
c_5_beef_a	1.00E-03	p_59_beef_a	7.05E-07																		
c_5_eggs_a	9.95E-04	p_59_eggs_a	6.65E-07																	c_9_tr_an_ig_a	7.12E-08
c_5_deer_a	3.55E-03	p_59_deer_a	1.41E-06																		
c_5_BMlk_a	6.78E-04	p_59_BMlk_a	9.56E-05																		
c_5_beef_b	1.09E-06	p_59_beef_b	9.50E-08																		
c_5_eggs_b	3.53E-08	p_59_eggs_b	8.97E-08																	c_9_tr_an_ig_b	1.42E-12
c_5_deer_b	1.02E-06	p_59_deer_b	1.90E-07																		
c_5_BMlk_b	8.69E-08	p_59_BMlk_b	1.29E-05																		
Dose calculations: CG_D (honey source for CG A) location																					
c_5_honey_a	4.20E-03	p_59_honey_a	1.89E-07																		
c_5_BMlk_a	1.22E-06	p_59_BMlk_a	9.56E-05																	c_9_tr_an_ig_a	9.09E-10
c_5_honey_b	5.39E-06	p_59_honey_b	2.54E-08																		
c_5_BMlk_b	1.12E-11	p_59_BMlk_b	1.29E-05																	c_9_tr_an_ig_b	1.37E-13
* divided by 1000 to balance the units.																				**C_9 total at CG A (Sv/a)**	**8.91E-08**
** multiplied by 1000 to convert units from m3/L to L/L.																				**DRL (Bq/week) residential area critical group CG A (re-produced Sr-90 DRL value in Table 24)**	**6.79E+09**

B.2 SAMPLE CALCULATIONS BEHIND THE DRL FOR LIQUID EFFLUENT (PU-238) RELEASE FROM WL

When calculating DRLs for Pu-238 (Nuclide **A**), the dose contribution from its progeny U-234 (nuclide **B**) was calculated explicitly in this scenario (Table 30).

In this scenario, the sole release location (WL Process Outfall), the sole critical group (Farm A), and the bounding age class (3-month-old formula milk drinking infant) were modelled. Full detail of the dominant pathway (water intake) are available in Table 30.

As shown in the Table 6, for liquid effluent, Farm-A critical group was self-sufficient in all food product.

IMPACT code version 5.4.0 used in the calculations does not provide any transfer parameter values, which were obtained using an R&D tool CSA-DRL [19]. The DRL was calculated in both codes (IMPACT and CSA-DRL), both gave the same final DRL value of 1.16E+09 Bq month^{-1}. Then the relevant compartmental values and transfer parameter values outputted from CSA-DRL and populated in Table 30.

The resulting DRL value from this sample calculation table matched exactly with the result of Table 25, and hence verified the accuracy of DRL calculation corresponding to liquid effluents.

Table 30: Liquid release scenario.

Sample calculations for liquid releases shown for parent radionuclide Pu-238 marked as "a" and a progeny radionuclide U-234 marked as "b"									
Starting or the first intermediate:				**Second intermediate:**				**Final:**	
Compartment:		**Transfer parameter to right-most compartment:**		**Compartment:**		**Transfer parameter to right-most compartment:**		**Compartment:**	
Name	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**	**Name**	**Value**
		p_02_a	1.46E-03					c_2_a	1.46E-03
c_0_a (Bq/s)	**1**	p_02_b	1.32E-12					c_2_b	1.32E-12
c_2_a	1.46E-03	p_23_mass_a	4.91E+01					c_3_mass_a	7.15E-02
c_2_b	1.32E-12	p_23_mass_b	5.99E+01					c_3_mass_b	7.91E-11
c_2_a	1.46E-03	p_23_area_a	1.38E+04					c_3_area_a	2.00E+01
c_2_b	1.32E-12	p_23_area_b	1.68E+04					c_3_area_b	2.21E-08
c_2_a	1.46E-03	p_24_frt_a	1.33E-02	c_3_mass_a	7.15E-02	p_34_frt_a	1.40E-05	c_4_frt_a	2.03E-05
		p_24_grd_a	1.33E+00	c_3_mass_a	7.15E-02	p_34_grd_a	1.40E-05	c_4_grd_a	1.93E-03
		p_24_ptt_a	6.32E-03	c_3_mass_a	7.15E-02	p_34_ptt_a	2.94E-05	c_4_ptt_a	1.13E-05
c_2_b	1.32E-12	p_24_frt_b	1.33E-01	c_3_mass_b	7.91E-11	p_34_frt_b	1.00E-03	c_4_frt_b	2.54E-13
		p_24_grd_b	1.33E+00	c_3_mass_b	7.91E-11	p_34_grd_b	1.00E-03	c_4_grd_b	1.83E-12
		p_24_ptt_b	6.32E-02	c_3_mass_b	7.91E-11	p_34_ptt_b	2.10E-03	c_4_ptt_b	2.50E-13
c_2_a	1.46E-03	p_25_beef_a	6.51E-04	c_3_mass_a	7.15E-02	p_35_beef_a	2.98E-05	c_5_beef_a	3.08E-06
		p_25_eggs_a	3.90E-04	c_3_mass_a	7.15E-02	p_35_eggs_a	5.85E-05	c_5_eggs_a	4.75E-06
c_2_b	1.32E-12	p_25_beef_b	1.33E-02	c_3_mass_b	7.91E-11	p_35_beef_b	6.11E-04	c_5_beef_b	6.59E-14
		p_25_eggs_b	5.90E-02	c_3_mass_b	7.91E-11	p_35_eggs_b	8.85E-03	c_5_eggs_b	7.78E-13
c_2_a	1.46E-03	P_26_FWF_a	3.00E+01					c_6_FWF_a	4.37E-02
c_2_b	1.32E-12	P_26_FWF_b	1.00E+01					c_6_FWF_b	1.32E-11
c_2_a	1.46E-03	P_28_a	5.40E+03					c_8_a	7.86E+00
c_2_b	1.32E-12	P_28_b	3.30E+02					c_8_b	4.36E-10
c_2_a	1.46E-03	pi_29_a	1.39E-03					c_9_water_ig_a	2.02E-06
c_2_b	1.32E-12	pi_29_b	1.28E-04					c_9_water_ig_b	1.69E-16
c_2_a	1.46E-03	pe_2wt9_ef_a	1.40E-11					c_9_water_ex_ef_a	2.04E-14
c_2_b	1.32E-12	pe_2wt9_ef_b	2.39E-11					c_9_water_ex_ef_b	3.15E-23
c_3_area_a	2.00E+01	pe_39_ef_a	6.48E-12					c_9_g_ex_ef_a	1.30E-10
c_3_area_b	2.21E-08	pe_39_ef_b	6.06E-12					c_9_g_ex_ef_b	1.34E-19
c_3_mass_a	7.15E-02	pi_39_a	6.48E-08					c_9_soil_ig_a	4.63E-09
c_3_mass_b	7.91E-11	pi_39_b	5.99E-09					c_9_soil_ig_b	4.74E-19
c_4_frt_a	2.03E-05	p_49_frt_a	4.16E-05					c_9_tr_pl_ig_a	5.12E-08
c_4_grd_a	1.93E-03	p_49_grd_a	2.60E-05						
c_4_ptt_a	1.13E-05	p_49_ptt_a	1.85E-05						
c_4_frt_b	2.54E-13	p_49_frt_b	3.85E-06					c_9_tr_pl_ig_b	5.81E-18
c_4_grd_b	1.83E-12	p_49_grd_b	2.40E-06						
c_4_ptt_b	2.50E-13	p_49_ptt_b	1.71E-06						
c_5_beef_a	3.08E-06	p_59_beef_a	1.23E-05					c_9_tr_an_ig_a	9.27E-11
c_5_eggs_a	4.75E-06	p_59_eggs_a	1.16E-05						
c_5_beef_b	6.59E-14	p_59_beef_b	1.13E-06					c_9_tr_an_ig_b	9.07E-19
c_5_eggs_b	7.78E-13	p_59_eggs_b	1.07E-06						
c_6_FWF_a	4.37E-02	p_69_FWF_a	3.72E-07					c_9_aq_an_ig_a	1.63E-08
c_6_FWF_b	1.32E-11	p_69_FWF_b	3.44E-08					c_9_aq_an_ig_b	4.55E-19
c_8_a	7.86E+00	pe_89_ef_a	1.52E-13					c_9_sediment_ex_ef_a	1.19E-12
c_8_b	4.36E-10	pe_89_ef_b	4.07E-13					c_9_sediment_ex_ef_b	1.77E-22
c_8_a	7.86E+00	pi_89_a	2.16E-08					c_9_sediment_ig_a	1.70E-07
c_8_b	4.36E-10	pi_89_b	2.00E-09					c_9_sediment_ig_b	8.71E-19
								c_9_total (Sv/a)	**2.26E-06**
			DRL (Bq/month) residential area critical group CG A (re-produced Pu-238 DRL value in Table 25)						**1.16E+09**

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Standard

Administrative Levels and Action Levels for WL Air and Liquid Radioactive Effluents

MANAGEMENT SYSTEM DOCUMENT

900-509200-STD-016

Revision 0

Information Use

Approved by:	[signature]	2022/10/24
	George Dolinar Functional Support Manager Environmental Protection	Date

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Section **Page**

1. Scope and Applicability

This document specifies the Administrative Level (AdL) values and Action Level (AL) values for all radiological air and liquid effluent verification monitoring final discharge points that are a part of the WL Radiological Effluent Verification Monitoring Program (EVMP). This document applies to Whiteshell Laboratories only.

This document does not cover responsibilities of Facility Managers/Authorities (or equivalent), the Environmental Protection Designated Representative of the Licence (DROL), the Environmental Protection Program Manager, or the Environmental Specialist(s). These are covered in *Management and Monitoring of Emissions* [1].

This document does not cover the use or rules around the recording or reporting of calculated exceedances based on unavailable equipment or failed calibration of effluent verification monitoring equipment.

2. Purpose

This document provides relevant stakeholders with the AdL and AL values for all final discharge points that are part of the WL Radiological Effluent Verification Monitoring Program for use in routine monitoring and evaluation of effluent verification monitoring results. The levels in this document were developed in compliance with the Canadian Standards Association N288.8 document Establishing and implementing action levels for releases to the environment from nuclear facilities [2]. In addition, this document describes the methodology used to set the AL and AdL values.

3. Requirements

For requirements regarding the following:

- Planned emissions in excess of AdLs or ALs; and
- Reporting of exceedances of AdLs and ALs

Refer to 900-509200-STD-009, *Management and Monitoring of Emissions* [1].

4. Definitions and Acronyms

4.1 Definitions

This document relies primarily on word meaning as found in common dictionaries. The current *Glossary of Controlled Terms and Acronyms* [3] contains specific meanings for those words that require further clarification.

For definitions of Administrative Level and Action Level, refer to the *Environmental Protection Program Document Description* [4].

4.2 Acronyms

The current *Glossary of Controlled Terms and Acronyms* [3] contains specific meanings for those acronyms that require further clarification.

5. Roles and Responsibilities

For a description of responsibilities of Facility Managers/Authorities (or equivalent), the CNL Environmental DROL, the WL Environmental Protection Program Manager, and Environmental Specialists concerning AdLs and ALs, refer to *Management and Monitoring of Emissions* [1].

6. Standards

6.1 Methodology for Setting Administrative Levels

The purpose of AdLs is to provide warning of above normal emissions with the intent of aiding in the application of the As Low As Reasonably Achievable (ALARA) process. Hence, AdLs are established for indicator parameters representative of key radionuclides in the effluent stream at levels close to normal or predicted emissions. They are calculated for each final discharge point using a combination of statistical parameters applied to a chosen set of historical emission data:

1. A minimum of three years emission levels that are deemed representative of near-future emissions are used as the data set on which the AdL is based. The resulting data set must be comprised of a minimum of 36 data points to ensure a data set of adequate size. In the case where three years of operational performance is not available, the AdL is set based on less than three years of operational performance if this history is deemed representative of near-future emissions, or on best estimates/predictions based on professional experience and judgement. The choice of a representative data set is made in consultation with facility staff to ensure that the resulting AdL reflects actual future operating conditions.
2. If item 1) above yields a data set that includes both detects and non-detects, the following truncating guidelines are considered. Note that there are varying approaches to truncating the data to ensure that the calculated statistical parameters appropriately reflect emission levels of a facility in operational mode. The following guidance ensures that the AdL is set at a level that differs from background and is representative of actual emissions resulting from a facility during operation:
   i. Emission levels that do not differ statistically from analytical/instrument background, i.e., that are below the Critical Level (L_C), are removed from the data set as they most likely represent periods of inactivity and are not representative of regular operation.
   ii. When it is unfeasible to differentiate periods of inactivity from periods of regular operation, then this $<L_C$ data is <u>not</u> removed from the data set. Experience and

past reviews of emission data reveals that it becomes unfeasible to differentiate between inactivity and regular operation when more than 75% of the data set is comprised of $<L_C$ data. For facilities that experience low emissions, retaining the $<L_C$ data makes for a data set that is representative of regular operations (the $<L_C$ measurements occur during operation).

3. Any data points within the data set that represent abnormal emission events are removed to yield a data set that is most representative of normal emission levels. This is done as follows:
   i. Any data point that is known to be the result of an abnormal emission event is removed from the data set.
   ii. Any data point remaining within the data set after carrying out i) above that is judged suspect, is inconsistent with the rest of the data and cannot be explained by an intermittent or temporary operation, is deemed to be an outlier, and is also removed. The mean and standard deviation are recalculated on the updated data set. If the removed suspect data point differs from the new mean by more than three standard deviations, then it is rejected as an outlier, otherwise it is reinstated in the data set.
4. It is imperative that the number of false positives, i.e., where an AdL exceedance is not related to an abnormal emission event but is instead due to normal operation, is kept to a minimum. To this effect, the AdLs are set as follows:
   i. The AdL is set at the upper limit of the 99.7% confidence interval for the data set. It is expected that AdL exceedances will occur occasionally due to normal variation; an acceptably low percentage of the data points, 0.15% ([100%-99.7%]/2), is expected to represent these false positive AL exceedances. To calculate the upper limit of the 99.7% confidence interval, the statistical distribution of the data set is first determined, and an appropriate calculation method specific to the distribution is chosen.
   ii. Environmental or emission data most often follows a normal or log-normal distribution. If the data does not fit a normal (or log-normal) distribution, this may be due to working with a 'combined' data set, i.e., a data set that represents more than one distinct process each reflecting a different situational condition. For example, a facility's emissions may be duplicitous in that they vary according to intermittent campaign schedules or varying types of work based on customer requests. This results in a data set that effectively captures a combination of various operational modes. Interferences from other emission sources can also result in a combined data set. If the varying sources of emissions have different distributions parameters (e.g., one has consistently low emissions with little variability, and another has intermittent emissions with high variability), the combined data will not follow a normal (or log-normal) distribution.
   Because using such combined data sets decreases the fit of the emission data to the normal (or log-normal) distribution, this in turn affects the accuracy of the

99.7% confidence interval and thus the AdL. In this case, a coverage factor can be applied to the calculated AdL to decrease the number of false positives. This decision is made based on a review of historical operational performance, upcoming campaigns and work, potential for interferences, and professional judgement.

iii. Finally, a risk-based lower cap on the AdL is applied to afford operational flexibility for those final discharge points that have historically operated at very low emissions close to background. The historical data although representative of past emissions, could be unrepresentative of the operational envelope of the facility. Therefore, the caps address the situation where a very small change in operation could trigger an exceedance that is unwarranted. The determination of the level for the lower cap is based on the professional judgement of the Environmental Protection Program Manager.

6.2 Methodology for Setting Action Levels

ALs represent a level of emission that is significantly below the Derived Release Limits (DRLs) [5], below the Site Target (0.3 x DRL) and higher than the AdLs, and is sufficiently low and close to operational performance such that the requirement to keep doses ALARA is not jeopardized if this level is reached. In line with this requirement, individual ALs shall be set-to five times the respective AdLs, except in cases where a calculated AL is more than 50% of the respective site annual dose limit when the above methodology is applied, in which case the AL shall be set at a value equal to 50% of the site annual does limit.

Note: Changes to ALs will require notification to the CNSC.

6.3 Review Process

The AdLs should be reviewed at least once every three years or more frequently if warranted.

7. Documented Information

Creation, Capture and Use of Information Assets [6] provides current information on the storage, preservation, turnover and retention requirement for records.

The calculations and methodology of decision making for each station/parameter combination are recorded on individual Excel spreadsheets and are uploaded to ATOM once the AdLs have been approved for use by both EnvP and the facility. Records associated with this process include:

1. Excel spreadsheets used in the calculation of the levels [7].

These are considered permanent records and are stored in ATOM using the following identifier (191-509211-055-000).

8. References

[1] *Management and Monitoring of Emissions,* 900-509200-STD-009, 40788125

[2] *Establishing and implementing action levels for releases to the environment from nuclear facilities*, CAN/CSA N288.8-17, 2017.

[3] *Glossary of Controlled Terms and Acronyms*, http://terms_definitions/.

[4] *Environmental Protection Program Description Document,* 900-509200-PDD-001, 40812070

[5] *Derived Release Limits for CNL's Whiteshell Laboratories*, WL-509211-RRD-001, 53626314

[6] *Creation, Capture and Use of Information Assets*, 900-511300-STD-003, 50746207

[7] K. Ross, L. Wilson (2021). Excel Workbook, *Calculations of Admin and Action Levels*, 191-509211-055-000, 58271772

Appendix A Administrative Levels and Action Levels for Airborne Radioactive Effluents[1]

Building	Source Description	Sampling Station	EmLine Station Code	Parameter	Administrative Level (Bq/wk)	Action Level (Bq/wk)
WR-1 Stack, B100[2]	WR-1 structure & building ventilation exhaust to reactor stack	Stack	WR1	Tritium	5.66E+09	2.83E+10
				Gross Alpha	6.69E+03	3.34E+04
				Gross Beta	3.01E+04	1.51E+05
HCF, B300[3]	Hot Cells Facility (HCF), Building 300	Stack	HCF	Gross Alpha	3.40E+03	1.70E+04
				Gross Beta	1.56E+04	7.79E+04
IFTF, B300[4]	IFTF (Compactor Location), Building 300	Stack	IFTF	Gross Alpha	3.23E+03	1.61E+04
				Gross Beta	4.74E+04	2.37E+05

[1] All AdLs and ALs are based on the past at least ten years of operational history, i.e. years 2009-2019. Exceptions to this are specified where applicable. The B200 facility is no longer in operation and is in the process of being decommissioned.

[2] The current alpha and beta emissions from this facility are very low (near DL). Decommissioning plans involve work in the facility that could result in higher releases. Hence, the past eleven years of emissions data was not deemed representative of upcoming emissions and a coverage factor of 5 was applied to allow for the anticipated increase in emissions. If an action level was reached the dose (alpha 0.000019 mSv and beta 0.000025 mSv) as a result of the emissions would still be below 0.0005 mSv/a.

[3] The current alpha emissions from this facility are very low (near DL). Decommissioning plans involve work in the facility that could result in higher releases. Hence, the past eleven years of emissions data was not deemed representative of upcoming potential emissions and coverage factors of 5 was applied to the alpha emissions to allow for the anticipated increase in emissions. If an action level was reached the dose (alpha 0.00001 mSv) as a result of the emissions would still be below 0.0005 mSv/a.

[4] A coverage factor of five was applied to alpha emissions and ten for beta emissions to allow for the anticipated increase in emissions due to the effect that various decommissioning activities have on facility emission. If an action level was reached the dose (alpha 0.000009 mSv and beta 0.00007 mSv) as a result of the emissions would still be below 0.0005 mSv/a.

Appendix B Administrative Levels and Action Levels for Liquid Radioactive Effluents

Discharged To	Sampling Station	EmLine Station Code	Parameter	Administrative Level (Bq/month)	Action Level (Bq/month)
Winnipeg River	Process Outfall (includes effluent from B100 and B300 LLLW tanks and storm drains)	OFS	Gross Alpha[5]	1.18E+07	1.18E+08
			Gross Beta[6]	9.39E+07	4.70E+08
			Tritium	7.29E+09	3.30E+10
Winnipeg River	Sewage Lagoon (includes effluent from domestic waste water and inactive laundry facility)	SL2	Gross Alpha[7]	1.24E+07	6.21E+07
			Gross Beta[8]	3.88E+07	1.94E+08

[5] AL was increased by a factor of two to allow space between the AdL and AL, value does not exceed 50% of the Annual Site Dose Limit. Gross alpha assumed to be Pu-238 (most limiting and occasionally detected), emissions data indicates significant contributions of the gross alpha are from uranium and its progeny. Gross beta is assumed to be Sr-90.

[6] AL was increased by a factor of two to allow space between the AdL and AL, value does not exceed 50% of the Annual Site Dose Limit. Gross beta is assumed to be Sr-90.

[7] Gross alpha assumed to be Pu-238 (most limiting and occasionally detected), emissions data indicates significant contributions of the gross alpha are from uranium and its progeny. Gross beta is assumed to be Sr-90.

[8] Gross beta is assumed to be Sr-90 (most limiting and occasionally detected)

Whiteshell Laboratories Annual Compliance Monitoring Report for 2022

WL-514300-ACMR-2022

Revision 0

Approved by: Kerry Rod

K. Rod
WL General Manager

2023 April 25
Date

UNRESTRICTED

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Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
0	2023/04/30	Issued as “Approved for Use”.	R. Swartz		K. Rod
D2	2023/04/03	Issued for “Review and Comment”.	R. Swartz	K. Rod S. Brewer C. Gallagher	
D1	2023/03/06	Issued for “Review and Comment”.	R. Swartz	A. Bilton A. Caron A. Coulas A. Mahabir A. Nash A. Rehman A. Talebitaher B. Scott C. Bennett C. Clark C. McGregor D. Fillion D. Garrick D. Koopman D. Meldrum D. Palchewich E. Broughton G. Barnett G. Dolinar G. Snell J. DeRuiter J. Hayter J. Honda-McNeil J. Martino J. Slade J. Turcotte K. Erlandson K. Leroux L. Adams L. Magnusson L. Nel	

				L. Rasmussen M. Hammell M. MacKay P. Henschell P. Quinn P. Vilks R. Bilinsky R. Corby S. Faught S. Khan S. McLean S. Mistry T. Lackman T. Reimer	

EXECUTIVE SUMMARY

This annual compliance monitoring report for the 2022 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories (WL) Licence NRTEDL-W5-8.00/2024 [1] and Canadian Nuclear Safety Commission (CNSC) REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* [3] as a summary report of annual compliance monitoring and operational performance.

Canadian Nuclear Laboratories (CNL) acknowledges that its operations take place on ceded, unceded and unsurrendered traditional territories of numerous First Nations and the Red River Métis. At CNL, we recognize the unique history, spiritual beliefs, cultural practices and languages of Indigenous People in Canada, and we appreciate the responsibility they have as stewards of the environment. We remain firmly committed to being an active participant on Canada’s journey towards healing and reconciliation.

This stand-alone, unrestricted document provides CNL compliance monitoring and performance information for WL and is organized by CNSC’s 14 Safety and Control Areas (SCA). This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for 2022 [1], which provides programmatic updates and performance of the 14 SCAs, and CNL’s Indigenous engagement activities and Public Information and Disclosure program as applicable to all CNL sites.

The following provides overall performance highlights for 2022 activities:

- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2022 were below their respective Derived Release Limits (DRL).
- Demolition of Building 402/305, the former Health and Safety Facilities is complete, with some site cleanup remaining.
- A revised Environmental Impact Statement supporting the proposed in situ decommissioning of the WR-1 reactor, addressing previous comments, was submitted to CNSC.
- The WL site maintained safe and compliant performance under COVID-19 Pandemic conditions and protocols.

CNL recognizes the importance of, and places value on, ongoing engagement with Indigenous communities and organizations. CNL continues to work collaboratively with Sagkeeng First Nation (SFN), Manitoba Métis Federation (representing the Red River Métis), Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation, Wabaseemoong Independent Nations and Grand Council Treaty #3. Major project updates are shared with Iskatewizaagegan #39 Independent First Nation, Shoal Lake Independent Nation #40, and Northwest Angle #33, with opportunities for further engagement available to those communities at their discretion.

Environmental protection and environmental monitoring activities continue to be a regular topic of CNL's discussions with all Nations. In 2022, CNL and SFN focused on the development of the community-led Community Environmental Monitoring Program (CEMP) at WL, which was recognized through a traditional signing ceremony for SFN, CNL and Atomic Energy of Canada Limited (AECL) in December. CNL continued to work closely with the Manitoba Métis Federation (MMF) on the ongoing development of a Harvesting Sample Collection Program that will be led by the Red River Métis. Black River First Nation and Hollow Water First Nation, as well as with Grand Council Treaty #3, are working with CNL on developing monitoring programs that involve these communities to the degree they wish.

When pandemic restrictions were reduced and allowed in-person engagement to resume, CNL hosted tours of the site, the WR-1 reactor, and the Waste Management Area for the SFN Community Liaison Committee, the MMF, Black River First Nation and Hollow Water First Nation. CNL recognizes the importance of supporting culture and ceremony during these visits and identified spaces on site that could safely support activities such as smudging and water ceremony.

CNL remains interested in developing Long-Term Relationship Agreements with Nations that will support their capacity to participate meaningfully in the Whiteshell Laboratories Restoration Project (WLRP). While recent focus has been on the WR-1 project Environmental Impact Statement, environmental monitoring and other matters, CNL is committed to developing these agreements when the Nations are ready to move forward with these discussions.

Below is a summary of the SCAs for calendar year 2022.

- **SCA - Management System**: WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning, which was revised/updated in 2022. Three CNSC staff inspections were carried out.
- **SCA - Human Performance Management**: WL enlisted the support of the CNL Strike Team, comprised of experts from across CNL, to conduct an investigation into a Lock-Out Tag-Out event that resulted in a safety pause at the WL site. An outcome of this was improvements made to the tracking of training. CNL has a sufficient number of qualified staff to perform their licensed activities.
- **SCA - Operating Performance**: WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of "events". The total number of internal event reports raised continues to show a strong reporting culture. There were three CNSC reportable events in 2022.
- **SCA - Safety Analysis**: Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL's nuclear facilities, helping meet health, safety, security, environmental and regulatory requirements. Safety analyses continue to be developed for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing

Centre and Cask Loading facilities being constructed in the Waste Management Area. A Nuclear Safety Note was sent to the CNSC in support of the Phase 1 retrieval of fuel baskets from the Concrete Canister Storage Facility (for retrieval of Douglas Point fuel).

- **SCA - Physical Design**: The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba. The current Certificate of Authorization from Inspection and Technical Services Manitoba is valid until 2024 August. The Certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Plan.
- **SCA - Fitness for Service**: The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Facility Maintenance Plans, which list the Preventive Maintenance items relating to Safety Related Systems for the Shielded Facilities, WMA and WR-1, are being revised.
- **SCA - Radiation Protection**: No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 0.31 mSv and collective doses for the WL site remained below 50 person-mSv (17.2 person-mSv) No member of the public received a radiation dose that exceeded the regulatory limit.
- **SCA - Conventional Health and Safety**: Implementation of CNL's Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture. Safety advisories are regularly issued to staff about imminent issues that could impact their safety. There were no lost-time injuries although there were two hazardous occurrences that were reported to Employment and Social Development Canada at WL.
- **SCA - Environmental Protection**: Radiological emissions were 0.00015% of the Derived Release Limit (DRL) for air emissions and 0.58% of the DRL for liquids. The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment, and confirms that the WL site is operating in a manner that also protects workers and the public. WL maintained their ISO-14001 registration.
- **SCA - Emergency Management and Fire Protection**: The Emergency Management program's focus on COVID-19 gradually declined over the year, allowing focus to shift to program documentation. There were no emergency events requiring activation of the EOC. Interdepartmental fire training with the Town of Pinawa was interrupted by the COVID-19 pandemic and other issues, which were resolved with joint training set to resume in early 2023.

- **SCA - Waste Management**: WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 344.1 m^3 of radioactive waste to Chalk River Laboratories (CRL), 65.8 m^3 of radioactive waste to an off-site processor, 9.2 m^3 of solid and liquid hazardous waste to an off-site disposal facility, and 2,352 m^3 (2,434,265 kg) of clean and recycled waste shipped off-site. The WL Site Overview Detailed Decommissioning Plan was revised and accepted by CNSC.
- **SCA – Security**: The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for high-security sites. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC. All enforcement items from a 2021 Type II Security inspection were closed.
- **SCA - Safeguards**: There were no issues identified with the three International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL.
- **SCA - Packaging and Transport**: There were 37 radioactive transport packages making up 53 loads that were safely and successfully sent off-site, including approximately 342 m^3 of low-level waste and 2.5 m^3 of intermediate-level waste shipped to CRL.
- **Other matters of regulatory interest**: Two meetings of the WL Public Liaison Committee took place, the second a return to in-person engagement. Numerous virtual and in-person public information sessions and webinars were held on the plan for the proposed in-situ decommissioning of the Whiteshell reactor and on overall activities of the WL Restoration Project. CNL engaged a consultant to conduct a public attitude survey to gauge public opinion and understanding about the WL Restoration Project, with results indicating generally positive attitudes towards CNL and the project.
- **Facilities** (operating nuclear facilities, permanently shut down facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: demolition of the Health and Safety Facilities, Building 402/305 was completed, the Building 405 lunchroom/offices (formerly the library) was shut down and operational cleanup was completed to prepare the building for demolition, the Recoverable Surface Staging and Storage Area in the Waste Management Area was put into service, progress continued for the off-site fabrication of Standpipes/Bunkers remediation equipment, and progress has been made installing equipment at the waste management areas for additional power needed for future waste extraction activities, monitoring equipment and the future Cask Loading Facility.

CNL is committed to achieve high standards of operational safety and security. The information and data presented in this report support the conclusion that safe and secure performance was achieved at the Whiteshell Laboratories site, while enhancements were implemented to further improve results.

ACKNOWLEDGEMENT

The “Author” of this document would like to thank the many Whiteshell Laboratories authors and reviewers from the various Functional Support Areas and Facilities for their production of the individual sections of the report.

Table of Contents

FIGURES

TABLES

Introduction

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the eastern bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL. This work transitioned to Canadian Nuclear Laboratories (CNL) who are carrying out the work to achieve site closure on behalf of the site owner, AECL.

Activities are now underway to complete the orderly decommissioning of the WL site following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see the Decommissioning Strategies Section below).

Name:	*Whiteshell Laboratories*
Location:	*1 Ara Mooradian Way* *Pinawa, Manitoba* *R0E 1L0*

Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook for Whiteshell Laboratories,* herein referred to as “Licence Conditions Handbook” [2], and section 3 Annual Compliance Monitoring Report of Canadian Nuclear Safety Commission (CNSC) REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2022 January 01 to December 31.

This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to 14 Safety and Control Areas as they are applied across all of CNL.

The intent of this report is to provide sufficient detail to demonstrate how Whiteshell Laboratories programs are meeting the regulatory requirements as specified in the licence [1] and the Licence Conditions Handbook for Whiteshell Laboratories [2].

Changes to Organizational Structure

In 2022 June, a new General Manager (was the WL Deputy General Manager) and Site Licence Holder of the WL Closure Project was announced [5]. In November, an additional Deputy

General Manager position was added to the organizational structure, reporting to the General Manager, and a candidate was selected.

While not an organizational structure change, in 2022 December the “Whiteshell Laboratories Closure Project” was renamed the “Whiteshell Laboratories Restoration Project”, to better reflect the work being carried out at the WL site, and encompasses all activities under the WL licence.

Facilities Included in this Report

Appendix A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities included in this report are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and Building 305), and WR-1 Reactor.

Summary of Licensed Activities

There were no new licenced activities.

Decommissioning Strategies

Since 2015, work has been underway to complete decommissioning of the entire WL site. This includes leaving in-situ the selected Waste Management Area (WMA) trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this proposed change. The Environmental Impact Statement (EIS) supporting this is in progress, and a revised version addressing previous comments was submitted to CNSC.

Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [6], advising that as an agent of Her Majesty in Right of Canada, AECL’s liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee remains valid and in effect, as per the communication issued on 2020 August 25 [7].

1 Management System

1.1 Management System Program

Whiteshell Laboratories adheres to CNL's Management System Functional Support Area. See Section 1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The WL Quality Assurance Plan [8] supports the CNL Management System Manual [9] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to *Management System Requirements for Nuclear Facilities,* Canadian Standards Association (CSA) N286-12 [10] and *Decommissioning Quality Assurance for Nuclear Power Plants,* N286.6-98 [11]. The Quality Assurance Plan [8] was revised in 2022 and provide to CNSC [12].

1.2 Updates to Management System Documents

The CNSC has previously been provided notifications of revisions to Management System documents identified in CNL's individual Licence Conditions Handbooks as listed in Section 1.1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [1], including WL's Licence Conditions Handbook, in addition to two other document notifications specific to the WL Licence Conditions Handbook [12],[13].

1.3 Audits, Inspections and Self-Assessments

As per the requirements of the *Management System* [9], both functional support programs (Safety and Control Areas) and facilities conduct various audits, inspections, and self-assessments to ensure that the management system is functioning according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate actions taken to resolve them.

All actions resulting from audits, inspections, reviews and self-assessments are managed and tracked through CNL's Corrective Action Program.

1.3.1 Audits

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [1] for a list of all CNL-wide Audits for the reporting year 2022.

1.3.1.1 External Audits

The external audits conducted at WL in 2022 are summarized in the table below.

Table 1: External Audits

Title	Type of Audit	No. of Non-Compliances Raised	No. of Actions Raised[a]	No. of Actions Completed
External International Standards Organization (ISO) 14001 Surveillance (S1) Audit	Surveillance	0	1	0

a The actions raised may also include Opportunities for Improvement.

1.3.1.2 Internal Quality Audits

The internal audits completed by the Quality Audits and Processes branch in 2022 are summarized in the table below.

Table 2: Internal Quality Audits

Title	Audit Scope	No. of Non-Compliances Raised	No. of Corrective Actions Raised[a]	No. of Corrective Actions Completed
Environmental Protection	Environmental Protection Program	0	4	1

a The actions raised may also include Opportunities for Improvement.

1.3.2 Inspections

CNSC Inspections

The following CNSC Inspections were conducted at Whiteshell Laboratories.

Table 3: CNSC Inspections Conducted at Whiteshell Laboratories in 2022

Inspection No.	Area Inspected	No. of NNCs	No. of Recommendations	No. of NNC[a]s Closed
CNL-WL-2022-01	Radiation Protection	0	3	N/A
CNL-WL-NSD-T2-2022-001	Security	0	1	N/A
CNL-WL-2022-03	Waste Management Area	5	2	1

NNC Notice of Non-Compliance
a Closed as of 2022 Dec 31

Inspections by Other Regulatory Bodies

A Physical Inventory Verification inspection was carried out by the International Atomic Energy Agency (IAEA) on 2022 May 02. This inspection was a sampling of accessible items containing Special Fissionable Material. A Design Information Verification inspection was carried out by the IAEA on 2022 May 03. This inspection verified the information provided in the Design

Information Questionnaire. Two actions were raised and have been completed based on these inspections. A Complimentary Access inspection was carried out by the IAEA on 2022 June 01. This inspection was to assure the absence of undeclared nuclear materials and activities, to resolve a question or an inconsistency relating to correctness and completeness of the information provided in Canada's annual update to the IAEA, and to confirm the decommissioned status of a facility.

1.3.3 Self-Assessments

In 2022, there were 10 self-assessments conducted at WL covering various aspects of the management system, including both Safety and Control Areas, and various facilities.

Table 4: List of Self-Assessments Conducted at WL in 2022

Title	Facility/Safety and Control Area
Adherence to document control and development processes related to the Environmental Impact Statement and Decommissioning of WR-1	Management Systems
Occupied Buildings for WL site Emergency Response Readiness	Emergency Preparedness
Registration and Control of Radiation Sources	Radiation Protection
Radiation Protection Program Compliance Review for the WL Restoration Project	Radiation Protection
Inspection, testing and maintenance of the fire and related life safety systems. (General Fire Protection, Fixed Suppression, Fire Extinguishers)	Fire Protection
Maintenance and Revision WL Procedures	Management Systems
Verification Process for Decommissioning Work	Management Systems
Compliance to N286.6 Section 3.15 Records	Management Systems
WL Radiation Dose Reporting to Nuclear Energy Workers	Radiation Protection
Manager Dose Control Points and Radiation Protection Training Designation Annual Reviews	Radiation Protection

1.4 Management Reviews

A Whiteshell Laboratories Quality Assurance Program/Management System Review was completed for calendar year 2020 to evaluate the effectiveness of the management system. The review identified 2 actions, one is complete and the other is in progress. The 2021 review has been initiated.

2 Human Performance Management

2.1 Human Performance Program

Whiteshell Laboratories adheres to CNL's Performance Assurance Functional Support Area. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The effectiveness of the Human Performance program at WL has been enhanced through the following improvements:

- On 2022 May 27, WL experienced an event (ERM-22-1559 in Table 7) where a worker, while performing maintenance activities on a pump, received an electrical shock. As a result of this incident, WL Senior Leadership immediately initiated a safety stand down of all hazardous energy control work. Initial evaluation by a CNL investigative team revealed the event was due to non-adherence to the company-wide hazardous energy control procedure, resulting from human performance errors that identified a lack of thorough hazard identification and mitigation with an overall weakness in the release of work and maintenance supervision. On 2022 June 13, a site-wide safety pause of all fieldwork was declared. Immediate corrective and compensatory actions included a re-evaluation and retraining of the "Core 5" (Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls) as well as other key training courses, such as Lock-Out Tag-Out. Also included in the corrective and compensatory actions was rigorous senior leadership oversight of work approval for all work on-site. Throughout the months of June, July and August, WL senior leadership were focussed on developing a comprehensive plan for the safe restart of activities at the site. Phases of the plan were focussed on communication, management oversight, work activity reviews, training, extent of condition, restart authorization, and a phased approach to the full return to fieldwork, which occurred on 2022 December 09.
- In 2022 September, a WL Town Hall Session was held where WL employees were invited to join members of the Safety Excellence team and the Performance Assurance team for an open forum focused on CNL's ImpAct and Corrective Action Plan system. The Performance Assurance group worked on improving and addressing a number of issues and challenges with the ImpAct system and overall process. The session provided employees with the opportunity to have an open and constructive discussion on the Corrective Action Program.
- In 2022 October, the Independent Performance Assessment Team conducted a review of Whiteshell Implementation of/performance to *Management System Requirements for Nuclear Facilities*, CSA N286-12 [10]. The Atkins Nuclear Secured is chartered to perform senior independent reviews of project operations as an element of Atkins Nuclear Secured commitment to advance safety performance and the effectiveness of project team improvement actions. The team also reviewed the 2022 June Lock-Out Tag-Out event, and other unplanned events as appropriate, and evaluated WL's work pause implementation, communications, and corrective actions that supported re-

starting work. The Independent Performance Assessment Team review identified areas of focus (issues) and corresponding recommendations to improve on: safety culture, effective teamwork and communication across various levels of the organization, resource management and building trust across the organization. A total of 26 recommendations were made, and actions have and are being taken to address the recommendations.

2.2 Training program

Whiteshell Laboratories adheres to the Corporate Training and Development Functional Support Area. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

2.2.1 Program Improvements and Accomplishments

The effectiveness of WL Training Program has been enhanced through the following improvements:

- A Master Training Qualification Card that defines the qualifications requirements for WL Project Supervisors was developed.
- Training Qualification Cards that defines the qualification requirements for the WL Occupational Safety and Health (OSH) Specialist and Section Head were developed.
- Practical training modules were developed for air quality monitoring instruments.
- Detailed training matrices to track training compliance were developed for projects as part of the safe restart of activities at the WL.
- The Concrete Canister Storage Facility (CCSF) Training Analysis and Training Plan developed, and specific training modules are under development.
- Revisions to seven WL specific training, in support of WL restart activities, to ensure updated and accurate course content.
- Identification of position specific training for WL operational positions. This information is being used to develop WL position specific training certifications in CNL’s new Learning Management System in 2023.

2.2.2 Systematic Approach to Training

CNL maintains a list of positions and roles requiring Systematic Approach to Training programs in compliance with REGDOC-2.2.2, Personnel Training [14].

Training and Development evaluated the training programs for listed positions and roles at WL against the main elements of Systematic Approach to Training. The evaluation identified gaps in some training program documentation required to be consistent with a Systematic Approach to Training compliant training program. WL training resources are developing an action plan to upgrade these training programs in 2023. In the interim, while training program documentation is being upgraded, WL has ensured that employees assigned to perform listed positions and roles are controlled and that WL staff serving in these positions and roles are assessed for their ability to competently perform these assignments. CNL is confident that all staff are qualified to perform their job duties. CNL has a sufficient number of qualified staff to perform their licensed activities.

2.2.3 Required Training

Whiteshell Laboratories maintained a sufficient number of qualified workers to carry on the licensed activities safely and in accordance with the Nuclear Safety and Control Act [35] and the regulations made under the Nuclear Safety and Control Act.

All Whiteshell Laboratories personnel, both employees and contractors, are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work under the licence [1]. Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [1] provides the 2022 CNL Employee and Manager/Supervisor required training. The table below provides a list of federally/provincially legislated training courses that appear in position-specific training plans at Whiteshell Laboratories.

Table 5: Whiteshell Laboratories Operating Staff Training in 2022

Course Code	Course Title	No. of Attendees 2021*	No. of Attendees 2022**
OSH-1001-Online	Crane (Safe Indoor Hoist) – Theory	44	23
OSH-1002-Online	Lift Truck Operation – Theory	40	39
OSH-1003-Online	Aerial Work Platform – Theory	59	53
OSH-1004-Online	Lock Out / Tag Out Exam	28	153
OSH-3048	Lock Out / Tag Out Practical	N/A	118
OSH-1005-Online	Working at Heights – Theory	84	121
OSH-1006	Confined Space Entry	14	N/A
OSH-1006-Online	Confined Space Exam	15	N/A
OSH-9118	Confined Space Entry	N/A	134
OSH-9119	Confined Space Awareness	N/A	16
OSH-1007	Asbestos Module 6E	51	23
OSH-1033-Online	Ladder Safety	27	60
OSH-1046-Online	Heat Stress	7	38
OSH-3001-E	Crane – Safe Indoor Hoist – Practical – Jib Crane	3	0
OSH-3001-F	Crane – Safe Indoor Hoist – Practical – Bridge Crane	3	1
OSH-3001-J	Crane – Safe Indoor Hoist – Practical Gantry Crane	2	3
OSH-3001-K	Crane – Safe Indoor Hoist – Practical	1	3

Course Code	Course Title	No. of Attendees 2021*	No. of Attendees 2022**
OSH-3001-L	Crane – Safe Indoor Hoist Only	13	3
OSH-3001-MULTI	Crane – Safe Indoor Hoist – Practical – All Equipment Codes	8	3
OSH-3002-C	Lift Truck Practical – Counter Balance	18	8
OSH-3002-MULTI	Lift Truck Practical –Telehandler >9 ton to <15 ton	N/A	8
OSH-3002-MULTI	Lift Truck Operation – Practical/All Equipment Codes	4	1
OSH-3003-B	Aerial Work Platform Practical – Articulating Boom 60 ft (or less)	21	3
OSH-3003-C	Aerial Work Platform Practical – Rough Terrain Scissor Lift	27	0
OSH-3003-D	Aerial Work Platform Practical – Scissor Lift	25	5
OSH-3003-E	Aerial Work Platform Practical – Single Person Up-Up	1	0
OSH-3003-Multi	Aerial Platform – Practical (All Equipment Codes)	34	3
OSH-3005	Working at Heights – Practical	88	62
HU-1036-Online	Pre job Brief	12	2
WL-306	Pre Job Brief	N/A	105

* Where the 2021 attendance appears as N/A, course attendance was not reported in the 2021 ACMR.
** Where the 2022 attendance appears as N/A the course was not offered in 2022 and was replaced by an alternate course (e.g. OSH-1006 Confined Space Entry became OSH-9118).

2.2.4 Contractor Training

Before accessing the Whiteshell Laboratories site, contractors are required to complete the following training:

- Whiteshell Site Orientation
- Radiation Protection Group 4 (if required to work unescorted)
- Whiteshell Contractor Awareness

These courses are provided to contractors via classroom training upon arrival on their first day at the Whiteshell site and tracked by the WL branch of Human Performance and Training.

WL utilizes the contract terms and conditions, in addition verifying and approving the contractor company’s safety programs and training records, to ensure contractors are qualified to work at WL. CNL Contractor Representatives are required to verify contractor training records prior to the commencement of work.

WL oversees contractors’ work in the field and all WL work control protocols apply.

2.2.5 Training Evaluations Summary

In 2022 WL continued to utilize trainee feedback forms to capture learner input as part of training program improvement and maintenance activities. WL also implemented a Manager training evaluation program in 2022. The WL Management team performed management observations of training, on a rotational basis. 11 different training courses had Management Evaluations performed with 69 individual course feedback forms received and processed. The average number of feedback forms was just over 6 per course. While most were scoring in the 80-90% satisfaction range, suggestions and opportunities for improvements were all assessed, the results were tracked and improvements managed by Training and Development staff.

2.3 Hours of Work Exceedances

As per REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* [49] Sections 4.2 and 4.3, CNL has recorded all exceedances of hours of work for Security's safety-sensitive positions. See Table 6 below for a list of exceedances for 2022. Note: the COVID-19 pandemic had a direct contribution to Table 6 as it relates to the maintenance of the WL Security minimum shift complement.

Table 6: Hours of Work Exceedances for Nuclear Security Officers and Tiered Response Force Personnel at WL

Limits	2021				2022			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
>16 hrs in a 24-hour period	3	4	7	4	19	28	11	10
> 28 hrs in a 48-hour period	15	21	28	11	16	25	10	6
> 120 hrs in a 14-day period	6	4	1	1	0	9	5	7
Min recovery 48 hrs after 2 consecutive nights	19	11	5	15	7	7	19	9
Min recovery 72 hrs after 3 consecutive nights	2	5	3	2	1	2	2	3
Total	45	45	44	33	35	43	71	47

3 Operating Performance

3.1 Operating Program

Whiteshell Laboratories adheres to the Operating and Cleanup Functional Support Areas. See Section 3.1 and Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review board and other internal assessment activities such as self-assessments and audits (see Section 1.2).

3.1.1 Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [15] for WL are given in Appendix A through F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [16] processes.

Relevant modifications to WL facilities are given in Appendix A through G (Facility Changes subsection of Appendices).

3.2 Reporting Requirements

3.2.1 Reportable Events to CNSC

In 2022, there were 3 events that occurred at WL that were deemed reportable to the CNSC. They are listed in the table below.

3.2.2 Reportable Events to Other Regulators

Reports to other regulatory agencies consisted of:

- 2 Hazardous Occurrence Investigation Reports made to Employment and Social Development Canada (see Section 8 Conventional Health and Safety for further details)

Table 7: Reportable Events to the CNSC at Whiteshell Laboratories in 2022

ImpAct No.	Title	SCA	Facility (if applicable)
ERM-22-3469	WL - Annual 3rd party inspection of Fire Devices Overdue	Fire Protection Program	
HSSE-22-3025	WL - Continuous Air Monitor in WL SF Waste Compactor Area Operated Past Calibration Due Date		Whiteshell Shielded Facilities
ERM-22-1559	WL - A Worker Receives an Electrical Shock while Performing Maintenance on a Fire System Water Pump		Whiteshell Laboratories Operations

3.2.3 Corrective Action Program

3.2.3.1 Trending of Events Related to Operational Activities

As events at WL occur, they are recorded in the Improvement Action (ImpAct[1]) system. This information is regularly reviewed and analyzed to identify any trends. To identify trends, Event Code based trend reports are also prepared to analyse ImpAct data on a monthly basis. Monthly site wide and WL specific trend reports are prepared by CNL Performance Assurance and shared with WL. WL specific trends are also specified in the monthly Contractor Assurance System scorecard.

The following trends were identified and raised as ImpActs:

- ERM-22-0593, WL TREND - Contractors Arriving to Site without Proof of Training
- HSSE-22-3640, WL TREND - Environmental Release Exceedances

The use of the Corrective Action process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

In 2022, a total of 374 ImpActs were raised by CNL employees at WL. Table 8 summarizes ImpActs raised over the past 5 years by Significance Level[2].

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

1 ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

2 Significance Level: Levels assigned to an event (SL1 being most significant, SL4 being least significant) based on the actual or potential result in safety, environmental, or business consequences.

Table 8: Number of ImpActs raised at Whiteshell Laboratories

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609
2020	13	0	3	58	276	350
2021	5	0	2	81	336	424
2022	2	1	4	61	306	374

a Level 0 will be assigned if the ImpAct is deemed to be a "non- problem" and a recommendation to close the Impact will be given.

4 Safety Analysis

4.1 Safety Analysis Program

Whiteshell Laboratories adheres to CNL's Safety Analysis Functional Support Area. See Section 4.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, three facilities have SARs and Facility Authorizations: Shielded Facilities (SF), WMA and Concrete Canister Storage Facility (CCSF).

Work has been initiated to revise the SF SAR, and an assessment is in progress to determine if the WMA SAR needs to be revised.

A Nuclear Safety Note is being developed for the non-robotic retrieval of materials from non-fissile-bearing Standpipes in the WMA, and will be submitted to CNSC in 2023. A SAR is being prepared for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and conversion of the Shielded Modular Above Ground Storage (SMAGS) building to a Cask Loading Facility. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC before these facilities are operated. The WMA SAR is also being revised.

A Nuclear Safety Note was sent to the CNSC in support of the Phase 1 retrieval of fuel baskets from the CCSF (Douglas Point fuel). The CCSF SAR will be updated prior to Phase 2 fuel retrieval activities.

4.2 Nuclear Criticality Safety Program

Whiteshell Laboratories adheres to CNL's Nuclear Criticality Safety Functional Support Area. See Section 4.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

As the Nuclear Criticality Safety Program is a company-wide program, enhancements and improvements made were intended to target all sites including WL and are identified in [1].

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSDs) for the Intermediate-Level Liquid Waste Processing Centre (CSD-74), Concrete Canister Storage Facility (CSD-11), and the Fuel Basket Transfer Flask (CSD-54) are in progress to allow retrieval of waste from the WMA and CCSF.

5 Physical Design

5.1 Design Program

Whiteshell Laboratories adheres to the CNL's Design Authority and Design Engineering Functional Support Area. See Section 5.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Design Authority and Design Engineering Functional Support Area maintains and controls the design basis for all design activities performed at WL, and it ensures that design is planned, executed, verified and documented according to applicable codes, standards, and regulatory and customer requirements.

The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba in 2022 March. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of *The Engineering and Geoscientific Professions Act*.

5.1.1 Items Important to Safety

In 2022, the Design Authority and Design Engineering Program ensured that any structures, systems and components important to safety met and maintained their design basis, and any changes made were controlled through the Engineering Change Control Process [16].

5.2 Pressure Boundary Program

Whiteshell Laboratories adheres to CNL's Pressure Boundary Functional Support Area. See Section 5.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Pressure Boundary Functional Support Area applies to design, procurement, fabrication, installation, examination, testing, repair, modification, construction and maintenance of pressure retaining systems and components performed by CNL at WL.

The *WL Pressure Boundary Quality Assurance Plan* [17] details the specific scopes of pressure boundary work carried out at WL, as permitted by the Certificates of Authorization issued by Inspection and Technical Services Manitoba, describes the controls, authorities, and responsibilities applicable at the WL site, and is consistent with CNL's Pressure Boundary Program requirements.

The current Certificate of Authorization from Inspection and Technical Services Manitoba is valid until 2024 August. The Certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Plan [17].

6 Fitness for Service

6.1 Fitness for Service Program

Whiteshell Laboratories adheres to CNL's Fitness for Service Functional Support Area. See Section 6.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Site and Nuclear Operations Branch provides monitoring and operation of building and facility processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedure reviews are conducted on a five year cycle. Most of these procedures having reached the five-year timeline for review. A team was formed to facilitate the review and publishing of these documents. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023. These documents include Facility Maintenance Plans, which list the Preventive Maintenance items relating to Safety Related Systems for the Shielded Facilities, Waste Management Area, and WR-1. The revised Facility Maintenance Plans are to be published in 2023.

In 2022, the Aging Management Program conducted an assessment which showed that WL was fully and partially implementing REGDOC-2.6.3 [18]. In 2023, a review will be conducted to determine if any further actions are needed.

As facilities are decommissioned, procedures related to those buildings or processes are voided.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service, WL staff ensure that critical systems, structures and components related to the safe operation and decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities ensures that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance per the Facility Maintenance Plan is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plans are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

Issues with missed and archived preventive maintenance activities were identified in 2021 and previously reported to the CNSC. A corrective action plan was developed, and continues to be implemented in order to fix the issues and prevent recurrence. The effectiveness of the corrective action plan will be investigated upon completion of the actions.

During maintenance of a firewater pump resulting in a Lock-Out Tag-Out event that was reported to the CNSC (see ImpAct ERM-22-1559 in Table 7), it was noted that part of the issue was the lack of a dedicated maintenance group on site that was adequately staffed, trained and qualified to maintain the licensed facilities. As part of the corrective action plan it was determined to return to having a dedicated maintenance group. Work to staff and organize that group occurred and the group was considered to be sufficiently staffed and functional by 2022 December. The focus in 2022 was on overdue preventive maintenance work, first focussing on those relating to safety related systems with corrective maintenance being given an increased focus later in 2022. There are outstanding preventive maintenance checks remaining at the end of 2022 for transformers for Buildings 423 and 923 at the WMA. There is an increased yet still low risk that either transformer could lose some functionality.

6.1.3 Condition of Structures

Waste storage structures include the WMA concrete storage facilities (termed "bunkers") and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [19] was developed in 2007 and continues to be implemented to confirm the ongoing fitness-for-service of the bunkers at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done, to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site, they will be removed from the inspection process. The 2022 annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [19]. Low Level Waste Bunker 6 and B923 were de-inventoried and were removed from waste storage usage. They are no longer inspected as part of the PIP [19]. Both are in the process of being converted to waste processing structures.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however existing cracks and pour pockets were regularly checked for changes. Requests for patching were placed in 2021 and 2022, and several canisters require more extensive patching of pour pockets that have gradually become more noticeable over time, however no increased radiation field was noted.

Environmental monitoring was conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers or concrete canisters.

7 Radiation Protection

7.1 Radiation Protection Program

Whiteshell Laboratories adheres to CNL's Radiation Protection Functional Support Area. See Section 7 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Whiteshell Laboratories uses the Chalk River Laboratories (CRL) licensed dosimetry service provider for external and internal dosimetry for site/facility staff and contractors.

Whiteshell Laboratories staff and contractors who work at the WL site are assigned Thermoluminescent Dosimeters (TLDs) to monitor for external radiation exposures.

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2022 included:

- Radiation Material Management training was developed for WL project and facility supervisors and piloted to WL radiation protection staff.
- A number of site RP forms were reviewed and updated. A new form was developed and implemented to perform RP inspections of radioactive material storage areas.
- New radiological barriers were implemented to delineate boundaries of radioactive material areas, areas of elevated dose rates and contaminated areas.
- Existing long term radioactive material storage areas in WL nuclear facilities were formally registered with the WL RP program.
- Process improvements were made on scheduling and verifying RP instruments are removed from the work place and sent for calibration 30 days ahead of the annual calibration due date.
- Process improvements were made for the TLD badging of delivery truck drivers to demonstrate drivers do not receive radiation dose while on site. A single TLD badge is issued to each delivery company which is issued to drivers.

WL RP performance metrics are measured and tracked weekly through WL Restoration Project status reports and quarterly through the Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies, opportunities for improvement, and establish and effectively implement corrective and preventive action plans.

7.1.2 Contamination Control

Regular contamination surveys of workplaces, material transfers, and personnel exiting nuclear facilities and controlled areas, are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls, and to warn of abnormal or unplanned airborne contamination conditions.

Table 9 shows the number of personnel, workplace and material contamination events identified in 2022 and over the past five years. None of the contamination events in 2022 resulted in a recordable whole-body, skin or internal dose.

Material contaminations decreased from 11 in 2021 to two in 2022. There were two workplace surface contaminations in 2022 compared to one in 2021. These were localised surface contamination found during routine compliance surveys in nuclear facilities. There were no worker skin or clothing contaminations in 2022.

In 2022, there were no airborne contamination exposure events and no radioactive material spills.

Table 9: Contamination Events

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	Personal Clothing[a]	Radiological Work Clothing[b]	Total	Surface[c, d]	Vehicle / Materials [b, c]
2018/19 FY	1	0	5	6	6	0
2019 CY	3	0	4	7	2	4
2020 CY	2	0	3	5	1	1
2021 CY	0	0	0	0	1	11
2022 CY	0	0	0	0	2	2

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area.

b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area.

c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas

d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.3 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2022, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to TLD badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition. Table 10 summarizes maximum daily recorded doses and dose rates for PAD work in 2022 and the previous four years. In 2022, the maximum PAD recorded daily dose received by a worker was 0.08 mSv and the highest dose rate measured in the year was 4.8 mSv/h. These were associated with the replacement of hot cell roughing filters. There were no PAD dose alarm exceedances and the PAD records demonstrates there were no unplanned whole-body radiation exposure exceeding the WL Action Level of 0.5 mSv in a day.

Table 10: PAD Dose Readings Summary

	2018	2019	2020	2021	2022
PAD[a] – Maximum Daily Dose (mSv)	0.24	0.42	0.28	0.22	0.08
PAD – Maximum Dose Rate (mSv/hr)	4.95	5.82	5.56	3.10	4.80

a Personal Alarming Dosimeter

At the beginning of 2022, managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by managers and supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified. At the end of 2022, there were no individuals with an assigned DCP higher than 2 mSv, 41 individuals with an assigned DCP of 2 (RP and nuclear operations staff), and the remainder of workers with a DCP of 1 mSv. No worker dose exceeded their assigned DCP in 2022.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2022, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2022 December 31, the total number of registered sealed or contained sources at WL, was 53. One Californium-252 source was added to the registry and one Cesium (Cs)-137 was removed. The Californium-252 is a source contained in a neutron scatterometer that was removed from waste storage in the WMA and relocated to the SF and awaiting processing to remove and re-package the source. The removed Cs-137 source was a check source from an area radiation monitor that was sent to CRL for waste disposal.

7.2 Dosimetry

7.2.1 Interpretation of Reported Dose Quantities

WL uses the CRL licensed dosimetry service provider for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory document REGDOC-2.7.2, *Dosimetry*, Volume II [20] requires external exposure measurements to meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[3].

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Lens of the eye dosimeters are worn when workers are subject to non-uniform exposures to the eyes and the dose to the eye may have a reasonable probability of exceeding 15 mSv per year after taking shielding into account. Eye dosimeters are also required if exposed to beta, x-ray or gamma dose rates greater than 10 mSv/h without taking shielding into account, or if the potential dose to the eye could exceed 1 mSv taking shielding from personal protective equipment and clothing into account.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a committed effective dose from occupational intakes exceeding 1 mSv per year.

7.2.2 Radiation Doses to Personnel

The dose data in all tables below represent doses delivered at WL for all monitored persons, which includes employees (including those in temporary employment such as students), contractors and visitors.

Doses have not been broken down by individual facilities because employees, contractors, and visitors routinely move between facilities without changing TLDs, making it difficult to accurately determine how much dose can be attributed to an employee, contractor, or visitor at a single facility.

In 2022, there was one exception for individual monitoring of non-CNL employees and visitors at WL, other than drivers of delivery trucks and building demolition debris haulers in radiological Supervised Areas. The exception was granted for delivery of trailers within the Supervised Area.

There were no operations of exposure devices in 2022 which required employees or contractors to be placed on a two-week dosimetry period, and there were no formal dose

[3] Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.2).

calculations required during 2022 for local area skin contamination. Additionally, no lens of the eye dosimetry was performed in 2022.

Neutron dosimeters were assigned to two individuals during the leak testing of a neutron source in 2022. All neutron doses were below the detection threshold. Doses are summarized in Table 11 through Table 14.

In 2021 May the building (B402) that housed the WL Whole Body Counter (WBC) underwent decommissioning and demolition and a new building (B543) is currently being commissioned to house the WBC. This work is continued into 2023. During this outage, workers who normally participate in annual or bi-annual WBCs were evaluated against the site's current radiological activities to determine which workers required alternative monitoring. Workers with reasonable potential for an intake which warranted alternate monitoring were placed on a gamma spectrometry in urine analysis (provided by CRL Dosimetry Services) which provides similar minimum detectable doses to the WBC analysis. Additional random (biased toward likelihood of an intake) urine bioassay monitoring of workers who did not meet the alternative monitoring criteria is being undertaken until the new facility is ready.

In 2022, 189 individuals underwent internal bioassay, which involved strictly urinalysis during the continued WBC outage. Ten individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective dose estimates were necessary as a result of any bioassay sampling in 2022.

The instances of Nuclear Energy Worker (NEW) visitors listed below were associated with personnel previously designated as NEWs but not associated with radiological work at WL in 2022. These included former AECL/CNL personnel, contractors, and CNSC staff visits. The one instance of a non-NEW employee is associated with a fully remote worker who visited the WL site.

Table 11: Effective Dose for Whiteshell Laboratories

Monitored Person Type		Dose Range (mSv)							Total # of Persons	Individual Dose (mSv)			Collective Dose (person·mSv)
		0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00					
		Number of Persons								Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	136	329	0	0	0	0	0	465	0.31	0.05	0.03	15.94
	Contractor	74	25	0	0	0	0	0	99	0.17	0.05	0.01	1.24
	Visitor[c]	6	0	0	0	0	0	0	6	0.00	0.00	0.00	0.00
Non-NEW	Employee	1	0	0	0	0	0	0	1	0.00	0.00	0.00	0.00
	Contractor	170	1	0	0	0	0	0	171	0.01	0.01	0.00	0.01
	Visitor	349	0	0	0	0	0	0	349	0.00	0.00	0.00	0.00
Totals		736	355	0	0	0	0	0	1,091				17.19

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were historically employee and/or contractor NEWs, but have returned to the site as visitor while retaining their historical NEW status.

Table 12: Distribution of Equivalent Dose to the Skin for Whiteshell Laboratories

Monitored Person Type		Dose Range (mSv)							Total # of Persons	Individual Dose (mSv)			Collective Dose (person·mSv)
		0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00					
		Number of Persons								Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	136	326	3	0	0	0	0	465	0.66	0.05	0.04	17.55
	Contractor	74	25	0	0	0	0	0	99	0.17	0.05	0.01	1.24
	Visitor[c]	6	0	0	0	0	0	0	6	0.00	0.00	0.00	0.00
Non-NEW	Employee	1	0	0	0	0	0	0	1	0.00	0.00	0.00	0.00
	Contractor	170	1	0	0	0	0	0	171	0.01	0.01	0.00	0.01
	Visitor	349	0	0	0	0	0	0	349	0.00	0.00	0.00	0.00
Totals		736	352	3	0	0	0	0	1,091				18.80

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were historically employee and/or contractor NEWs, but have returned to the site as visitor while retaining their historical NEW status.

Table 13: Distribution of Equivalent Dose to the Hands and Feet for Whiteshell Laboratories

Monitored Person Type		Dose Range (mSv)							Total # of Persons	Individual Dose (mSv)			Collective Dose (person·mSv)
		0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00		Max	Ø Avg[a]	Avg All[b]	
		Number of Persons											
NEW	Employee	6	15	3	2	0	0	0	26	1.38	0.35	0.27	7.06
	Contractor	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
	Visitor[c]	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Non-NEW	Employee	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
	Contractor	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
	Visitor	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00
Totals		6	15	3	2	0	0	0	26				7.06

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were historically employee and/or contractor NEWs, but have returned to the site as visitor while retaining their historical NEW status.

Table 14: Summary of Dose Components Received as a Result of Licensed Activities for Whiteshell Laboratories [a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	465	15.94	0.31	0.05	0.03	465	17.55	0.66	0.05	0.04	26	7.06	1.38	0.35	0.27
	Contractor	99	1.24	0.17	0.05	0.01	99	1.24	0.17	0.05	0.01	0	0.00	0.00	0.00	0.00
	Visitor[c]	6	0.00	0.00	0.00	0.00	6	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
Non-NEWs	Employee	1	0.00	0.00	0.00	0.00	1	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
	Contractor	171	0.01	0.01	0.01	0.00	171	0.01	0.01	0.01	0.00	0	0.00	0.00	0.00	0.00
	Visitor	349	0.00	0.00	0.00	0.00	349	0.00	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00
Total		1,091	17.19				1,091	18.80				26	7.06			

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	-	-	-	-	-	-	-	-	-	-	2	0.00	0.00	0.00	0.00
	Contractor	-	-	-	-	-	-	-	-	-	-	0	0.00	0.00	0.00	0.00
	Visitor[d]	-	-	-	-	-	-	-	-	-	-	0	0.00	0.00	0.00	0.00
Non-NEWs	Employee	-	-	-	-	-	-	-	-	-	-	0	0.00	0.00	0.00	0.00
	Contractor	-	-	-	-	-	-	-	-	-	-	0	0.00	0.00	0.00	0.00
	Visitor	-	-	-	-	-	-	-	-	-	-	0	0.00	0.00	0.00	0.00
Total		-	-				-	-				2	0.00			

a All quantities are measured in mSv unless otherwise noted.
b Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
c Average of all measured doses that include the zero dose value, rounded to two decimal places.
d Visitor NEWs are persons who were historically employee and/or contractor NEWs, but have returned to the site as visitor while retaining their historical NEW status.

7.2.2.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2022 was 0.31 mSv and the site collective dose was 17.19 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the current five-year dosimetry period (2021 January 01 to 2025 December 31) was 0.57 mSv received by a pipe fitter.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2022 was 0.66 mSv and the site collective dose was 18.80 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2022 was 1.38 mSv and the site collective dose was 7.06 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2022, the maximum annual individual effective dose for a pregnant NEW was 0.06 mSv.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2022, the maximum individual effective dose to a non-NEW at WL was 0.01 mSv.

Table 15 provides a summary of radiation doses by worker group in 2022. The majority of radiation doses were received by RP, Nuclear Operations and Trades staff.

7.2.2.2 Radiation Dose Changes or Trends

Table 16 shows external whole body dose received from 2018 to 2022, and Figure 1 displays the maximum individual and collective dose from 2001-2022.

Worker doses decreased in 2022 with the site safety pause instituted in 2022 June.

The site collective dose decreased from 19 p-mSv in 2021 to 17 p-mSv in 2022. The number of workers receiving occupational doses above 0.2 mSv in a calendar year decreased from 11 workers in 2021 to 5 workers in 2022. This is a continued decrease compared to a maximum number of 42 workers in 2017. There were no workers receiving an annual radiation dose above 1 mSv in 2022.

Main contribution to radiation dose in 2022 was operational replacement of hot cell roughing filters. There was continued waste handling with low level waste package removal and characterization activities in the WL WMA. However, these activities had only a small contribution to site worker doses.

Table 15: Summary of Worker Group Radiation Doses at WL for 2022

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	p·mSv	p·mSv	p·mSv
Nuclear Facilities:						
SF Staff (HCF and IFTF)[c]	5	0.13	0.28	0.64	1.02	0.83
WR1 Staff	5	0.02	0.05	0.11	0.11	0
WMA and CCSF Staff[c]	8	0.03	0.09	0.22	0.22	0
Support Workgroups:						
Radiation Protection Staff [d]	49	0.06	0.31	3.09	4.08	3.77
Trades Staff [e]	105	0.04	0.15	4.38	4.62	2.46
All Remaining Staff:						
Other Staff [f]	564	0.02	0.19	8.75	8.75	0
WL Site[g]:	736	0.02	0.31	17.19	18.80	7.06

a Includes photon and neutron; there were no tritium committed effective doses for 2022.

b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.

c SF= Shielded Facilities; HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; WMA= Waste Management Area; CCSF= Concrete Canister Storage Facilities; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.

d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.

e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL site in general. In 2022 this group was expanded to include Heavy Equipment Operators and Utilities staff. There was also a large hiring campaign of trades staff.

f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.

g WL Site includes 466 CNL staff (WL and staff visiting from other CNL sites) and 270 contractors working at the WL site during 2022. This tally does not include visitor doses.

7.2.3 Program Exceedances

During 2022, radiation dose to all persons working at WL were below the WL dose Action Levels [2] and the respective CNSC regulatory limits [21]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 16: WL External Whole-Body Dose Performance 2018 to 2022

Performance Metric	2018	2019	2020	2021	2022
Site Collective Worker Dose (p-mSv)	40.2	49.6	33.4	18.9	17.2
Max Individual Worker Dose (mSv)	1.65	3.09	2.97	0.57	0.31
Number of Workers > 0.2 mSv in a year	39	38	25	11	5
Number of Workers > 1 mSv in a year	12	14	8	0	0

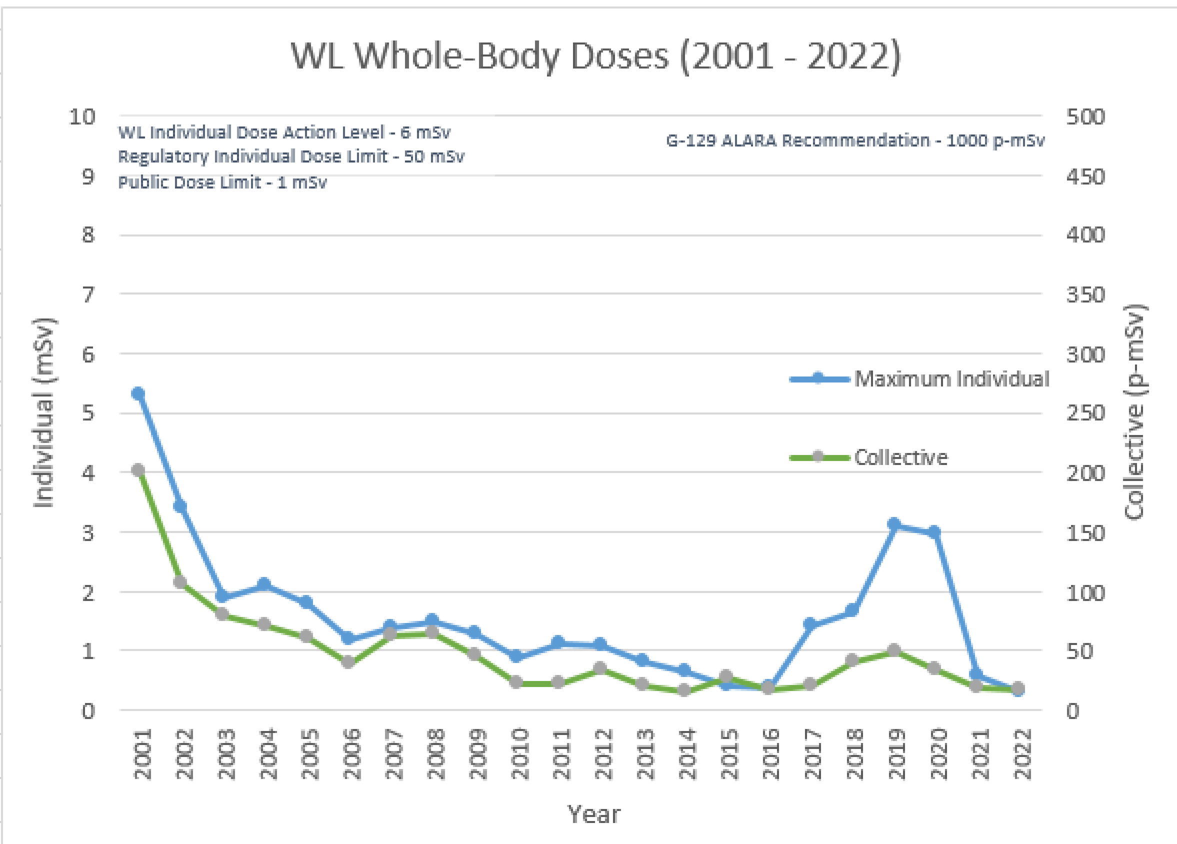

Figure 1: Whole-Body Effective Doses (2001 – 2022)

8 Conventional Health and Safety

8.1 Conventional Health and Safety Program

Whiteshell Laboratories adheres to the Corporate Conventional Health and Safety Program. See Section 8 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives began or are continuing in 2022:

- Facilitated two of the five core mandatory courses that resulted from the safety pause.
- Supported Training in delivering all OSH related courses throughout the year.
- Provided Site Safety and Health Committee training. Work place inspection training was complete with committee members in the field. Practical Training was complete using various staged hazards and members had to identify/find them while walking through the designated area.
- Completed existing Confined Space assessments throughout the WL Site (due every three years). Working with facilities on any new space assessments.
- Tracking employee exposure hours to asbestos and support the Health Centre with scheduling medical baseline testing for workers who perform asbestos type one and two abatement work. The baseline medical testing (includes chest x-rays, lung function testing) is continuing to allow for scheduled abatement work to proceed.
- Provided virtual ergonomic assessments for remote workers and in person assessments for workers on site.
- OSH personnel were present in the field at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to many of WL's safety successes.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- Continued participation in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Completed 10 internal safety advisories and 1 learning advisory which was sent to WL site employees. The bulletins inform WL employees about imminent issues that could impact their safety as a proactive approach to safety.
- Near miss reporting (a known industry best practice) continued with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 17). Near miss reporting at WL always includes an investigation/fact finding session. The majority of near miss reports also generate an ImpAct. The possibility of a human

error trap being involved in the near miss incident is always considered, evaluated and followed up as appropriate.

- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.
- Ongoing bi-weekly, quarterly and annual potable water samples were completed to test for turbidity, bacteria, mercury, metals and other materials.

Table 17: Summary of WL Near Miss Reporting

Year	2018	2019	2020	2021	2022
Near Misses Reported	53	46	10	26	19

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis, holding a minimum of (9) nine meetings per year.

In 2022, the WL Site Safety and Health Committee received 244 inquiries – 69 brought to member/OSH, and the remaining 175 from the Site Safety and Health suggestion box. Out of these 244, 42 remained open and in progress. The Site Safety and Health Committee is employee led and acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 64 site health and safety inspections completed in 2022. ImpActs were raised to address any findings from the inspections and remedial or corrective actions were taken as appropriate.

8.1.3 Hazardous Occurrence Investigation Reports and Lost-Time Injuries

There were two hazardous occurrences at WL that were reported to Employment and Social Development Canada in 2022. CNSC staff received a copy of the notifications, as per the requirements of the CNSC REGDOC-3.1.2 [3].

The following is a summary of injury rate data for the last 5 years.

Table 18: Summary of Whiteshell Laboratories Injury Rate Data

	2018	2019	2020	2021	2022
WL Employees					
Person Hours Worked	688,000	642,000	584,030	684,000	812,000
Lost-Time Injuries	1	0	1	0	0
Working Days Lost	5	0	2	0	0
Frequency[a]	0.25	0	0.34	0	0
Severity[b]	1.45	0	0.68	0	0
WL Contractors[c]					
Lost Time Injuries	0	0	0	0	0
Working Days Lost	0	0	0	0	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

c The Number of Person Hours worked are not divulged by Contractors. As such, Frequency and Severity rates cannot be calculated.

The Recordable Lost Time Injury rate over the last five years at WL in Manitoba is significantly lower than local lost-time injury rates for construction and manufacturing, as per the data from the Workers Compensation Board of Manitoba found in Table 1.4 in *The Manitoba Workplace Injury and Illness Statistics Report (safemanitoba.com).*

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2022.

9 Environmental Protection

9.1 Environmental Protection Program

Whiteshell Laboratories adheres to CNL's Environmental Protection Functional Support Area. See Section 9 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

WL has an integrated Environmental Protection Program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program, and the Groundwater Monitoring Program. The WL Environmental Protection Program is designed to implement the requirements of:

- CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [22],
- CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [23],
- CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [24],
- CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [25],
- CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [26], and
- ISO 14001:2015, *Environmental Management Systems* [27].

The integrated Environmental Protection Program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

This report will focus and discuss the implementation of the WL Effluent Verification Monitoring Plan [28]. This plan defines the methodologies and protocols followed in performing the effluent verification monitoring required in CSA N288.5-11 [23].

The WL site has maintained its ISO 14001 [27] registration in 2022 with initial registration in 2010.

The CNSC has previously been notified of revisions to *Environmental Protection documents* [29], as per the *Licence Conditions Handbook.*

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control programs as required by CSA N288.5 [23]. General quality assurance objectives for CNL's Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [30] for analytical laboratories.

Whiteshell Laboratories' Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 3764 quality verification tests during 2022 on WL's radiochemical counting equipment. Of these tests, 99.6% fully complied with acceptance criteria. The results of these tests are shown Table 19.

Table 19: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	1,201	2	99.8
Total Beta (Instrumentation)	1,210	1	99.9
Gamma (Instrumentation)	1,104	2	99.8
Tritium	249	11	95.6
2022 Total	**3,764**	**16**	**99.6**

In 2022, the WL Effluent verification program continued performing regular field Quality Verification testing on the Outfall, Lagoon, and Ditch effluent sampling (Table 20). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

Table 20: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	4	6.85	4	100
Conductivity	4	0.775	4	100
Total Organic Carbon	4	LMDL	4	75
Phenols	4	LMDL	4	100
TSS	4	LMDL	4	75
Phosphorus	4	LMDL	4	100
Oil and Grease	4	LMDL	4	100
Mercury	4	0.0021	4	100
Chromium	4	LMDL	4	100
Copper	4	39.0	4	100
Magnesium	4	0.0168	4	100
Iron	4	LMDL	4	100
Lead	4	0.4875	4	100
Nickel	4	LMDL	4	100
Potassium	4	13.3	4	100
Sodium	4	0.0158	4	100
Strontium	4	LMDL	4	100
Uranium	4	LMDL	4	100
Zinc	4	2.55	4	100
Bromodichloromethane	4	LMDL	4	100
Chloroform	4	2.75	4	100
Manganese	4	LMDL	4	75
Radiological Parameters:				
Gross Alpha	N/A	N/A	2	50
Gross Beta	N/A	N/A	2	50
Cesium-137	N/A	N/A	2	50
Americium-241	N/A	N/A	2	50

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Potassium-40	N/A	N/A	2	50
Lead-214	N/A	N/A	2	100
Beryllium-7	N/A	N/A	2	50
Strontium-90	N/A	N/A	2	50
Plutonium-238	N/A	N/A	2	100
Plutonium-239/240	N/A	N/A	2	100
Sewage Lagoon				
Un-ionized Ammonia	1	<LMDL	N/A	N/A
Total Residual Chlorine	1	<LMDL	N/A	N/A
pH	1	6.62	N/A	N/A
Phosphorus	1	<LMDL	N/A	N/A
TSS	1	<LMDL	N/A	N/A
Chromium	1	<LMDL	N/A	N/A
Copper	1	<LMDL	N/A	N/A
Iron	1	<LMDL	N/A	N/A
Lead	1	<LMDL	N/A	N/A
Nickel	1	<LMDL	N/A	N/A
Zinc	1	<LMDL	N/A	N/A
Mercury	1	<LMDL	N/A	N/A
Phenolics	1	<LMDL	N/A	N/A
Oil & Grease	1	<LMDL	N/A	N/A
Ditches				
Non-Radiological Parameters:				
pH	1	6.28	3	100
Conductivity	1	<LDML	3	100
Phenols	1	<LDML	3	100
TSS	1	<LDML	3	67
Phosphorus	1	< LMDL	3	100
Oil and Grease	1	< LMDL	3	100
Mercury	1	< LMDL	3	67

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Chromium	1	< LMDL	3	100
Copper	1	<LMDL	3	100
Iron	1	< LMDL	3	100
Lead	1	<LMDL	3	100
Nickel	1	<LMDL	3	100
Zinc	1	<LMDL	3	67
Radiological Parameters:				
Gross Alpha	1	< LMDL	3	100
Gross Beta	1	< LMDL	3	100
Tritium	1	< LMDL	3	100
Cesium-137	1	< LMDL	3	100
Americium-241	1	< LMDL	3	100
Cobalt-60	1	< LMDL	3	100
Radium-228	1	< LMDL	3	100
Europium-154	1	< LMDL	3	100
Lead-210	1	< LMDL	3	100
Thorium-228	1	< LMDL	3	100
Thorium-230	1	< LMDL	3	100
Thorium-234	1	< LMDL	3	100
Uranium-235	1	< LMDL	3	100
Radium-226	1	< LMDL	3	100
Actinium-228	1	< LMDL	3	100
Potassium -40	1	< LMDL	3	100
2022 Total	**224**	**--**	**195**	**93%**

LMDL = Laboratory Method Detection Limit

Out of the 195 duplicate quality verification tests, 182 of these tests meet the acceptance criteria (+/- 20% of the actual result) of the program, to yield a 93% pass rate.

In 2022, the WL Environmental Management group took part in three inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other study which focused on non-radiological analyses, was offered through the Canadian Association for Laboratory

Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 21 and Table 22. There was only one inter-laboratory testing performed on the non-radiological parameters in 2022, as CNL was unable to participate in the March testing.

There were also two individual tests in the fall Radiological testing that CNL was unable to perform due to laboratory equipment being taken out of commission for servicing. This prevented CNL from being able to process the Gross Alpha and Gross Beta in water samples for MRAD-37.

For all inter-laboratory tests pertaining to the effluent verification monitoring program CNL had a 100% passing rate.

Table 21: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2022

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-36	Air Filter Radionuclides	Americium-241	(pCi/Filter)	21.0	21.72	15.0-28.0	Acceptable
MRAD-36	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	549	461.98	356-673	Acceptable
MRAD-36	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	1,320	1,342.78	1,080-1,730	Acceptable
MRAD-36	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	885	911.00	752-1,120	Acceptable
MRAD-36	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	671	766.55	550-1,030	Acceptable
MRAD-36	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	94.2	95.83	49.2-155	Acceptable
MRAD-36	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	66.8	66.8	40.5-101	Acceptable
MRAD-36	Water Radionuclides	Americium-241	pCi/L	74.6	70.62	51.2-95.4	Acceptable
MRAD-36	Water Radionuclides	Cesium-134	pCi/L	1,720	1,470.33	1,300-1,890	Acceptable
MRAD-36	Water Radionuclides	Cesium-137	pCi/L	1,120	1,052.84	959-1,270	Acceptable
MRAD-36	Water Radionuclides	Cobalt-60	pCi/L	2,710	2,628.91	2,340-3,110	Acceptable
MRAD-36	Water Radionuclides	Zinc-65	pCi/L	1,220	1,268.39	1,090-1,540	Acceptable
MRAD-36	Water Gross Alpha/Beta	Gross Alpha	pCi/L	79.4	59.67	29.0-109	Acceptable
MRAD-36	Water Gross Alpha/Beta	Gross Beta	pCi/L	65.0	79.76	32.5-89.4	Acceptable
MRAD-36	Water Tritium	Tritium	pCi/L	28,200	27,971.56	21,300-34,300	Acceptable
MRAD-37	Air Filter Radionuclides	Americium-241	(pCi/Filter)	38.8	40.1	27.7-51.7	Acceptable
MRAD-37	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	325	265	211-399	Acceptable

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-37	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	795	765	653-1,040	Acceptable
MRAD-37	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	191	194	162-243	Acceptable
MRAD-37	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	120	132	98.4-183	Acceptable
MRAD-37	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	55.5	65	29.0-91.4	Acceptable
MRAD-37	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	64.8	63.5	39.3-97.9	Acceptable
MRAD-37	Water Radionuclides	Americium-241	pCi/L	96.2	96.2	66.0-123	Acceptable
MRAD-37	Water Radionuclides	Cesium-134	pCi/L	483	421	365-531	Acceptable
MRAD-37	Water Radionuclides	Cesium-137	pCi/L	1,250	1,204	1,070-1,420	Acceptable
MRAD-37	Water Radionuclides	Cobalt-60	pCi/L	1,420	1,392	1,220-1,630	Acceptable
MRAD-37	Water Radionuclides	Zinc-65	pCi/L	122	129	109-154	Acceptable
MRAD-37	Water Gross Alpha/Beta	Gross Alpha	pCi/L	-	-	-	Unable to perform
MRAD-37	Water Gross Alpha/Beta	Gross Beta	pCi/L	-	-	-	Unable to perform
MRAD-37	Water Tritium	Tritium	pCi/L	18,800	18,278	14,200-22,900	Acceptable

* MRAD: Multi-Media Radiochemistry

Table 22: Proficiency Testing Canada Accreditation Inter-Laboratory Comparison Program CNL WL - 2022

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2022	CO1A-1	Conductivity	(µS/cm)	-	-	-	-
	CO1A-2	Conductivity	(µS/cm)	-	-		
	CO1A-3	Conductivity	(µS/cm)	-	-		
	CO1A-4	Conductivity	(µS/cm)	-	-		
March -2022	CO4A-1	TSS	(mg/L)	-	-	-	-
	CO4A-2	TSS	(mg/L)	-	-		
	CO4A-3	TSS	(mg/L)	-	-		
	CO4A-4	TSS	(mg/L)	-	-		
March -2022	C15-1	pH	(pH units)	-	-	-	-
	C15-2	pH	(pH units)	-	-		
	C15-3	pH	(pH units)	-	-		
	C15-4	pH	(pH units)	-	-		
October-2022	CO1A-1	Conductivity	(µS/cm)	689	689	100	Acceptable
	CO1A-2	Conductivity	(µS/cm)	483	483		
	CO1A-3	Conductivity	(µS/cm)	434	434		
	CO1A-4	Conductivity	(µS/cm)	328	329		
October-2022	CO4A-1	TSS	(mg/L)	186	175	89	Acceptable
	CO4A-2	TSS	(mg/L)	139	133		
	CO4A-3	TSS	(mg/L)	18	16		
	CO4A-4	TSS	(mg/L)	72	66		
October-2022	C15-1	pH	(pH units)	5.2	5.14	90	Acceptable
	C15-2	pH	(pH units)	4	3.93		
	C15-3	pH	(pH units)	8.98	8.87		
	C15-4	pH	(pH units)	7.12	7.10		

9.3 Supplementary Studies

In 2020, the WL site began to do temporary enhanced monitoring on the effluent verification ditches for the year. The enhanced monitoring is being done to confirm the absence of a number of radiological and non-radiological parameters. The enhanced monitoring involved doing an open scan for Volatile Organic Carbons, semi-volatile organic carbons, and an expansion of the metals and gamma isotopes list currently being used to monitor the ditches.

This study was concluded in 2022. Whiteshell is reviewing the data, and is evaluating the need for additional parameters within the effluent verification monitoring program.

9.4 Effluent Monitoring – Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [31] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, *Environmental Monitoring in 2022 at Whiteshell Laboratories* [32] and *2022 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [31].

9.4.1 Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable Derived Release Limits (DRLs) [33]. The DRLs in use at WL came into effect on 2021 January 31. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction and analysis of individual beta emitting radionuclides, such as Strontium (Sr)-90, complemented by examination of historical data.

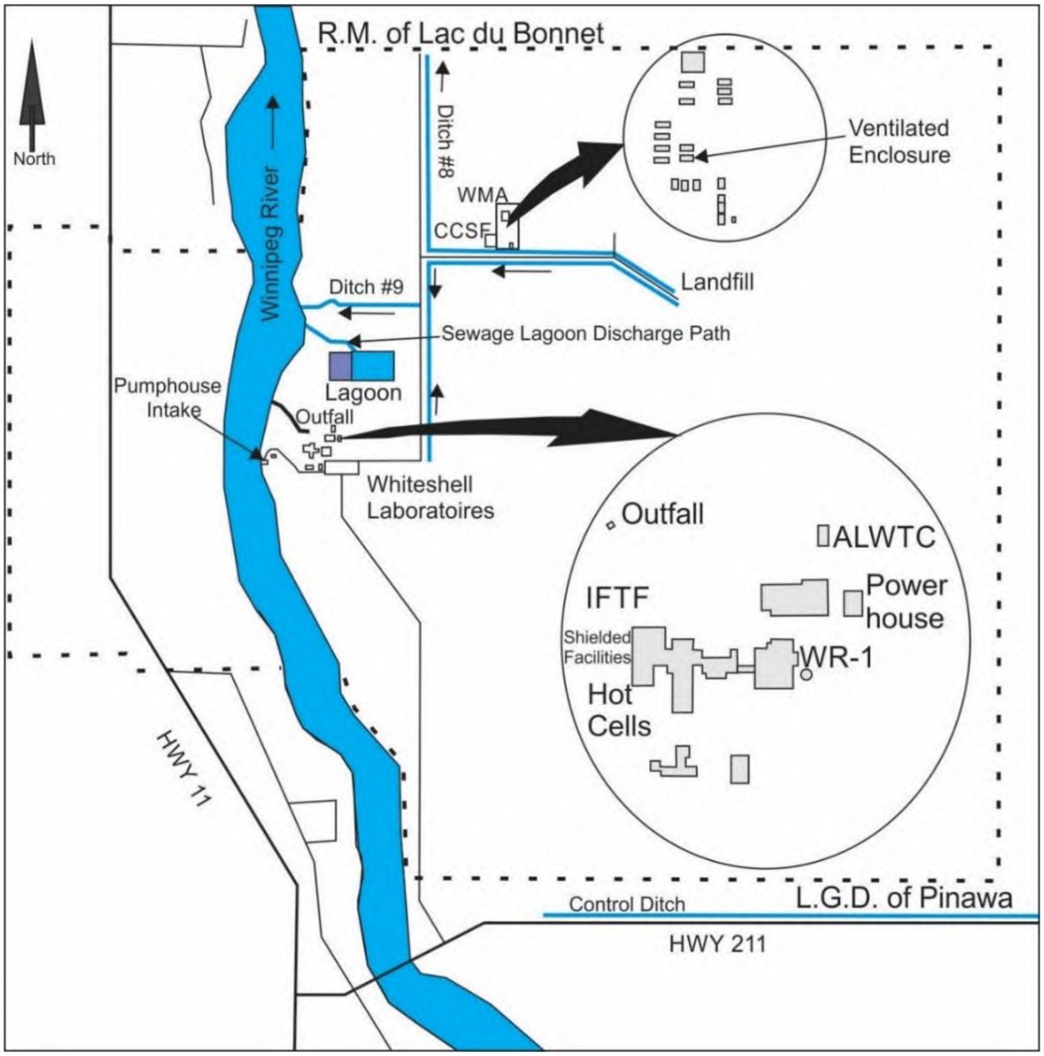

Figure 2: Effluent Monitoring Locations

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in CSA N288.1-08 [34]. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [35]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[4] that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3, the increase in 2019 to 2022 liquid effluents is due to an increase in detection limit values for Am-241 and Plutonium (Pu)-239/240. When the activities of radionuclide contaminants are not detected it is standard practice to report detection limit values as if they were observed concentrations. For example, Pu isotope activities were always detection level values and Am-241 and Cs-137 activities are very close to detection levels.

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Administrative and Action Levels[5] as specified in Reference [36]. The Action Levels were calculated based on current CNSC guidance to meet CSA N288.8 [26] and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

[4] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).

[5] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

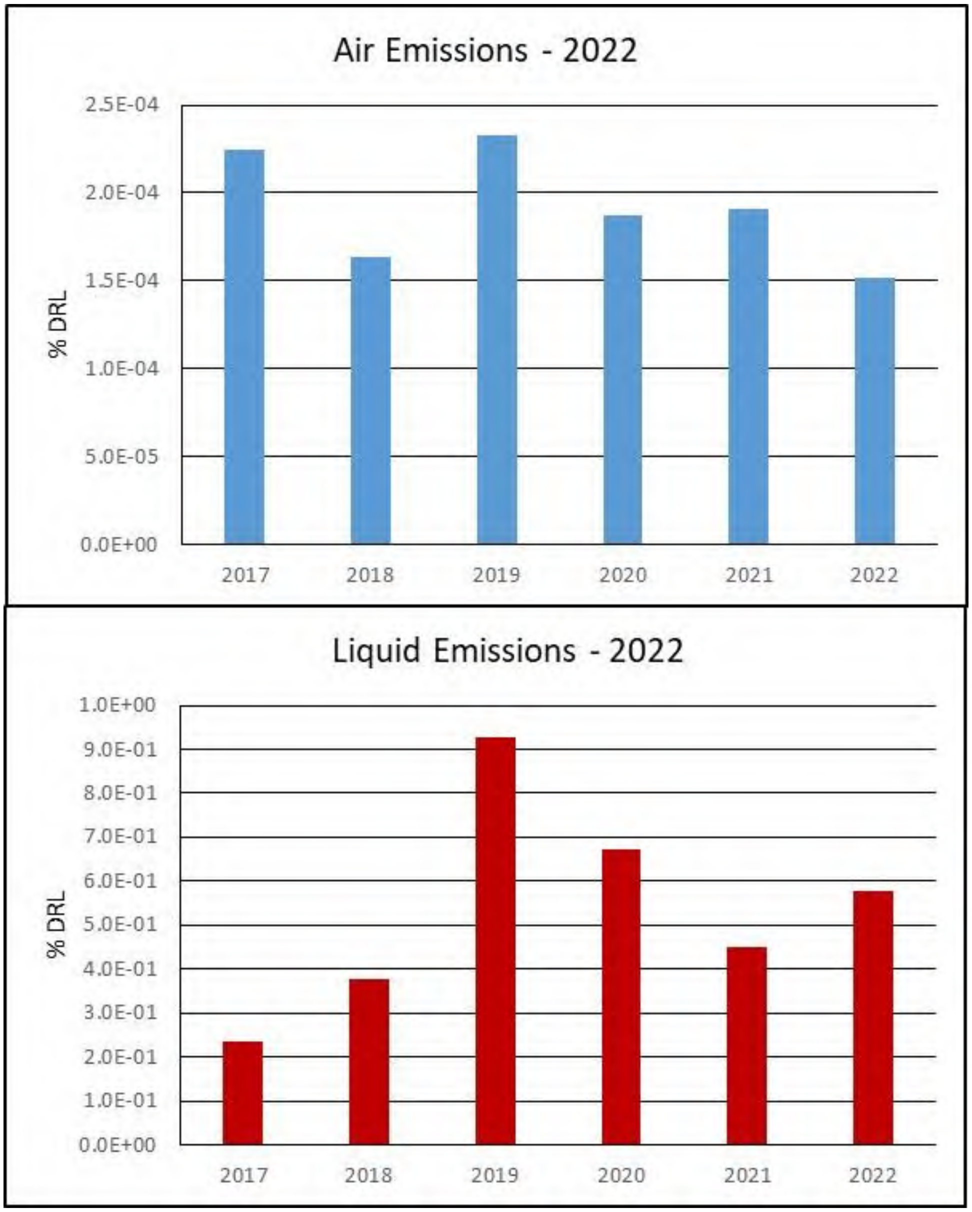

Figure 3: Trends for Airborne and Liquid Emissions form WL for 2017 to 2022

9.4.1.2 Airborne Effluent Monitoring

9.4.1.2.1 Monitoring Points, Schedules and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)

Air effluents from Buildings 100 and 300 were sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 23. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns.

Table 23: Radiological Air Effluent Monitoring Schedule – 2022

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
Building 100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
Building 300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
Building 300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured but passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water Bubbler for tritium.

W Weekly

N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The WL maintenance planning team performs the measurements for the stack flows and the RP team measures the sampler flow. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [33]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (Sr-90 for gross beta and Pu-239 and Pu-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 24 and Figure 3 for the years 2017 to 2022. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also include tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. The reader should be aware that the values for 2022 in Table 24 represent averages that include detection limit values where nothing has actually been detected.

Airborne emissions remain a small fraction of the release limit. The result for 2022 (0.00015% of the DRL) is lower than in 2021 and the average for the last five years. Total site gross alpha in 2022 is lower than in 2021 and the last five years average. It remains near detection limit values. The gross beta emissions are less than in 2021 and the last five-year average. In 2022, the air emissions from all facilities were below Administrative Levels and regulatory Action Levels. In 2021, Building 200 was demolished no longer contributes to air emissions. The average values of the previous five years shows that Building 200 had contributed 16 percent of the total alpha air emissions and 8 percent of the total beta air emissions.

Tritium emissions from the WR-1 stack were slightly higher than in 2021 and the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative level (7.29E+09 Bq/week) for the facility and well below the Action Level (3.30E+10 Bq/week) and DRL (1.65E+15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence.

Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Building 100, and work in the Shielded Facilities and Concrete Canister Storage Facility. Environmental airborne dust monitoring was performed close to the east, north, west and south boundaries of the WL campus during building demolitions. The results of the 2022 dust monitoring are described in the *2022 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [31].

Table 24: Radionuclides in Air Effluents from WL Facilities – 2017 to 2022

Location/ Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	2019 (Bq/wk)	2020 (Bq/wk)	2021(Bq/ wk)	Five-Year Average		2022		2022 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building (B100)													
Gross Alpha[b]	1.73E+09	3.34E+04	3.82E+02	2.65E+02	2.89E+02	3.07E+02	4.16E+02	3.32E+02	1.92E-05	2.79E+02	1.61E-05	7.97E+02	4.60E-05
Gross Beta[b]	6.79E+09	1.51E+05	1.83E+03	1.07E+03	1.95E+03	1.62E+03	2.34E+03	1.76E+03	2.59E-05	8.27E+02	1.22E-05	4.78E+03	7.04E-05
Tritium	1.65E+15	2.83E+10	9.68E+08	2.51E+08	6.43E+08	2.51E+08	5.19E+08	5.26E+08	3.19E-05	5.36E+08	3.25E-05	9.03E+08	5.47E-05
ALWTC (B200)													
Gross Alpha	1.73E+09		2.37E+02	3.13E+02	3.12E+02	3.80E+02	N/A	3.10E+02	1.79E-05				
Gross Beta	6.79E+09		2.92E+02	3.24E+02	4.54E+02	4.59E+02	N/A	3.82E+02	5.63E-06				
HCF (B300)													
Gross Alpha	1.73E+09	1.70E+04	6.00E+02	6.00E+02	6.10E+02	6.00E+02	6.19E+02	6.06E+02	3.50E-05	6.00E+02	3.47E-05	6.00E+02	3.47E-05
Gross Beta	6.79E+09	7.79E+04	1.15E+03	1.04E+03	2.05E+03	8.43E+02	1.07E+03	1.23E+03	1.81E-05	9.07E+02	1.34E-05	6.64E+03	9.78E-05
IFTF (B300)													
Gross Alpha	1.73E+09	1.61E+04	5.78E+02	5.78E+02	5.78E+02	6.37E+02	5.78E+02	5.90E+02	3.41E-05	5.78E+02	3.34E-05	5.78E+02	3.34E-05
Gross Beta	6.79E+09	2.37E+05	1.04E+03	8.41E+02	1.84E+03	1.18E+03	1.08E+03	1.19E+03	1.76E-05	6.35E+02	9.35E-06	1.79E+03	2.64E-05
Total Tritium (as %DRL)			5.87E-05	1.52E-05	3.90E-05	1.52E-05	3.15E-05	5.26E+08	3.19E-05	5.36E+08	3.25E-05	9.03E+08	5.47E-05
Total Alpha (as %DRL)			1.04E-04	1.02E-04	1.03E-04	1.11E-04	9.32E-05	1.78E+03	1.06E-04	1.46E+03	8.42E-05	1.97E+03	1.14E-04
Total Beta (as %DRL)			6.23E-05	4.73E-05	9.21E-05	6.04E-05	6.61E-05	4.49E+03	6.73E-05	2.37E+03	3.49E-05	1.32E+04	1.95E-04
Total (%DRL)			**2.25E-04**	**1.64E-04**	**2.33E-04**	**1.87E-04**	**1.91E-04**	**2.05E-04**		**1.52E-04**		**3.64E-04**	

a The DRL's shown are for members of the public at the WL boundary as described in reference [33].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A – Not applicable

9.4.1.3 Liquid Effluent Monitoring

9.4.1.3.1 Monitoring Points, Schedules and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the process water outflow (Outfall), the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the Outfall, which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways, around buildings through the weeping tile system, cooling water used in process and experimental facilities, and discharges from the Low Level Liquid Waste treatment systems tanks based in Building 100 and Building 300. The Active Liquid Waste Treatment Centre (ALWTC) was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 25.

Table 25: Radiological Liquid Effluent Monitoring Schedule – 2022

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	Frequency	Method	Beta Screen	Gross Beta	Gross Alpha	Tritium	Gamma Spec (liquid)	Gamma Spec (ash)	Sr-90 (ash)	U-238 Pu-239/240 Pu-238	C-14
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wc	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, up to twice a year for the Lagoon.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2021 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2022 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers in 2018, which reduced the contribution from the washing of footwear. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4 L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 32 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (Am-241, Cs-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for Pu-239/240, Pu-238 and Pu-241 isotopic analyses. Monitoring for Carbon (C-14) and tritium in Outfall samples was initiated in 2020 because they are known to exist in WR-1, and decommissioning activities have a potential for releasing these isotopes. The activities of tritium and C-14 at the Outfall continued to be below the lower limits of detection.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. The minimum residence time for the lagoon is equal to the amount of time the secondary cell is isolated from the primary cell, to allow for biodegradation and settling. This is typically around 45 days. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail in Section 9.5.1.4.5.1). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon's north side. In 2022, the effluent from the Lagoon was discharged in October.

Whenever there is a discharge from the Lagoon, the outflow is continuously sampled. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium, and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at sampling locations 7 and 8 in Ditch 8 (see Figure 15), are released to the Winnipeg River through Ditches 8 and 9 (Figure 2). Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (687 mm) in 2022 was significantly more than in 2021 (395 mm), and in 2020 (441 mm). The spring precipitation in 2022 April and May was 2 to3 times higher than normal. June precipitation was normal, while July was dry. August was above normal, while the remaining months of 2022 had normal amounts of precipitation. As a result of the 2022 precipitation, ditches were sampled during April, May, June, July and August.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[6]. The samples are analyzed for gross alpha, gross beta, gamma spec and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are submitted for radio strontium analysis. Uranium activities are calculated from uranium concentrations obtained from total metals analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [33]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cs-137 for beta activity and Pu-239 and Pu-240 for alpha activity. With the introduction of total uranium (U) and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

9.4.1.3.2 Monitoring Results

The liquid emission results are summarized in Table 27 and Figure 3 for the years 2017 to 2022. Average monthly emissions, in Becquerels, are shown for gross alpha, gross beta, total U (including U-234, U-235, and U-238), Am-241, Sr-90 and Cs-137 for the releases from the Outfall and the Lagoon. The monitoring of tritium from the Outfall began in 2019. In addition, quarterly activities of Pu-239/240 and Pu-238 were reported for Outfall effluents. A plot of the monthly Cs-137 and Sr 90 releases as Bq from the Outfall in 2022 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of Sr-90 and Cs-137 from the tanks in 2022 were 1.05E+06 Bq and 4.03E+06 Bq, respectively. These releases were only a fraction of the total Sr-90 (2.24E+07 Bq) and Cs-137 (8.20E+06 Bq) releases from the Outfall. There was good correlation between the patterns of releases from the tanks with the pattern of releases from the Outfall. Normally 1 to 3 tank volumes are discharged per month. However, due to the previously mentioned significantly higher precipitation in 2022, the number of discharged tanks increased in April, May, June, July and August to 7, 11, 6, 3, and 5, respectively. This led to a spike in radioactivity discharged

[6] The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

during these months. The additional Sr-90 and Cs-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical site contamination events and historical radioactivity disposition in the storm drain line from Building 200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970’s, although more likely from the Building 200 drain line.

Note, all monthly releases from the Outfall were well below the administrative release levels of 1.18E+07 Bq/month for gross alpha, 9.39E+07 Bq/month for gross beta and 7.29E+09 Bq/month for tritium [7]. Releases of gross alpha were less than the 2021 releases and the five year average. Gross beta releases in 2022 were higher than the 2021 releases and less than the five year average. Sr-90 releases in 2022 were less than in 2021 and the five year average. The Cs-137 releases were less than the 2021 releases and the five year averages. Am-241 releases were less than 2021 releases, and the five year average. The total uranium releases were higher than in 2021 and the five year average. The relatively constant emissions of gross alpha, gross beta, Sr-90 and Cs-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Pu-239/240 and Pu-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.2). In 2022, Outfall water was also analyzed for the presence of C-14, which could be introduced by the discharge tanks from Building 100. C-14 was below detection levels (varying from 1.03 to 1.52 Bq/L) in Outfall samples. Given that the DRL for C-14 is 7.67E+10 Bq/month, a detection limit of 1.52 Bq/L would correspond to a %DRL value of 0.21.

As stated above the Lagoon was discharged in October of 2022. In 2022 the lagoon contributed 14.6% to the total liquid discharges from the site. From 2016 till 2020, the Lagoon discharge contributed 3 to 23 percent of the total effluent discharge.

The averaged results for the two drainage ditches and control sample are shown in Table 26. The reported errors are the standard deviations of parameter values indicating their variability between different sampling events.

[7] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the ALARA process.

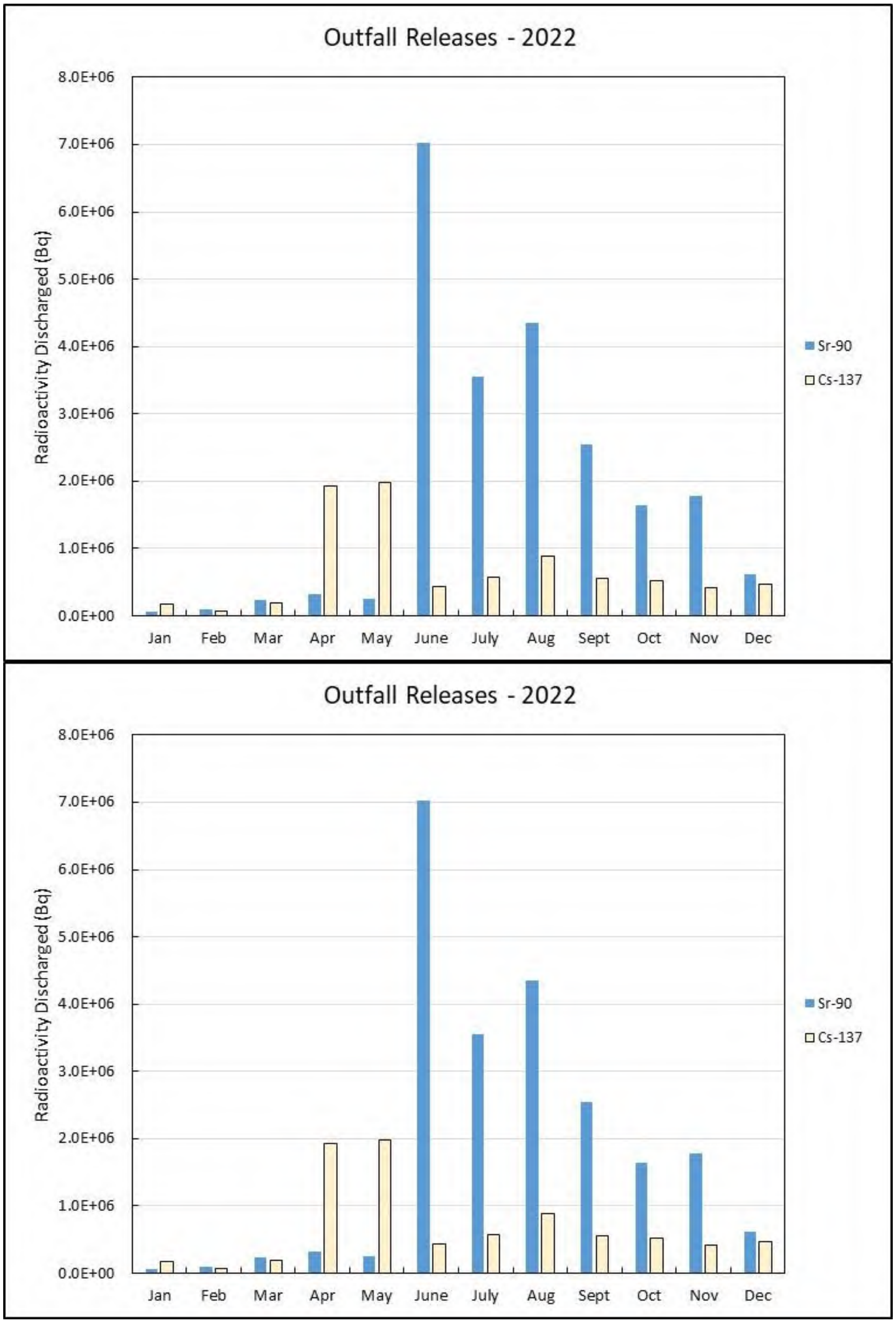

Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2022

Table 26: Annual Mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2017 to 2022

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2017**	**2018**	**2019**	**2020**	**2021**	**Five-Year Average**	**2022[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.14	0.52	0.19	0.12	0.13	0.22	0.32 ± 0.06
Gross Alpha	0.50	0.07	0.11	0.18	0.15	0.10	0.05	0.12	0.23 ± 0.04
Tritium	7,000	3	4.8	5.3	5.5	4.3	4.6	4.9	4.9 ± 1.7
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.13	0.32	0.20	0.11	0.24	0.20	0.35 ± 0.12
Gross Alpha	0.50	0.07	0.09	0.16	0.20	0.06	0.07	0.12	0.25 ± 0.09
Tritium	7,000	3.00	21.1	9	10	6.5	4.7	10	6.2 ± 4.5
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.15	0.14	0.19	0.11	0.17	0.15	0.33 ± 0.09
Gross Alpha	0.50	0.07	0.10	0.22	0.114	0.07	0.05	0.11	0.27 ± 0.11
Tritium	7,000	4	4.67	<4	<4	4.7	4.4	4.4	4.1 ± 0.7

a Compliance with Guidelines for Canadian Drinking Water [37] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. LLD is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.

b LLD = Lower Limit of Detection.

c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2022, the gross beta activities in Ditches 8 and 9 were higher than in 2021. The 2022 gross alpha activities were higher in Ditch 8 and in Ditch 9 compared to 2021. The average gross beta values were similar to the control sample collected off of Highway 211, given the variability in their values. The gross alpha values were similar to the control ditch. The control sample is unaffected by CNL's operations. Compliance with the *Guidelines for Canadian Drinking Water Quality* [37] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [38] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amounts measured in drainage Ditch 8 (4.9 ± 1.7 Bq/L) and Ditch 9 (6.2 ± 4.5 Bq/L) were not significantly different from that noted at the control location (4.1 ± 0.7 Bq/L). A number of ditches close to WMA are known to contain tritium. In 2022, the amount of tritium reaching the Ditch 8 and 9 locations was not significant. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [37].

Table 27 summarizes the data for releases of liquid effluents[8] for the years 2017 to 2022. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2022 was 0.58 % of the DRL, which is higher than 2021 and the five-year average (0.54%). The main reason for the higher 2019, 2020, 2021 and 2022 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release from the Outfall in 2022 was Pu-239/240 at 0.40 % of the DRL. The lagoon was discharged in 2022 October.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 28) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

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[8] The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [37] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 27: Radionuclides in Liquid Effluents from WL – 2017 to 2022

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	2019 (Bq/mo)	2020 (Bq/mo)	2021 (Bq/mo)	Five-Year Average		2022		2022 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.18E+08	2.20E+06	2.86E+06	4.23E+06	3.99E+06	2.33E+06	3.12E+06	-	1.54E+06	-	4.54E+06	-
Uranium-total	1.25E+10	N/A	1.24E+06	9.13E+05	1.05E+06	9.65E+05	9.28E+05	1.02E+06	9.18E-02	1.29E+06	1.04E-02	2.92E+06	2.33E-02
Plutonium-239/240	1.11E+09	N/A	5.76E+05	1.89E+06	3.19E+06	2.32E+06	1.86E+06	1.97E+06	1.77E-01	2.00E+06	1.80E-01	4.42E+06	3.98E-01
Plutonium-238	1.16E+09	N/A	7.24E+05	1.53E+06	4.05E+06	1.99E+06	1.86E+06	2.03E+06	1.83E-01	1.95E+06	1.68E-01	3.95E+06	3.40E-01
Americium-241	1.04E+09	N/A	1.49E+05	1.07E+05	1.06E+06	9.76E+05	9.70E+05	6.53E+05	5.88E-02	5.97E+05	5.74E-02	1.41E+06	1.35E-01
Gross Beta[b]	-	4.7E+08	2.06E+07	1.36E+07	2.06E+07	1.98E+07	1.26E+07	1.74E+07	-	1.48E+07	-	4.72E+07	-
Strontium-90	1.30E+10	N/A	4.83E+06	2.39E+06	3.11E+06	2.41E+06	1.99E+06	2.95E+06	2.27E-02	1.87E+05	1.44E-02	7.02E+06	5.40E-02
Cesium-137	1.16E+10	N/A	1.51E+06	1.26E+06	1.14E+06	1.03E+06	8.63E+05	1.16E+06	1.00E-02	6.84E+05	5.89E-03	1.98E+06	1.71E-02
Tritium	6.80E+13	3.30E+10			3.76E+08	4.09E+08	3.48E+08	N/A		4.97E+08	7.30E-04	1.23E+09	1.81E-03
LAGOON													
Gross Alpha[a]	1.11E+09	6.21E+07	1.03E+06	3.92E+05	6.17E+05	1.57E+06	N/A	7.21+05	6.21E-02	7.01E+05	-	7.01E+05	-
Uranium-total	1.25E+10	N/A	1.66E+05	5.49E+04	1.92E+05	1.19E+05	N/A	NA		4.77E+06	3.82E-02	4.77E+06	3.82E-02
Americium-241	1.04E+09	N/A	2.76E+05	2.44E+05	6.17E+05	5.22E+05	N/A	NA		7.47E+04	7.18E-03	7.47E+04	7.18E-03
Pu-239/240[a]	1.11E+09	N/A	4.22E+05	4.52E+04	7.28E+05	9.67E+05	N/A	NA		1.01E+06	9.08E-02	1.01E+06	9.08E-02
Gross Beta	-	1.94E+08	4.14E+06	2.53E+06	8.00E+06	1.04E+07	N/A	5.02E+06	-	4.10E+06	-	4.10E+06	-
Strontium-90	1.30E+10	N/A	7.26E+05	2.82E+05	1.85E+06	2.35E+06	N/A	1.04E+06	8.01E-03	6.68E+05	5.14E-03	6.68E+05	5.14E-03
Cesium-137	1.16E+10	N/A	6.43E+04	2.44E+02	6.17E+05	5.22E+05	N/A	2.41E+05	2.08E-03	1.24E+04	1.07E-04	1.24E+04	1.07E-04
TOTAL as %DRL	**-**	**-**	**2.61E-01**	**3.79E-01**	**9.27E-01**	**6.71E-01**	**4.52E-01**		**5.38E-01**		**5.78E-01**		**1.11E+00**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 and Cs-137 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 28: Effluents Monitoring Equipment Unavailability – 2022

	Unavailability Criteria[a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 28) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2022, there were no instances in which the unavailability criteria (Table 28) outlined above were exceeded. In fact there were 0 hours of planned or unplanned unavailability of monitoring for air and liquid effluents. Had there been an instance of monitoring unavailability, an estimate of the release during unavailability would be calculated as per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 24 and Table 27 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2017 to 2022. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2022 were below CNL's Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [33]. All air emissions were below CNL's Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2022 continue to be very low, averaging 0.00015% of the DRL, which is lower than 2021 and lower than the five year average.

Radioactivity in the WL liquid releases for 2022 was 0.58% of the DRL which is higher than in 2021 (0.45%) and the last five-year average (0.54%). The main reason for the higher 2019 to 2022 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Pu-239/240, at detection limit values, was the primary contributor to the Outfall, averaging 0.18% of the DRL. Another factor for higher liquid releases in 2022 was the above average level of precipitation which increased the total amount of released radioactivity. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2022 release results, as well as the previous years' trends, indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement on hazardous substances monitoring of liquid and airborne effluents for the WL site for 2022. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [31].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedules, and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Lagoon at point of discharge to the Lagoon drainage ditch, the Outfall, the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low-Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are used as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial Highway 211. More details for each monitoring area are provided in the sections that follow.

Referring to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 29 lists the non-radiological parameters monitored at the inlet and effluent streams sampled, and the sampling schedule that is followed. The WL monitoring program follows the protocols from the Ontario Ministry of Environment [39] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups. These are described in Table 30, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment. The LMDL and Smallest Reporting Increment were decided following protocol. The WL monitoring program also meets the requirements set out in the Federal Wastewater Systems Effluent Regulations [40], and the standards from CSA N288.5-11, *Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [23].

Table 29: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS Tanks	
						Building 300-LLLWTS	Building 100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	Quarterly	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
5b	Total Organic Carbon	Monthly	-	Discharge	-	-	-
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9a	Magnesium	Monthly	-	Discharge	-	-	-
9	Manganese	Monthly	-	Discharge	-	-	-
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
-	Potassium	Monthly	-	Discharge	-	-	-
9	Strontium	Monthly	-	Discharge	-	-	-
9a	Uranium	Monthly	-	Discharge	-	-	-
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
16	Bromodichloromethane	Monthly	-	Discharge	-	-	-
16	Chloroform	Monthly	-	Discharge	-	-	-
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.

b The Monthly = grab sample taken once within each month.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

In 2022, there was one discharge of the Lagoon during the fall.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were twelve sampling events in 2022.

Whenever a tank was discharged at either of the LLLWTS, the effluent was sampled.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [39]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system supplies a justifiable set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into Analytical Test Groups, listed in Table 30. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses, and result reporting.

Table 30: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.001
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.020
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
5b	Total Organic Carbon	High Temperature Combustion	mg/L	-	-	-	0.5
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9a	Magnesium	ICP	mg/L	--	--	--	0.05
9	Manganese	ICP	mg/L	--	--	--	0.001
9	Nickel	ICP	mg/L	0.02	--	--	0.001
-	Potassium	ICP	mg/L	--	--	--	0.05
9	Strontium	ICP	mg/L	--	--	--	0.001
9a	Uranium	ICP	mg/L	--	--	--	0.0001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0019
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
16	Bromodichloromethane	GC-MS	mg/L	--	--	--	0.0005
16	Chloroform	GC-MS	mg/L	--	--	--	0.0005
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.

b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a common estimate of bacterial counts, especially for sewage effluent.

c RMDL = Regulation Method Detection Limit

d The LMDL = Laboratory Method Detection Limit (“MDL” also used).

e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is found for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results because of equipment failure, maintenance/calibration outages or operator action requiring “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 28) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2022, there were no instances in which the unavailability criteria (Table 28) outlined above were exceeded. In fact there were 0 hours of planned or unplanned unavailability of monitoring for air and liquid effluents. Had there been an instance of monitoring unavailability, an estimate of the release during unavailability would be calculated as per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2022. These include an averages summary table and a comparison against the CNL's Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2022 are presented in Table 31 through Table 35. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [39]. The next three give the CNL monthly guideline concentration, LMDL (Table 30) and units for each measurement. The next six columns provide comparison of the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven columns have a summary of the results for the 2022 monitoring period (explained further below).

WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 30.

Within the 2022 results section, the number of samples included in the average ("# Spl.") is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled "ND's") gives the number of samples in which the analyte was not detected and was therefore deemed a "zero" result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables found at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number allows some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 32 through Table 35, yearly average values for parameters marked with an asterisk show that a monthly guideline was exceeded for at least one month during the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected in Table 37, and compared to the previous five years).

Table 31: Water Quality Averages Summary for Site Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2022							
ATG	**Parameter**	**Monthly Guide[b]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.[a]**	**RSTD (%)[e]**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.42	7.41	7.43	7.17	7.66	7.42	12	0	6.82	7.85	7.49	4.29	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	9.0	8.4	8.7	12	0	8.3	11	9.4	10.3	72000
6	Phosphorus	1.0	0.003	mg/L	0.026	0.020	0.017	0.014	0.014	0.018	12	0	0.015	0.033	0.023	21.1	176
7	Conductivity	N/A	2.0	µS/cm	93.0	107	107	98	101	101	12	0	95	120	105	6.92	N/A
8	TSS	25	1.0	mg/L	3.03	2.05	3.15	3.80	2.23	2.85	12	2	0	8.9	3.67	75.4	27863
9	Chromium	0.5	0.001	mg/L	0	0.0001	0.0005	0.0006	0.0005	0.0003	12	12	0	0	0	0	0
9	Copper	0.5	0.0005	mg/L	0.004	0.005	0.007	0.007	0.007	0.006	12	0	0.0013	0.0093	0.005	47.0	40
9a	Iron	1.0	0.01	mg/L	0.310	0.233	0.331	0.242	0.247	0.273	12	0	0.120	0.475	0.275	35.8	2096
9	Lead	0.1	0.0002	mg/L	0.0002	0.0001	0.0001	0.0001	0.0001	0.0001	12	7	0	0.0031	0.0001	126	0.81
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	3.62	3.70	3.66	12	0	3.17	4.64	3.78	10.85	28864
9	Manganese	-	0.001	mg/L	-	-	-	-	-	-	12	0	0.0072	0.0274	0.0153	36.1	118
9	Nickel	0.5	0.001	mg/L	0	0	0.0001	0.0002	0.0025	0.0006	12	10	0	0.0012	0.0002	234	1.52
9	Potassium [f]	-	0.05	mg/L	-	-	-	0.823	0.810	0.817	12	0	0.677	1.030	0.908	11.3	6913
9	Sodium [f]	-	0.05	mg/L	-	-	-	2.23	2.38	2.31	12	0	2.12	3.04	2.518	10.6	19178
9	Strontium [f]	-	0.001	mg/L	-	-	-	0.023	0.024	0.024	12	0	0.022	0.030	0.024	0.009	185
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	0.0000	0.0000	0	12	7	0	0.0002	0.0000	127	0.34
9	Zinc	0.5	0.005	mg/L	0	0	0	0.0022	0.0006	0.0006	12	11	0	0.0051	0.0004	346	3.14
12	Mercury	1.0	0.002	µg/L	0	0.0002	0	0.0016	0	0.0004	12	9	0	0.0089	0.0011	230	0.0086
14	Phenolics	0.02	0.001	mg/L	0.0017	0.0002	0.0007	0	0	0.0005	12	12	0	0	0	0	0
16	Bromodichloromethane [f]	-	0.0005	mg/L	-	-	-	0.0015	0.0017	0.0016	12	8	0	0.0035	0.0010	151	7.46
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	0.068	0.053	0.061	12	2	0	0.230	0.058	144	453

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2022							
ATG	**Parameter**	**Monthly Guide[b]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.[a]**	**RSTD (%)[e]**	**Load (kg)**
17	Toluene [g]	-	0.0004	mg/L	-	-	-	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	Oil & Grease	15	1.0	mg/L	0.1	0.1	0	0	0	0.04	12	12	0	0	0	0	0
--	Estimated Flow (total volume for year)			m^3	1.21E+06	1.18E+06	1.01E+06	1.12E+06	3.14E+06	1.53E+06	7.61E+06						

a Averages were calculated by setting to zero results reported as “< DL”.
b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.
c # Spl. is the number of samples analyzed and reported.
d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).
e RSTD = Relative Standard Deviation
f New parameter (2020) being tracked by the effluent monitoring program
g Parameter no longer being investigated by Environmental, not considered a contaminant of concern, due to its lack of presence previous years of monitoring.
N/A Not Applicable

Table 32: Effluent Averages Summary for Lagoon

					Monitoring Point: Lagoon												
					Averages from Previous Five Years						Results for Year 2022						
ATG	**Parameter**	**Monthly Guide[a]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Spl.[b]**	**NDs[c]**	**Min.**	**Max.**	**Vol. Wt. Avg.**	**RSTD[d] (%)**	**Load (kg)**
-	CBOD	25	2.0	mg/L	2.5	17.7	0	0	N/A	5.1	3	0	5.80	13	8.2[h]	50.7	340
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.0100	0.0097	0.0011	0.0010	N/A	0.0055	4	2	0	0.0005	0.0002	128	0.006
-	Total Residual Chlorine	0.02	0.02	mg/L	0.017	0.018	0.022	0.057	N/A	0.0285	4	0	0.02	0.06	0.034	50.9	0.001
--	Total Coliform	N/A	3	MPNU/100 mL	534	330	200	763	N/A	457	3	0	200	200	200[g]	0	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	40	5	13.5	88	N/A	37	3	0	5	2420	133[g]	1011	N/A
3	pH	6 to 9	N/A	pH	8.59	8.68	6.66	7.00	N/A	7.73	4	0	7.55	7.90	7.76	2.02	N/A
6	Phosphorus	1.0	0.003	mg/L	0.069	0.131	0.049	0.075	N/A	0.081	4	0	0.055	0.11	0.078	33.4	0.003
7	Conductivity	N/A	2.0	µS/cm	223	229	348	446	N/A	312	4	0	388	399	394	1.22	N/A
8	TSS	25	1.0	mg/L	4.807	3.8	1.2	3.9	N/A	3.4	4	0	2.7	11	5.2	76.1	216
9	Chromium	0.5	0.001	mg/L	0	0	0	0	N/A	0	4	4	0	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0021	0.0015	0.0007	0	N/A	0.0011	4	2	0	0.0036	0.0017	9.16	0.072
9a	Iron	1.0	0.01	mg/L	0.283	0.370	0.119	0.116	N/A	0.222	4	0	0.103	0.359	0.163	77.3	6.76
9	Lead	0.1	0.0002	mg/L	0.0001	0	0	0	N/A	0	4	4	0	0	0	0	0
9	Nickel	0.5	0.001	mg/L	0.0015	0.0015	0.0011	0	N/A	0.0010	4	3	0	0.0019	0.0009	106	0.036
9	Zinc	0.5	0.005	mg/L	0	0	0	0	N/A	0	4	3	0	0.0072	0.0004	900	0.020
12	Mercury	1.0	0.002	µg/L	0	0	0	0	N/A	0	4	4	0	0	0	0	0
4	Phenolics	0.02	0.001	mg/L	0.0017	0.0033	0	0	N/A	0.0013	4	4	0	0	0	0	0
25	Oil & Grease	15	1.0	mg/L	0.78	0.856	0	0	N/A	0.409	4	3	0	1.1	0.275	0.550	2.99
--	Estimated Flow (total volume for year)[f]			m^3	4.72E+04	1.22E+04	3.83E+04	3.08E+04	N/A	3.21 E+04	4.15E+04						
--	Number of Batches Discharged			--	2	2	1	1	N/A	1.5	1						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

d RSTD = Relative Standard Deviation calculated using Vol Wt Average

e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.

f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: There were no discharges in 2021 of the Lagoon.

g Geometric Mean actually used instead of Vol Wt average for this parameter, due to exponential growth of microbes

h Simple average actually, as this parameter is measured prior to the lagoon being permitted to discharge.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 33: Effluent Averages Summary for Outfall

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2022							
ATG	Parameter	Monthly Guide [b]	LMDL	Unit	2017	2018	2019	2020	2021	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.	RSTD[e] (%)	Load (kg)
3	pH	6 to 9	N/A	pH	7.81	7.76	7.67	7.50	7.66	7.68	52	0	7.06	8.04	7.62	3.33	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	13.4	10.2	11.8	52	0	7.5	47	17.9	54.78	29960
6	Phosphorus	1.0	0.003	mg/L	0.035	0.030	0.022	0.021	0.022	0.026	52	8	0	0.180	0.041	89.5	59.16
7	Conductivity	N/A	2.0	µS/cm	139	131	164	134	149	143.4	52	0	110	410	142	32.3	N/A
8	TSS	25	1.0	mg/L	2.97	1.5	4.2	5.4	5.3	3.874	52	5	0	100	14.3*	149	21533
9	Chromium	0.5	0.001	mg/L	0	0.0001	0.0006	0.0005	0.0003	0.0003	52	30	0	0.0027	0.0006	125	0.1004
9	Copper	0.5	0.0005	mg/L	0.006	0.005	0.005	0.010	0.007	0.0066	52	0	0.003	0.011	0.005	37.5	8.42
9a	Iron	1.0	0.01	mg/L	0.262	0.186	0.218	0.302	0.271	0.2478	52	0	0.101	3.020	0.773*	95.67	1200
9	Lead	0.1	0.0002	mg/L	0.0003	0.0002	0.0002	0.0004	0.0003	0.00028	52	17	0	0.0021	0.0005	109	0.711
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	5.46	5.18	5.32	52	0	3.29	8.75	5.96	21.8	9099
9	Manganese [g]	-	0.001	mg/L	-	-	-	-	-	-	52	0	0.005	1.420	0.188	160	1666
9	Nickel	0.5	0.001	mg/L	0.0020	0.0006	0.0005	0.0007	0.0017	0.0011	52	18	0	0.0034	0.0013	82.2	2.17
-	Potassium [f]	-	0.05	mg/L	-	-	-	1.111	1.10	1.1055	52	0	0.772	2.990	1.276	34.8	1931
9	Sodium [f]	-	0.05	mg/L	-	-	-	4.40	4.34	4.37	52	0	2.47	52.7	5.15	140	7348
9	Strontium [f]	-	0.001	mg/L	-	-	-	0.033	0.034	0.0335	52	0	0.026	0.044	0.034	13.4	50.10
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	0.0004	0.0004	0.0004	52	0	0.0002	0.0007	0.0004	24.5	0.639
9	Zinc	0.5	0.005	mg/L	0.001	0.001	0.004	0.006	0.006	0.0036	52	13	0	0.023	0.0009	72.4	15.62
12	Mercury	1.0	0.002	µg/L	0	0.0006	0.0009	0.0002	0.0003	0.0004	52	22	0	0.036	0.0039	149	0.0073
14	Phenolics	0.02	0.001	mg/L	0.004	0.0001	0.0003	0.0000	0	0.00088	52	48	0	0.0022	0.0001	367	0.21
16	Bromodichloro methane [f]	-	0.0005	mg/L	-	-	-	0.0005	0	0.00025	52	52	0	0		N/A	0

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2022							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	0.0259	0.0072	0.01655	52	1	0	0.019	0.007	70.4	8.82
17	Toluene [g]	-	0.0004	mg/L	-	-	-	0	0	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	Oil & Grease	15	1.0	mg/L	0.19	0.10	0.02	0	0.15	0.092	52	49	0	1.90	0.09	422	108
--	Estimated Flow (total volume for year)			m^3	1.13E+06	1.16E+06	1.25E+06	1.21E+06	1.23E+06	1.20E+06	1.45E+06						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

g Parameter no longer being investigated by Environmental, not considered a contaminant of concern, due to its lack of presence previous years of monitoring.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1.

Table 34: Effluent Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2022					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2017	2018	2019	2020	2021	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.88	7.81	7.73	7.64	7.81	7.77	10	0	7.17	7.78	7.59	2.47
6	Phosphorus	1.0	0.003	mg/L	0.071	0.045	0.043	0.135	0.041	0.067	10	2	0	0.190	0.078	79.7
7	Conductivity	N/A	2.0	µS/cm	445	690	586	451	454	525	10	0	140	570	427	31.9
8	TSS	25	1.0	mg/L	1.4	1.65	1.92	3.4	1.26	1.93	10	3	0	6.9	2.87	93.6
9	Chromium	0.5	0.001	mg/L	0	0	0.0005	0.0002	0	0.0001	10	10	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0015	0.0015	0.0013	0.0010	0.0014	0.0013	10	0	0.0006	0.0024	0.0014	52.3
9a	Iron	1.0	0.01	mg/L	0.192	0.083	0.147	0.205	0.141	0.154	10	0	0.0995	0.457	0.27	43.7
9	Lead	0.1	0.0002	mg/L	0	0	0	0	0	0	10	10	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.004	0.003	0.003	0.003	0.003	0.003	10	0	0.002	0.006	0.0044	32.6
9	Zinc	0.5	0.005	mg/L	0.002	0.001	0.001	0.001	0.004	0.002	10	4	0	0.010	0.003	104.9
12	Mercury	1.0	0.002	µg/L	0	0.0020	0.0009	0.0014	0.0037	0.0016	10	2	0	0.4620	0.0521	277
14	Phenolics	0.02	0.001	mg/L	0.0070	0.0002	0.0006	0.0008	0.0002	0.0018	10	4	0	0.0021	0.0008	95.4
25	Oil & Grease	15	1.0	mg/L	0.4	0.13	0.17	0.08	0	0.16	10	8	0	1.9	0.29	223

Continued from previous page

					Monitoring Point: DITCH 9 (Westbound)[a]											
					Averages from Previous Years[b]						Results for Year 2022					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**#Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.67	7.69	7.58	7.32	7.57	7.56	12	0	6.94	7.49	7.22	1.99
6	Phosphorus	1.0	0.003	mg/L	0.045	0.042	0.004	0.039	0.097	0.045	12	4	0	0.320	0.0563	161
7	Conductivity	N/A	2.0	µS/cm	214	538	400	224	300	335	12	0	93	320	200	32.7
8	TSS	25	1.0	mg/L	2.1	2.1	2.7	3.3	2.3	2.5	12	2	0	13	4.6	83.9
9	Chromium	0.5	0.001	mg/L	0	0	0.0005	0.0004	0	0.0002	12	12	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0013	0.0021	0.0018	0.0018	0.0019	0.0018	12	0	0.0010	0.0019	0.0014	21.4
9a	Iron	1.0	0.01	mg/L	0.326	0.315	0.250	0.558	0.382	0.366	12	0	0.185	5.63	1.69	118
9	Lead	0.1	0.0002	mg/L	0	0	0	0.0000	0	0	12	10	0	0.0008	0.0001	235
9	Nickel	0.5	0.001	mg/L	0.002	0.003	0.003	0.004	0.003	0.003	12	0	0.001	0.006	0.003	51.3
9	Zinc	0.5	0.005	mg/L	0.002	0.004	0.003	0.006	0.015	0.006	12	0	0.004	0.012	0.007	29.1
12	Mercury	1.0	0.002	µg/L	0	0.0021	0.0016	0.005	0.0109	0.0039	12	0	0.0082	0.4790	0.0544	246
14	Phenolics	0.02	0.001	mg/L	0.0086	0	0.0005	0.0002	0.0002	0.0019	12	6	0	0.0021	0.0007	112
25	Oil & Grease	15	1.0	mg/L	0	0	0	0.1	0.2	0.06	12	9	0	26	2.38	314

Continued from previous page

					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						Results for Year 2022					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.76	7.83	7.72	7.54	7.76	7.72	12	0	7.17	7.82	7.44	3.17
6	Phosphorus	1.0	0.003	mg/L	0.083	0.065	0.104	0.071	0.06	0.08	12	5	0	0.11	0.04	101
7	Conductivity	N/A	2.0	µS/cm	380	939	579	385	415	540	12	0	170	570	372	34.3
8	TSS	25	1.0	mg/L	6.2	2.9	7.0	3.1	5.63	4.97	12	2	0	25	5.66	130
9	Chromium	0.5	0.001	mg/L	0	0	0.0008	0.0001	0	0.0002	12	11	0	0.0042	0.0004	346
9	Copper	0.5	0.0005	mg/L	0.0010	0.0015	0.0018	0.0009	0.0013	0.0013	12	0	0.0008	0.0080	0.0017	115
9a	Iron	1.0	0.01	mg/L	0.594	0.674	0.762	0.464	0.509	0.601	12	0	0.126	12.6	1.69	206
9	Lead	0.1	0.0002	mg/L	0.0002	0	0.0002	0.0000	0	0.0001	12	10	0	0.0026	0.0003	280
9	Nickel	0.5	0.001	mg/L	0.002	0.005	0.003	0.002	0.002	0.0028	12	0	0.0011	0.0137	0.0034	91.4
9	Zinc	0.5	0.005	mg/L	0	0.013	0.011	0.001	0.004	0.0058	12	5	0	0.0377	0.0056	187
12	Mercury	1.0	0.002	µg/L	0	0.0004	0.0007	0.0008	0.0031	0.0010	12	1	0	0.456	0.0500	268
14	Phenolics	0.02	0.001	mg/L	0.0074	0.0001	0.0007	0.0006	0.0004	0.0018	12	11	0	0.0010	0.0001	346
25	Oil & Grease	15	1.0	mg/L	0	0.3	0	0.01	0	0.06	12	10	0	3.1	0.34	267

a All results below the LMDL, originally flagged as “< DL” when reported, are only estimates.

b Averages were calculated by setting to zero results reported as “< W.”

c Monthly Guide is from CNL’s limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = “< W,” result = 0).

f RSTD = Relative Standard Deviation

N/A not applicable

Table 35: Effluent Averages Summary for the Low-Level Liquid Waste Treatment Systems

					Monitoring Point: Building 100 & 300 LLLW Treatment Systems [a]													
					Averages from Previous Five Years[b]						Results for Year 2022							
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2017	2018	2019	2020	2021	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)	Load (kg)
3	pH	6 to 9	N/A	pH	7.52	7.39	7.54	7.69	7.55	7.54	44	0	6.92	8.35	7.97	3.95	N/A
6	Phosphorus	1.0	0.003	mg/L	0.370	0.327	0.554	0.503	0.810*	0.513	44	0	0.015	1.40	0.440*	81.2	0.0534
7	Conductivity	N/A	2.0	µS/cm	267	348.84	352	473	527	394	44	0	330	720	552	18.4	N/A
8	TSS	25	1.0	mg/L	14.67*	16.28*	8.25	15.0*	10.2	12.9	44	13	0	36.0	5.37*	145	0.6455
9	Chromium	0.5	0.001	mg/L	0.0007	0.0006	0.0009	0.0011	0.0021	0.0011	44	26	0	0.0021	0.0006	120	0.0001
9	Copper	0.5	0.0005	mg/L	0.509*	0.516*	0.512	0.423*	0.333*	0.459	44	0	0.015	1.140	0.163*	122	0.0198
9a	Iron	1.0	0.01	mg/L	3.39*	1.660*	0.465	1.77*	1.57*	1.77	44	0	0.06	2.23	0.64*	90.6	0.0753
9	Lead	0.1	0.0002	mg/L	0.014	0.0112	0.0057	0.0047	0.0143	0.0100	44	0	0.0006	0.0973	0.0086	233	0.0010
9	Nickel	0.5	0.001	mg/L	0.0066	0.0055	0.003	0.0040	0.0117	0.0062	44	0	0.0014	0.0123	0.00036	59.2	0.0004
9	Zinc	0.5	0.005	mg/L	0.180	0.272	0.152	0.124	0.175*	0.181	44	0	0.015	0.680	0.102*	116	0.0123
12	Mercury	1.0	0.002	µg/L	0.130	0.060	0.030	0.010	0.023	0.051	44	0	0.0036	0.2600	0.0366	147	0.0000
14	Phenolics	0.02	0.001	mg/L	0.007	0.01*	0.005	0.005	0.004	0.005	44	20	0	0.022	0.003*	181	0.0004
25	Oil & Grease	15	1.0	mg/L	0.73	0.88	0.59	0.70	0.18	0.62	44	41	0	5.10	0.26	402	0.0316
--	Estimated Flow (total volume for year)			m³	1.72E+02	1.32E+02	1.89E+02	1.07E+02	8.82E+01	1.38E+02	1.20E+02						
--	Number of batches discharged			--	24	50	68	40	33	43	44						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< DL."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).
f RSTD = Relative Standard Deviation
N/A not applicable
Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.
Discharges of effluent coming from the new low level liquid waste treatment systems are being combined, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. These guidelines are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 36 supplies a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2022 or at any time during the previous five years.

As with the average summary table provided, for each monitoring point, the first two columns in the table identify the Ontario Ministry of Environment ATG and parameter names. The next three columns give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns show the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

To assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 36: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2022		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	83	100	67	90	12	4	67
	8	TSS	25	1.0	mg/L	78	92	100	92	100	92	12	1	92
	9	Copper	0.5	0.0005	mg/L	67	33	42	58	83	57	12	1	92
	9a	Iron	1.0	0.010	mg/L	44	50	83	42	33	50	12	3	75
	9	Zinc	0.5	0.005	mg/L	100	100	100	100	92	98	12	0	100
	14	Phenolics	0.02	0.0010	mg/L	100	92	100	100	100	98	12	2	83
Outfall	8	TSS	25	1.0	mg/L	100	100	100	100	100	100	12	3	67
	9a	Iron	1.0	0.010	mg/L	100	100	100	100	100	100	12	4	67

Notes: Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table. Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that parameter at the monitoring point. This year there were 8 months when one of five parameters (Iron, Copper, Phosphorous, TSS, and Phenols) from the LLLWTS or the Outfall monitoring station had monthly values higher than CNL monthly guidelines. Figure 5 shows the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, Figure 8, Figure 9, Figure 10, Figure 11, and Figure 12 for each parameter, and the explanations for the observed high values can be found in Sections 9.5.1.4.5.2, and 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is shown by a broken red line in the corresponding figures.

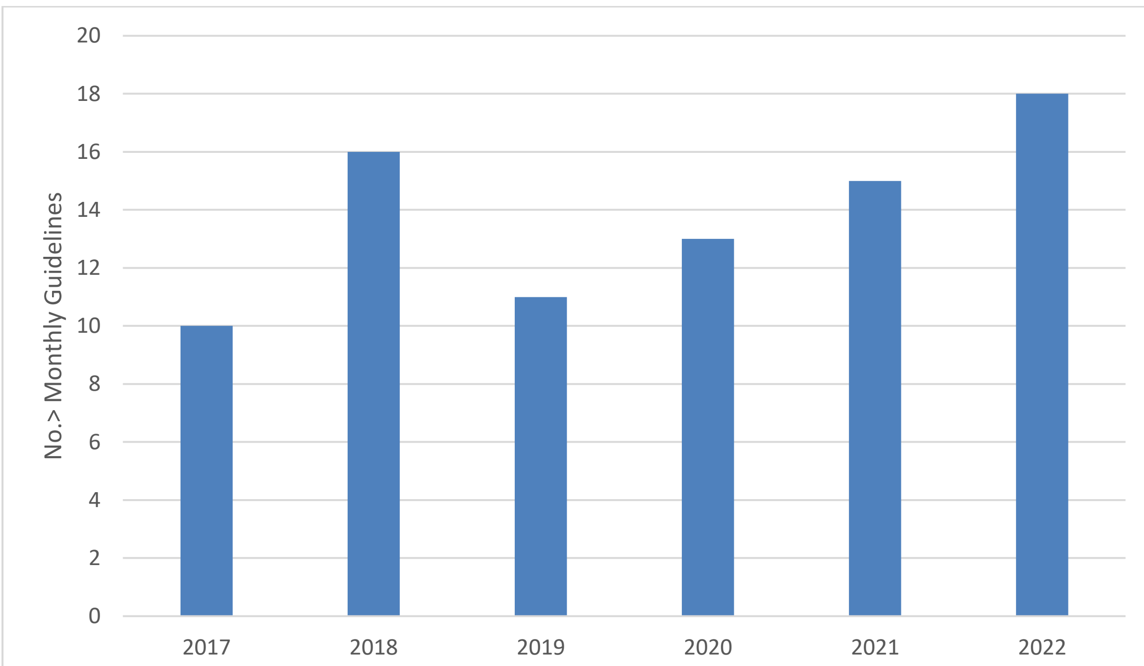

Figure 5: Non-Radiological Monitored Effluent Parameters Above CNL Monthly Guidelines

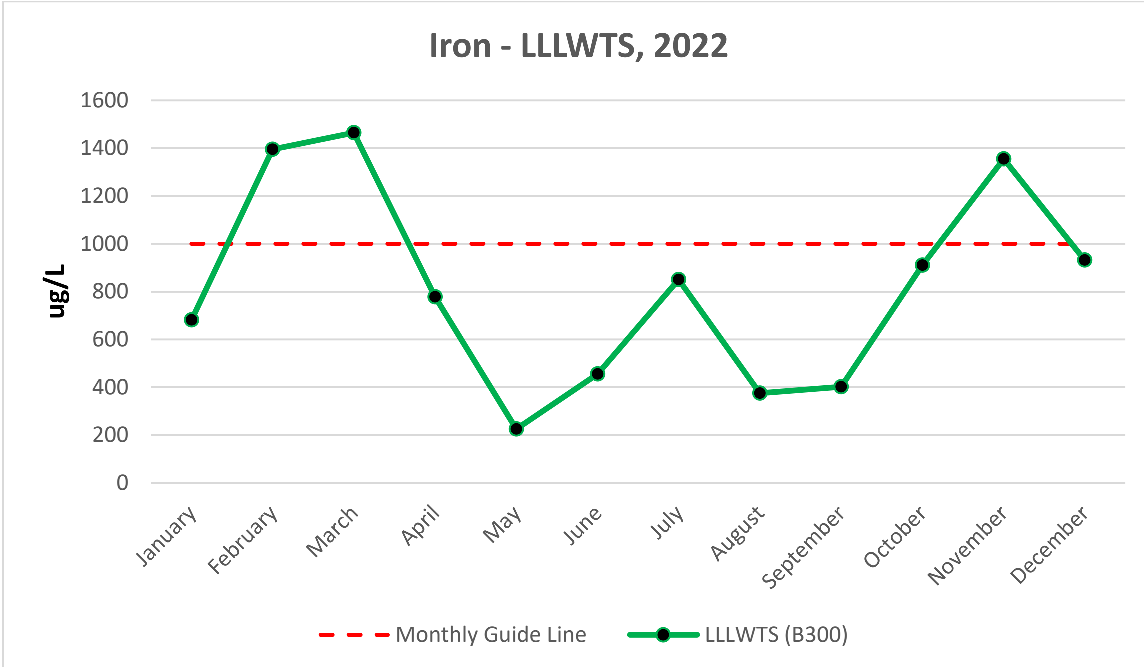

Figure 6: Monthly Average Iron Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2022

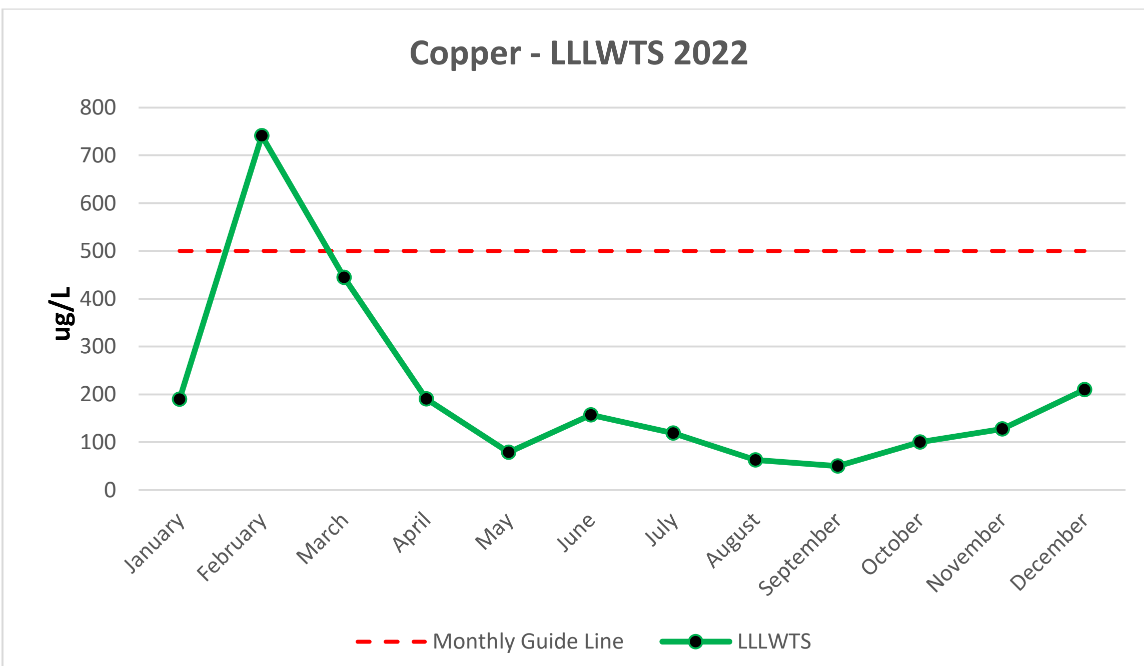

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2022

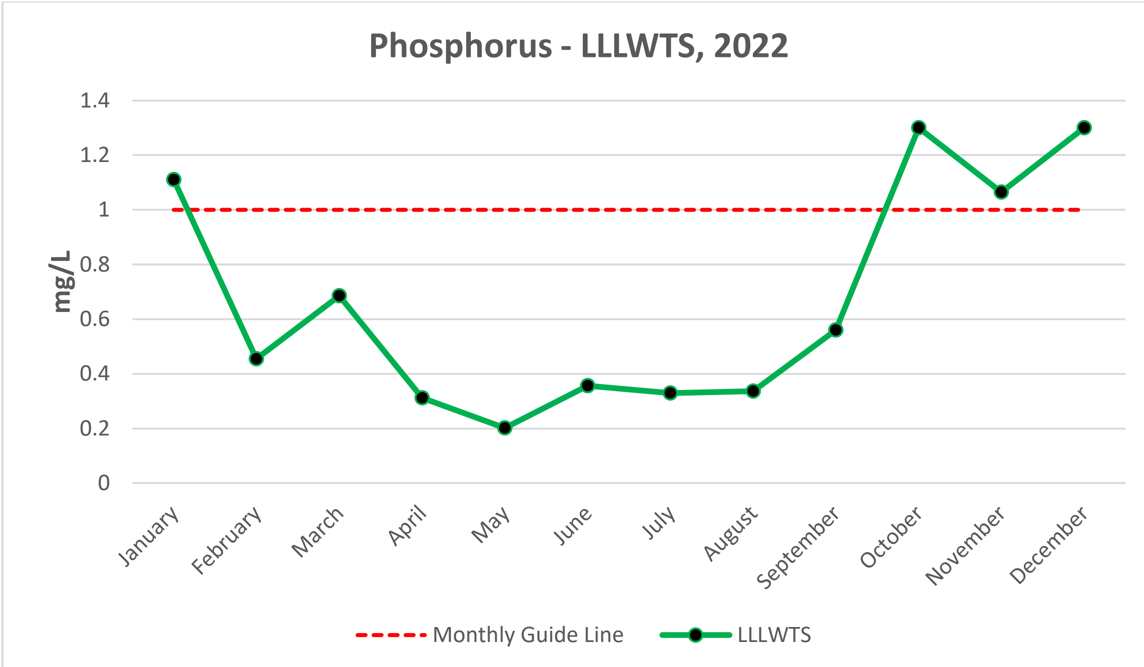

Figure 8: Monthly Average Phosphorus Concentration of Effluents from the Low-Level Liquid Waste Treatment Systems for 2022

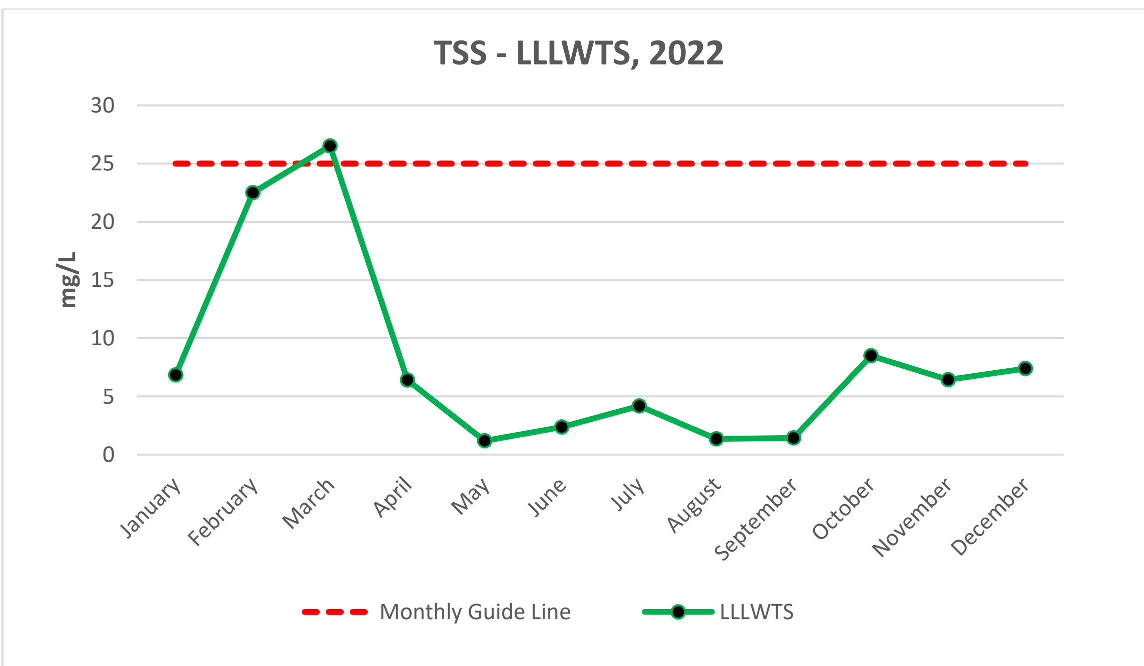

Figure 9: Monthly Average TSS Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2022

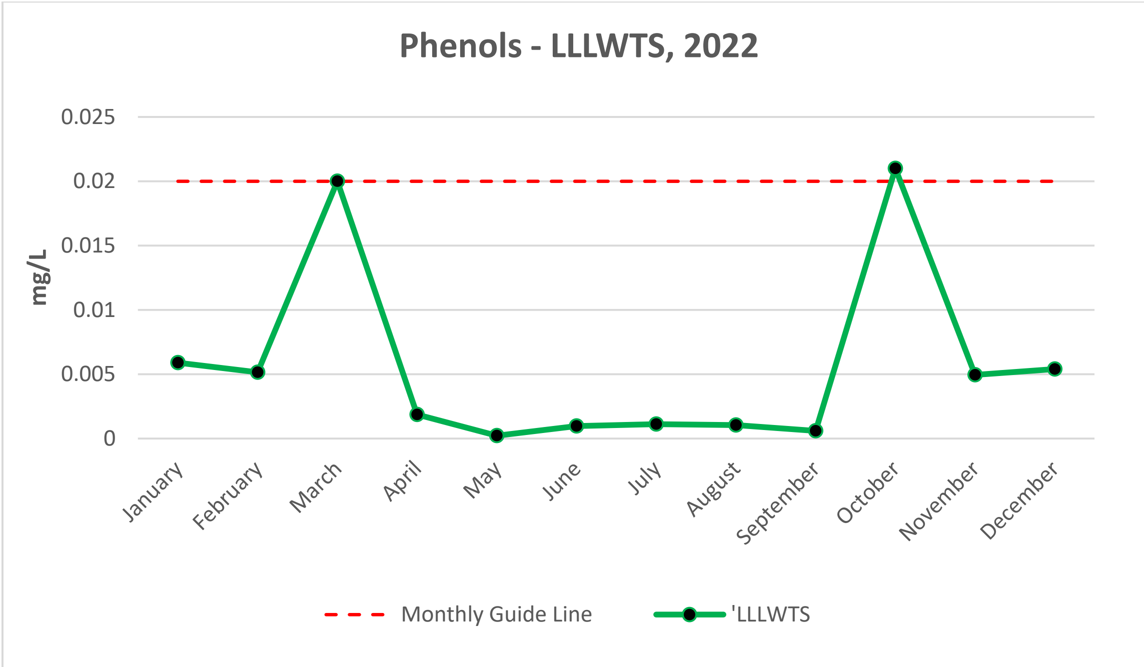

Figure 10: Monthly Average phenol Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2022

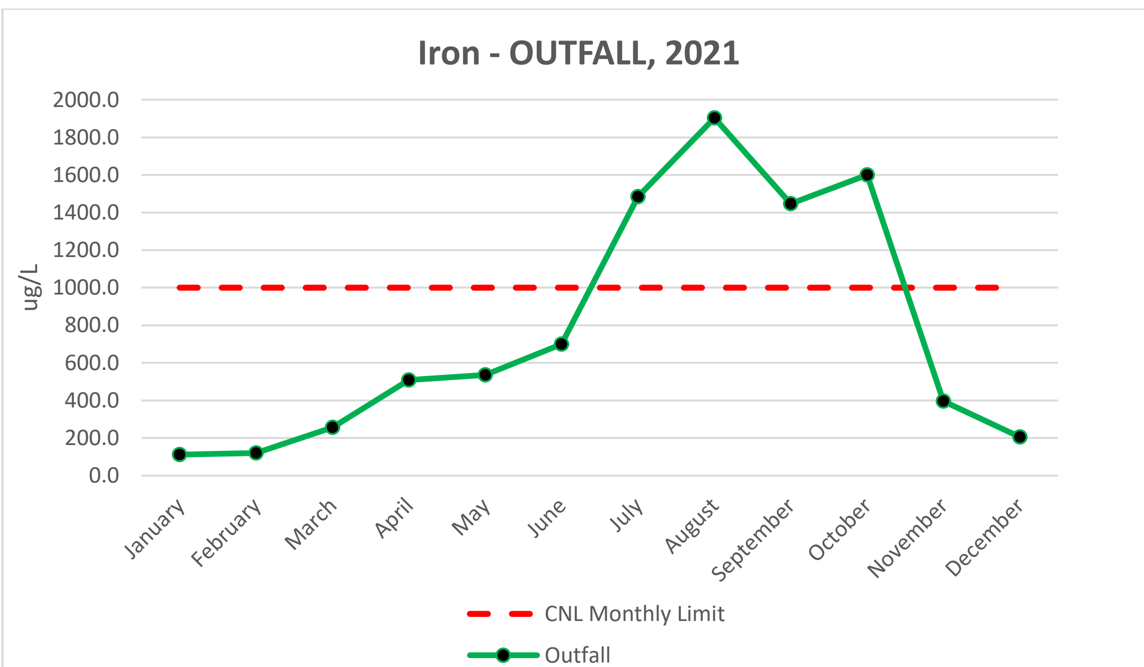

Figure 11: Monthly Average Iron Concentrations of Effluents from the Outfall Monitoring Station for 2022

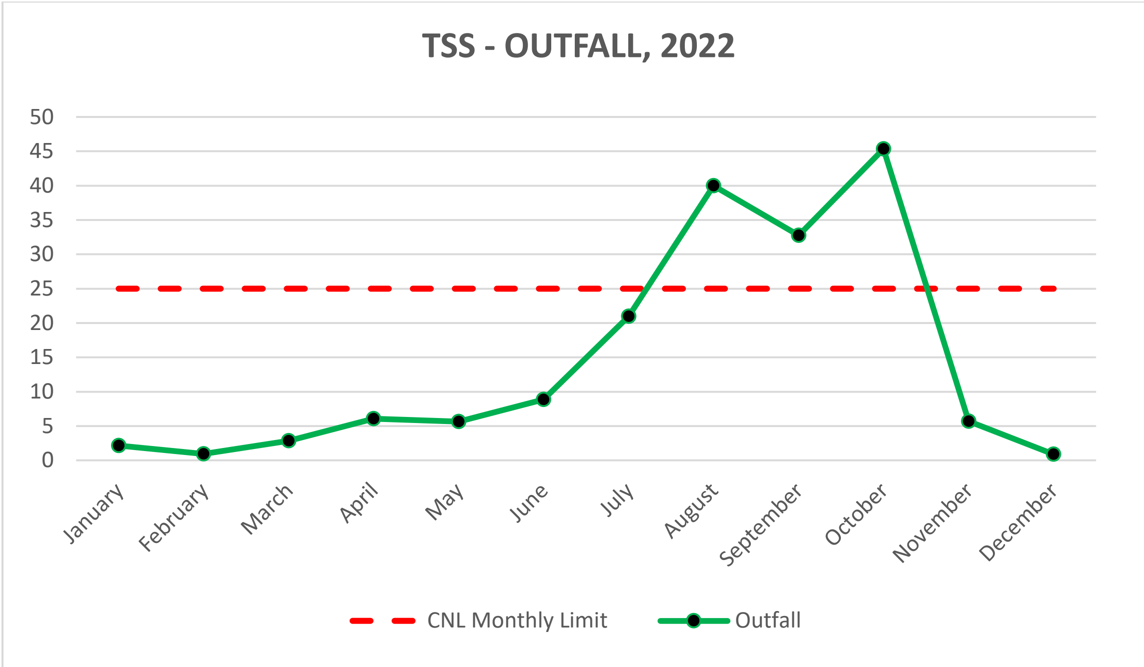

Figure 12: Monthly Average TSS Concentrations of Effluents from the Outfall Monitoring Station for 2022

9.5.1.4.4 Monitoring of Intake Water from Winnipeg River

Except for bottled drinking water, all the water needed to run the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 31, where they are compared to available data for the previous five years. Figure 13 shows the estimated amount of water used monthly for 2022.

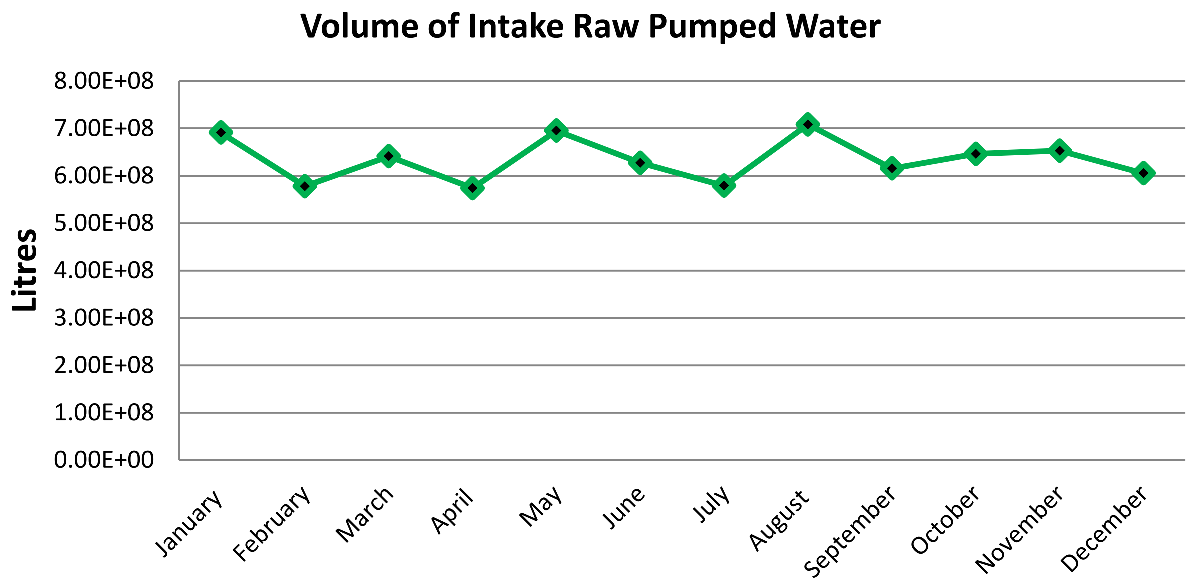

Figure 13: Monthly 2022 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2022 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 7.61E+06 m^3 of water was pumped from the river over the year. This is an increase of 5 times the previous five-year average. This increase is reflective of the water used during the demolition projects conducted over the winter of the 2021/2022 fiscal year to keep particulate generation down, a significant fire hydrant flushing campaign conducted by site operations, and a fire water line break that went undiagnosed during the winter months at the start of 2022.
- Compared to the five-year average, increased concentrations (> 10%) were seen for Phosphorous, TSS, Potassium, and Mercury. Mercury saw a 300% increase in the concentrations observed at the Intake.
- Parameters that had their concentrations decrease (> 10%) this year compared to the average seen for the last five years are Copper, Lead, Nickel, Zinc, and Bromodichloromethane.

Intake water results can have a significant impact on the environmental performance of the WL site and they will continue to be monitored closely.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell was discharged in the fall of 2022. The total amount of effluent discharged from the Lagoon in 2022 was 4.15E+04 m^3.

Prior to discharge, the lagoon was tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the secondary cell occurs, and will determine whether discharging the lagoon is permissible. During the actual lagoon discharge, grab-samples are collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters are collected on a weekly basis during the discharge.

The vertical scale from which surface height is found was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

Volume (in L) = Height x [Width_Bottom x Length_Bottom
+ 0.5(Width-Width_Bottom) Length_Bottom
+ 0.5(Length-Length_Bottom) Width_Bottom
+ (1/3) (Width-Width_Bottom) (Length-Length_Bottom)]

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

$$\text{Volume (in L)} = 636\,655{*}d + 206.886{*}d^2 + 0.02133{*}d^3 \text{ for depth “d” (in cm)}$$

The position of the Lagoon’s water surface would be recorded once or twice daily while emptying. The daily flow would then be calculated from changes in the contained volume. This permits the calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in deciding meaningful average concentrations.

Discharging of the secondary cell is only allowed to proceed after initial testing. Once discharging begins, the pH is checked daily throughout the discharge period.

Table 32 summarizes the results of the fall discharge. Some notable points are:

- The Lagoon was only discharged during the fall of 2022.
- There were no instances of CNL’s monthly guidelines being exceeded at the Lagoon.

- Compared to the five-year average, there was an increase in concentrations (> 10%) for CBOD, Total Residual chlorine, fecal coliforms, Conductivity, TSS, Copper, and Zinc.
- Compared to the five-year averages Unionized Ammonia, total coliforms, Iron, Nickel, and oil and grease, were all substantially lower (> 10% decrease).
- No signs of Chromium, Lead, Mercury, and Phenolics in the discharged effluent.
- No trout mortality was observed in the fall Lagoon effluent sample that underwent acute lethality testing.

The WL Lagoon discharge was compared against the limits set by the federal government in the Wastewater Systems Effluent Regulations in The Canadian Gazette [40]. The limits in force were met in all cases.

The results of the federally regulated parameters are indicated below:

- Carbonaceous Biochemical Oxygen Demand - annual volume weighted average was 8.2 mg/L, which is less than the 25 mg/L limit.
- TSS - annual volume weighted average was 5.2 mg/L which is less than the 25 mg/L limit.
- Un-ionized Ammonia - the volume weighted average concentration was 0.0002 mg/L which is less than the 1.25 mg/L limit.

9.5.1.4.5.2 Process outfall

The Outfall monitoring station functioned as expected during 2022. The total discharge volume was 1.45 GL. This volume is higher than the previous five-year average of 1.20 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 52 samples of each parameter for the year.

Table 33 summarizes the results obtained in 2022, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were seven instances of CNL's monthly guidelines being exceeded at the Outfall monitoring station. Elevated TSS concentrations were observed in August through October, and elevated Iron concentrations were observed July through to October.
- The parameters that had a notable increase (> 10%) compared to the 5-year average were Total Organic Carbon, Phosphorus, TSS, Chromium, Iron, Lead, Magnesium, Nickel, Potassium, Sodium, and Mercury.
- The increased sediment loads entering the storm drain are responsible for the increases being noted. The increased sediment loads are a result of the demolition/construction work happening on site spreading soil and tearing up the landscape so increased soil erosion is happening on site. Annual street sweeping was not performed in the spring of 2022, however it has been recognized due to the increased sediment loads that street sweeping needs to be performed each spring going forward.

- The parameters that had a notable decrease (>10%) compared to the five-year average were Copper, Zinc, Bromodichlormethane, Chloroform, and Phenolics concentration levels
- Quarterly Acute Lethality Testing on the Outfall effluent was performed for three of the four quarters in 2022. All three samples came back showing no mortality on the rainbow trout tested. In Q2 the sample was collected and submitted to a contract laboratory, but a paper work error on CNL's end resulted in the sample not being analysed. Corrective action has been taken.
- Resulting from the Environmental Risk Assessment on the lagoon and landfill, the Environmental Management program began tracking Manganese in 2022, at the outfall monitoring station and the intake. The soils on the Whiteshell site are naturally elevated in Manganese, and it was noted as a parameter of concern. During the 2022 calendar year, this parameter's concentration exceeded the Action Level (a self-imposed operational control limit that signifies a potential loss of control from routine operations requiring the regulator to be notified) that was established for it, for the months of July through October. The cause of the increase has been attributed to the quantity of the sediments entering the storm drain.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were twelve sampling events from 2022 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparisons are made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines in 2022. The measurement data are summarized in Table 34. The following are notable points for the 2022 ditches results:

- There were twelve sampling events for the ditches. However only ten samples were collected from ditch 8 as this ditch took longer to thaw in April.
- The sample events were equally influenced by the spring melt, and the subsequent rainfalls throughout the year.
- All concentrations remain well below the CNL's monthly guidelines.

- Phosphorus, TSS, Iron, Nickel, Zinc, Mercury, and Oil and Grease were the parameters that had a notable increase in concentration (>10%) compared to the previous five-year average for Ditch 8. The parameters that had a notable increase in concentration (>10%) compared to the previous five-year average for Ditch 9 were Phosphorus, TSS, Iron, Zinc, Mercury, and Oil and Grease. The parameters that had a notable increase in concentration (>10%) compared to the previous five-year average for the control ditch were TSS, Chromium, Copper, Iron, lead, Nickel, Mercury and Oil and Grease.
- Metal concentrations detected are very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase being observed in Ditch 8 and Ditch 9.
- The five year average for Phosphorus in Ditch 9 was higher this year due to the limited sampling in the fall. It is not uncommon for the spring melt to observe elevated Phosphorus concentrations due to the decaying vegetation from the previous fall. Typically these results are balanced out with the concentrations observed later in the calendar year, but there was minimal rain events where sufficient flow was observed in the fall. As the majority of the sampling events occurred from April-June, the result for Phosphorous were higher than previous years.
- All parameters measured in Ditch 8 and Ditch 9 are comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.
- For the month of July Ditch 9 did have elevate levels of Iron being noted in the water, but a similar trend of greater magnitude was also noted in the Control ditch for that month as well, because of this no further investigation was performed for Ditch 9.

It should be noted that sediment control measures were put in place for projects in the WMA in 2022, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria do not include all parameters listed in CNL's non-radiological guideline limit values; however, the post-discharge analysis includes all these parameters. CNL staff have determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the earlier system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging requires a day or less to complete, and can be more gradual if needed.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to measure pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the Research and Development (R&D) Complex in Building 300 and Building 100 are similar enough that a comparison is worthwhile.

In 2022, 0.12 ML was discharged from the LLLWTS.

The weighted averages of the joint releases from the LLLWTS are presented in Table 35 and monthly plots for the parameters that exceed the monthly guidelines as indicated in Table 36 are in Figure 6, Figure 7, Figure 8, Figure 9, and Figure 10 .

The following are notable results for 2022:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being observed at the Outfall monitoring location downstream in the process. All exceedances that occurred at the Outfall are observed in different months than the exceedances observed in the LLLWTS for TSS and Iron.
- There were increases (> 10%) in average conductivity reading, when compared to the previous five-year average.
- Except for pH, all other parameter concentrations were noticeably less than the observed five year average. The pH average was comparable to the five year average.
- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines three times (February, March, and November). The overall Iron concentration seen for the year is lower than the previous 5-years. The Iron exceedances for February and March are related to soil, likely entering the system through the decontamination center’s boot and respirator washers, based on the fact elevated TSS concentrations are also observed in these months, which aligns with the demolition work occurring on site. The cause of November’s exceedance is unknown.
- The TSS concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in 2022 (March).
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in 2022 (February). Frequent exceedances are being seen in relation to the

new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon as the new tanks were commissioned and used, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration seen at the Outfall is still well below the monthly guideline limits.

- The Phenols concentrations exceeded the monthly guideline twice in 2022 (March and October). No cause has been identified for the increase.
- The Phosphorus concentration in the Building 300 effluent has returned to normal from last year's doubling. The phosphorus concentration still exceeded the CNL monthly guideline limit four times throughout the calendar year (January, September, October, and November). No cause has been identified for the exceedances.

9.5.1.5 Loading Calculations

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 37 shows the results from the calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- CBOD, Organic Carbon, Phosphorus, TSS, Iron, Lead, Nickel, Potassium, Sodium, Strontium, Uranium, Zinc, and Mercury are the parameters that had a load increase greater than 10% when compared to the five-year average.
- The majority of the increase is related to the large amount of soil and sediments that made it into the storm drain system over the 2022 calendar year. The Iron and TSS loads increased by approximately 400 %. See Section 9.6 for more information.
- Un-ionized Ammonia, Total Residual Chlorine, Chromium, Phenolics, Bromodichloromethane, and Chloroform all had notable decreases of 10% or more in their loads when compared to the 5-year average.

Table 37: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2022		
			2017	2018	2019	2020	2021	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	132	216	0	0	0	69.6	3	0	340
		Site Total	**132**	**216**	**0**	**0**	**0**	**69.6**	**3**	**0**	**340**
-	Un-ionized Ammonia	Lagoon	0.46	0.118	0.042	0.043	0	0.133	4	2	0.006
		Site Total	**0.46**	**0.118**	**0.042**	**0.043**	**0**	**0.133**	**4**	**2**	**0.006**
-	Total Residual Chlorine	Lagoon	0.808	0.220	0.831	1.743	0	0.720	4	0	0.001
		Site Total	**0.808**	**0.220**	**0.831**	**1.743**	**0**	**0.720**	**4**	**0**	**0.001**
5b	Total Organic Carbon	Outfall	-	-	-	16,814	12,230	14,522	52	0	29,960
		Site Total	-	-	-	**16,814**	**12,230**	14,522	**52**	**0**	**29,960**
6	Phosphorus	Lagoon	3.29	1.59	1.90	2.30	0	1.82	4	0	0.003
		Outfall	38.0	42.6	27.7	25.2	25.9	31.9	52	8	59.2
		Site Total	**41.3**	**44.2**	**28.6**	**27.5**	**25.9**	**33.5**	**56**	**8**	**59.2**
8	TSS	Lagoon	227	46.4	44.7	120	0	87.6	4	0	216
		Outfall	3,142	2,031	5,764	6,657	6,630	4,845	52	5	21,533
		Site Total	**3,369**	**2,077**	**5,809**	**6,777**	**6,630**	**4,932**	**56**	**5**	**21,749**
9	Chromium	Lagoon	0	0	0	0	0	0	4	4	0
		Outfall	0	0.06	0.818	0.651	0.035	0.313	52	30	0.100
		Site Total	**0**	**0.06**	**0.818**	**0.651**	**0.035**	**0.313**	**56**	**34**	**0.100**
9	Copper	Lagoon	0.10	0.018	0.027	0	0	0.029	4	2	0.072
		Outfall	6.61	7.63	7.03	13.5	8.44	8.64	52	0	8.42
		Site Total	**6.71**	**7.65**	**7.06**	**13.5**	**8.44**	**8.67**	**56**	**2**	**8.49**
9a	Iron	Lagoon	13.34	4.52	4.56	3.57	0	5.20	4	0	6.76
		Outfall	291.1	258	296	381	322	310	52	0	1,200
		Site Total	**304**	**263**	**301**	**385**	**322**	**315**	**56**	**0**	**1,207**
9	Lead	Lagoon	0.003	0	0	0	0	0.001	4	4	0
		Outfall	0.312	0.23	0.220	0.481	0.303	0.309	52	17	0.711
		Site Total	**0.32**	**0.23**	**0.220**	**0.481**	**0.303**	**0.311**	**56**	**21**	**0.711**
9	Nickel	Lagoon	0.069	0.019	0.042	0	0	0.026	4	3	0.036

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2022		
			2017	2018	2019	2020	2021	Average	# Spl. [b]	NDs[c]	Load (kg)
		Outfall	1.349	0.836	0.742	0.972	1.49	1.08	52	18	2.17
		Site Total	**1.42**	**0.855**	**0.784**	**0.972**	**1.49**	**1.10**	**56**	**21**	**2.21**
9	Potassium	Outfall	-	-	-	1,348	1,302	1,325	52	0	1,931
		Site Total	-	-	-	**1,348**	**1,302**	1,325	**52**	**0**	**1,931**
9	Sodium	Outfall	-	-	-	5,223	5,086	5,155	52	0	7,348
		Site Total	-	-	-	**5,223**	**5,086**	5,155	**52**	**0**	**7,348**
9	Strontium	Outfall	-	-	-	39.9	39.3	39.6	52	0	50.10
		Site Total	-	-	-	**39.9**	**39.3**	39.6	**52**	**0**	**50.10**
9a	Uranium	Outfall	-	-	-	0.485	0.461	0.473	52	0	0.639
		Site Total	-	-	-	**0.485**	**0.461**	0.473	**52**	**0**	**0.639**
9	Zinc	Lagoon	0	0	0	0	0	0	4	3	0.020
		Outfall	1.167	1.77	6.13	0.306	7.88	3.45	52	13	15.62
		Site Total	**1.17**	**1.77**	**6.13**	**0.306**	**7.88**	**3.45**	**56**	**16**	**15.64**
12	Mercury	Lagoon	0	0	0	0	0	0	4	4	0
		Outfall	0	0.001	0.001	0.0003	0.0003	0.0005	52	22	0.0073
		Site Total	**0**	**0.001**	**0.001**	**0.0003**	**0.0003**	**0.0005**	**56**	**26**	**0.0073**
14	Phenolics	Lagoon	0.155	0	0	0	0	0.031	4	4	0
		Outfall	4.024	0.0001	0.0003	0	0	0.8049	52	48	0.21
		Site Total	**4.18**	**0.0001**	**0.0003**	**0**	**0**	**0.8359**	**56**	**52**	**0.21**
16	Bromodichlo-romethane	Outfall	-	-	-	0.547	0	0.274	52	52	0
		Site Total	-	-	-	**0.547**	**0**	0.274	**52**	**52**	**0**
16	Chloroform	Outfall	-	-	-	31.4	8.82	20.1	52	1	8.82
		Site Total	-	-	-	**31.4**	**8.82**	20.1	**52**	**1**	**8.82**
25	Oil & Grease	Lagoon	40.40	0	0	0	0	8.08	4	3	2.99
		Outfall	163.5	124	19.1	0	188	98.9	52	49	108
		Site Total	**204**	**124**	**19.1**	**0**	**188**	**107.0**	**56**	**52**	**111**

a Averages were calculated by setting to zero results reported as “< DL.”
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

9.5.2 Airborne Effluent Monitoring

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen for cleaner burning propane used on site. Table 38 presents WL heating fuel consumption from 2017 to 2022. Fuel consumption continues to trend downward (see Section 9.7.2 and Figure 14).

Table 38: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2022
Parameter	**Unit**	**2017**	**2018**	**2019**	**2020**	**2021**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	287,982	209,158	243,268	190,372	160,159	218,188	172,865
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	7.827	5.685	6.612	5.1743	4.3531	5.9303	4.6985
Total	**TJ**	7.827	**5.685**	**6.612**	**5.1743**	**4.3531**	**5.9303**	**4.6985**
Heating Demand								
Heating Degree Days	HDD	5,403	5,855	6,079	5,615	5,233	5,637	6,064

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.

b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

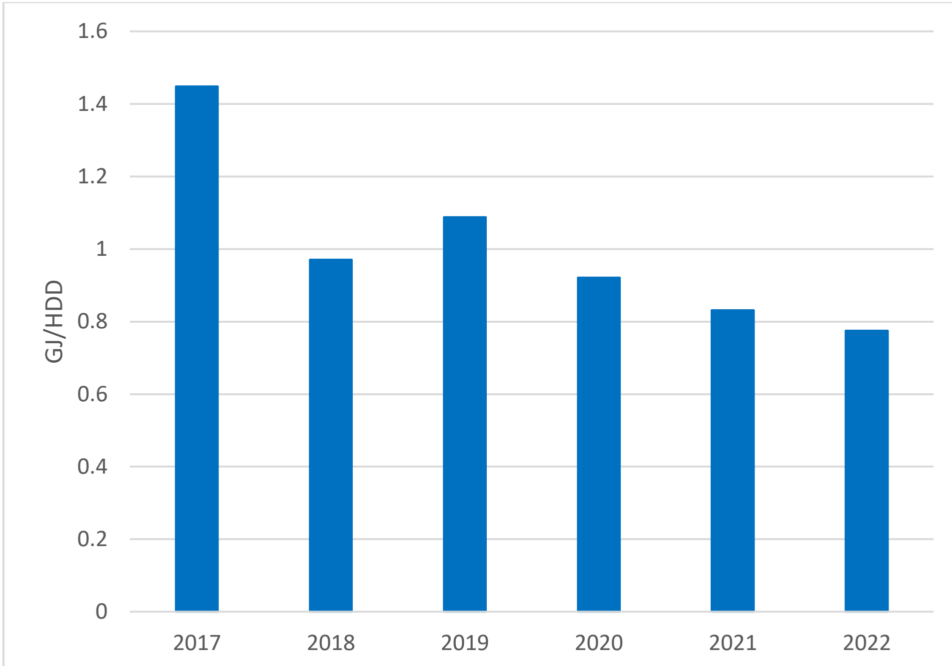

Figure 14: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory

Under the authority of the *Canadian Environmental Protection Act*, 1999 [41], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [42]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM10), particulate matter below 2.5 microns (PM2.5), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2022 will be captured in the *2022 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories* [31]. Table 39 outlines the annual CACs generated from site activities, and shows a large increase in emissions seen in 2022 compared to the 5-year average for the values for total particulate matter, PM10, and PM2.5. This is a result of CNL not applying any dust suppressant to the gravel road ways in 2022. As a result the Whiteshell site has reached the reporting thresholds for the generation of all types of particulate matter. This includes total particulate matter, PM10 and PM2.5. In previous years, Whiteshell would only need to report on PM10. Whiteshell Laboratories intends to continue to apply dust suppressant in future years.

Table 39: Stationary Combustion Data and Emissions from WL

Parameter	Unit	Data for Previous Five Years						Data for 2022	NPRI Reporting Threshold
		2017	2018	2019	2020	2021	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	0.753	0.536	0.621	0.602	0.331	0.569	0.485	20
SO_2	Mg	0.020	0.014	0.016	0.017	0.005	0.014	0.014	20
CO	Mg	0.348	0.233	0.271	0.256	0.162	0.254	0.202	20
Total Particulate Matter	Mg	13.651	14.562	10.574	8.883	8.174	11.17	46.9	20
PM_{10}	Mg	3.499	3.726	2.712	2.281	2.091	2.862	11.97	0.5
$PM_{2.5}$	Mg	0.376	0.391	0.292	0.249	0.218	0.305	1.21	0.3
Volatile Organic Compounds	Mg	0.059	0.042	0.049	0.048	0.026	0.045	0.038	10

9.5.2.3 Greenhouse Gas Emissions

Under the authority of the *Canadian Environmental Protection Act*, 1999 [41] WL must report releases under the GHGs emissions notice [43] providing the facility emits over 10,000 tonnes of carbon dioxide equivalent or more within the calendar-year.

Greenhouse Gas emissions from WL include carbon dioxide, methane, and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill, and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential. Table 40 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have decreased significantly from 2020. This decrease can be attributed to the decrease in propane needed to heat the site, however when compared to 2021, there was a slight increase in emissions as there was an increase in the number of heating degree days (i.e., increased demand for building heat based on temperature) as shown in Table 38. Overall, greenhouse gases in 2022 are 26% less than the average for the last 5 years.

Table 40: WL Site Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2022 Releases
	2017	2018	2019	2020	2021	5-yr. Avg.	
GHG CO_2e tonnes	1,873	1,678	1,756	1,692	1,177	1,635.2	1,215

Note: GHG CO2e tonnes - A unit of measure used to compare between gases that have different Global Warming Potential. For example, the Global Warming Potential for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, following the Federal Halocarbon Regulations [44]. All releases greater than 10 kg are considered reportable.

As seen in Table 41, there were no reportable releases of halocarbons in 2022.

Table 41: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2022	
Type	Global Warming Potential[b]	Ozone Depleting Potential[c]	2017	2018	2019	2020	2021	Number of Losses	Annual Loss (kg)
Refrigerants[a]									
CFC (R-11)	4,600	1	0	0	0	0	0	0	0
CFC (R-12)	10,600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1,700	0	0	0	0	0	0	0	0
HFC (R-134a)	1,300	0	12.47	0	0	0	31.8	0	0
Fire Suppressants									
Halon (R-1301)	6,900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b Global Warming Potential per unit mass, compared to CO2 = 1.00
c Ozone Depleting Potential per unit mass, compared to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [44]

9.5.3 Overall Performance

The non-radiological effluent monitoring program set up by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were notable increases (>10%) in the loadings being released in the effluent to the Winnipeg River, and with the amount of particulate generated in the air. See Section 9.6 for more information.

There were four months (July –October) when CNL monthly guideline limits were exceeded at the Outfall for the parameters of TSS and Iron for a total of seven exceedances. The Whiteshell environmental program investigation is attributing these occurrences to the amount of soil/sediments that were able to make their way into storm drain system on site.

The Whiteshell site also reached the reporting threshold for the generation of all types of particulate matter this includes total particulate matter, PM_{10} and $PM_{2.5}$. In previous years, Whiteshell would only need to report on PM_{10}.

There were no discharges from the Lagoon in 2022 which exceeded any of the current CNL monthly guideline limits.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances in 2022. However, there was one reportable event made to the CNSC regarding an Action Level being exceeded at the Outfall Monitoring Station for Manganese (July through October). The event was discovered and reported in 2023 for the 2022 event. As discussed in Section 9.5.1.4.5.2, increased sediment loads entering the storm drain were responsible for the exceedance due to not performing street sweeping in the spring of 2022, however it has been recognized due to the increased sediment loads that street sweeping needs to be performed each spring going forward.

9.7 Discussion of Improvement Initiatives

The following sections describe some of the ongoing efforts the WL site is undertaking to enhance the effluent verification monitoring program.

9.7.1 Monitoring Site Intake Water and Outfall Effluent

In 2020, the WL site expanded the monitoring program to encompass additional parameters at the site’s Intake and Outfall monitoring station. This expansion resulted from the enhanced monitoring that was performed on the Intake and the Outfall in 2019 to address the gaps in baseline data when assessed against the monitoring criteria in Table 19-1 of the *WL Effluent Verification Monitoring Plan* [28]. It was decided that when there was a 20% change in concentration when comparing the results for a given parameter at the Intake and Outfall, that these parameters would be incorporated in the effluent verification monitoring program.

Under this criteria, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, Chloroform and Toluene have been added to the list of parameters being measured at these stations. In 2022, the parameter of Toluene was dropped again from the monitoring requirements for the Intake and the Outfall Monitoring station, as both 2020, and 2021 yielded nothing but non-detects on all submitted samples.

In 2022, Manganese was added as a parameter to be monitored at the Intake and Outfall. This parameter is being reported on for 2022 as it has been identified as a contaminant of concern, through the Environmental Risk Assessment that was performed on the Lagoon and Landfill, as elevated levels of Manganese were found in the surrounding soils.

Although the need to monitor for these parameters is currently captured in *WL Effluent Verification Monitoring Plan* [28], WL laboratories acknowledges that the plan needs to be updated to reflect that these parameters are actively being monitored, and plans to revise Reference [28] in 2023.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, to heat the site buildings. Starting in 2013, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 14 shows the annual fossil energy consumption since 2016, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 14, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply. In 2022, it was the first year where Buildings 305 and 402 no longer were heated as demolition activities for these building began in 2021, and carried over to 2022.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2022 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [31] (to be issued to the CNSC by 2023 June 30).

10 Emergency Management and Fire Protection

10.1 Emergency Preparedness Program

Whiteshell Laboratories adheres to CNL's Emergency Preparedness Functional Support Area. See Section 10.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Whiteshell Laboratories Emergency Preparedness continues to adapt to the changes on site, including the demolition of buildings/assets, the construction of temporary structures, the number and composition of staffing levels, and the organisational structure. Vacated buildings are transitioned from detailed building emergency procedures to construction/demolition specific emergency placards. The *WL Site Emergency Response Plan* [45] is being updated to reflect necessary changes in the Officer-In-Charge program, and re-working content to reflect current site and staff realities, and will be implemented in 2023.

Planning for and responding to COVID-19 gradually declined over 2022 and should not be a primary focus of the Emergency Preparedness Functional Support Area at WL in 2023.

10.1.1 Drills and Exercises

As COVID-19 restrictions were reduced over 2022, the focus of WL's Emergency Preparedness shifted to reviewing program documentation, as the drills and exercises are based on the program documentation. The decrease in COVID-19 risks across the province also resulted in renewed interest in joint training from some key external response partners. WL plans to take full advantage of this in the coming year.

As COVID-19 restrictions were reduced over 2022, the focus of WL's Emergency Preparedness shifted to ensuring all program documentation was compliant and still appropriate for the current and forecast condition of the site. This documentation forms the basis from which the exercise and drill campaign is run. The decrease in COVID-19 risks across the province also resulted in renewed interest in joint training from some key external response partners. WL plans to take full advantage of this in the coming year.

In 2022, a total of 127 exercises and drills were conducted at WL. Training

There were changes to the Emergency Operations Centre (EOC) staff in 2022, with new alternates being added to positions where the alternates had resigned or been promoted to active positions. Training will be offered at the earliest convenience. Work is underway to alter the building emergency team composition, with training and implementation to occur in 2023. Personnel in active positions are fully trained.

Table 42 provides details on the number and type of the exercises and drills conducted in 2022.

10.1.2 Training

There were changes to the Emergency Operations Centre (EOC) staff in 2022, with new alternates being added to positions where the alternates had resigned or been promoted to active positions. Training will be offered at the earliest convenience. Work is underway to alter the building emergency team composition, with training and implementation to occur in 2023. Personnel in active positions are fully trained.

Table 42: WL Emergency Preparedness Exercises – 2022

Type of Drill or Exercise	Number Completed in 2022
Fire Drills	9
Site-wide Specialty Drills	86
Table Top Exercises [a]	1
Targeted Communication Exercise	17
Site-wide Communication Exercise	12
Field Exercises (Functional)	2

a Table Top exercises include EOC skill workshops and EOC teaching sessions. Each workshop focuses on a unique aspect of EOC operations.

10.1.3 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains a physical EOC, and conducts monthly tests of the technical equipment stored for use in that location. Repairs, improvements, and updates are requested as required and when identified. All checks were completed in 2022. A cache of emergency food rations is also maintained at WL, which have a five year shelf life. The rations were replaced in 2019. The cache is stored in a secure location and the condition of the cases is checked annually.

10.1.3.1 Emergency Operation Center

As part of WL's EOC framework, there are two teams of EOC staff, and an alternate person for each of the team positions that can be engaged to cover for members of either team. These two teams operate on a two week on-call rotation. There was also an alteration to the structure of the team, with one function being removed from the mandatory attendance list as the focus of that function was more on the field operations than the work of the EOC. EOC documentation was updated to reflect this change.

There were no emergency events requiring activation of the EOC in 2022.

10.1.3.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories continues to maintain the Mobile Nuclear Laboratory for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the Mobile Nuclear Laboratory in 2022.

10.1.3.3 Equipment Checks

Respirators make up the majority of the equipment in the strategically placed emergency cabinets that remain on-site. These cabinets are opened and inspected monthly by Radiation Protection staff. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2022.

There were no emergency events requiring the use of this equipment in 2022.

10.1.3.4 Public Address System

The Public Address system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2022.

10.1.3.5 EOC Notification System

WL continued to use the Everbridge mass notification system in 2022. The system continues to perform very well, with a 100% coverage for all monthly communication tests for the fourth year in a row. The monthly tests include only the on-call members for the EOC team.

In addition to these regularly scheduled monthly drills, WL continues to conduct random quarterly drills. These drills are scheduled for random times and dates, involving weekends, evenings, and work hours. These random drills include the expanded EOC teams, including all alternates and non-routine staff. Table 43 identifies the response rates of the 2022 WL EOC Staff to the Quarterly Random EOC call out drills, with an average of 91% response. Only responses received within an hour of the notification being sent out are considered a positive response; the rest are considered ‘no response’.

Table 43: WL EOC Random Quarterly Communication Tests: 2022

	Q1	Q2	Q3	Q4
Response Percentage	95%	95%	75%	100%

10.1.4 External Collaborations

In 2022, contact was maintained with a variety of external emergency response/management organizations and interested public groups. Due to COVID-19 many of these were once again virtual meetings or connections. WL Emergency Preparedness:

- Engaged with Pinawa Volunteer Fire Department in the fall. A recent change in the department’s management has created a renewed interest in joint training and exercises. The first joint exercises is currently being planned and will be run in 2023.
- Participated in the Manitoba Provincial Flood and Forest Fire forecasting sessions in the spring.

- Continued to participate in the Manitoba Municipal Relations Governance COVID-19 teleconference meetings in early 2022, at which time the province ceased these meetings.
- Engaged with the Ontario Office of Emergency Management to reach out to the community emergency planners and responders along the potential shipping path of radioactive material shipments in Northern Ontario. A virtual information session was held with the planning district representatives on responding to accidents that involve radiological materials.
- WL Emergency Preparedness attended the Northern Ontario Fire Conference as a tradeshow member in an effort to connect with first responders in the area and raise awareness on potential responses involving radioactive material shipments on the regions highways.
- Continued to communicate with the Federal Coordination Working Group via email, helping to maintain relationships with multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police, Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada. These relationships continue to be leveraged to support organizational project and response planning at WL.
- The Prairie Region Federal Coordination Working Group did not meet virtually or in person in 2022. There was a large amount of staff changes for the Winnipeg Public Safety Canada office this year, who facilitate these meetings. WL has been in contact with the new team and an orientation visit to the WL site is scheduled for early 2023.

10.1.5 Unplanned Emergency Events

There were no incidents requiring initiation of the WL Site Emergency Plan in 2022.

10.2 Fire Protection Program

Whiteshell Laboratories adheres to CNL's Fire Protection Functional Support Area. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Whiteshell Laboratories maintains a comprehensive fire program with fire inspection, project fire screenings and assessments, alarm systems and an equipped 24/7 response force.

There was one reportable event connected to the fire program at WL in 2022 related to fire detection system verification testing (see ImpAct ERM-22-3469 in Table 7). The annual third party fire detection system verification testing was conducted two months late due to scheduling conflicts arising with the contractor. An alternate vendor was selected to carry out the testing in December, bringing the site back into alignment with the annual testing requirement.

10.2.1 Fire Response Drills

In 2022, WL conducted all seven fire drills that are an annual requirement in accordance with the National Fire Code of Canada [46] and CSA standard N393-13 Fire Protection for Facilities that Process Handle, or Store Nuclear Substances [47]. There were no findings associated with the fire drills in 2022.

10.2.2 External Collaborations

The 2019 Fire Protection Service Agreement between Whiteshell Laboratories and the Town of Pinawa remains in effect. Interdepartmental training was interrupted by the COVID-19 pandemic, and by personnel challenges at the Pinawa Fire Department. These issues were resolved at the end of 2022, and arrangements are being made to resume joint training and exercises in early 2023.

10.2.3 Third Party Audits & Inspections

Preparations began this year to engage a qualified third party consultant to assess the fire response capabilities at WL through an exercise. This exercise and assessment will meet the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [47], which requires a third party Fire Protection Audit to be conducted once every three years. It is expected that the contract will be in place and the exercise run in spring of 2023.

10.2.4 Fire Hazard Analysis

A third party fire hazard analysis was conducted in 2022 for all nuclear facilities in alignment with a corrective action plan sent to the CNSC. Associated nuclear facility’s assessments will be completed in subsequent years as per the submitted corrective action plan.

11 Waste Management

11.1 Waste Management Program

Whiteshell Laboratories adheres to CNL's Waste Management Functional Support Area. See Section 11.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program in 2022 included:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL sites to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Restoration Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for the waste receiving facilities on-site (including the Waste Handling Area and the WMA storage facilities) remained unchanged for 2022.

11.1.1 Waste Management Operations

Radioactive, clean and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for storage.

Demolition of Buildings 402 and 305 was completed in 2022. A total of 1,852 m^3 clean waste was generated in 2022; 906 m^3 of concrete material was dispositioned to an off-site receiver for future re-use, 24 m^3 of metal was recycled, while 899 m^3 of asbestos-containing material, 11 m^3 of polychlorinated biphenyl (PCB) contaminated materials and 11 m^3 of construction and demolition waste was dispositioned to appropriate off-site waste receivers.

Volumes of radioactive wastes (201 m^3 of low-level waste (LLW) and 77.5 m^3 of intermediate-level waste (ILW)) generated from the demolition of Building 200 Active Liquid Waste Treatment Centre in 2021 remain safely stored in certified transportation packages within the demolition Controlled Area. The 77.5 m^3 of ILW consists of a former intermediate level liquid mixing tank. To enable its consignment as a Surface Contaminated Object, accessible areas of the tank (which were created from collecting several coupons for characterization purposes) must be made inaccessible. This work is expected to be completed in 2023. The 201 m^3 of LLW is planned for dispositioning to CRL in 2023.

De-inventorying efforts of legacy waste stored in LLW Bunker 5 continued. Wastes are undergoing additional qualification and inspection to ensure transportation and waste criteria compliance are met. This activity has generated 430 m^3 of LLW to date, of which approximately half of this volume has been safely shipped to CRL, with the remaining volume safely stored in certified transportation packages awaiting shipment to CRL in 2023.

De-inventorying efforts of legacy wastes stored in LLW Quonsets (B433, B432, and B431) also continued. Wastes are undergoing additional qualification and inspection to ensure transportation and waste criteria compliance are met. This activity has generated approximately 305 m^3 of LLW to date, which is safely stored in certified transportation packages awaiting shipment to CRL in 2023. A reflux boiler, comprising 65.8 m^3 of LLW, was shipped to an offsite vendor for processing due to its physical size not meeting the CRL waste acceptance criteria.

Table 44 summarizes the quantities of radioactive waste generated in 2022 that was sent to each storage location.

Table 45 summarized the volumes of solid low-level radioactive waste originating from each facility in 2022. Table 46 summarizes the volumes of solid intermediate-level radioactive waste originating from facilities in 2022.

Table 44: Radioactive Waste by Storage Location

Storage Facility	Volume (m^3)	
	2021	2022
Low-Level Quonsets	0.0	0.0
Intermediate-Level Waste Bunkers	2.5	0.0
Soil Storage Compound	0.0	0.0
Total	2.5	0.0

Table 45: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2021		2022	
	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)
Building 100	1.5	0.0	0.5	0.0
Building 200	0.0	875.6	0.0	0.0
Building 300	0.0	0.0	0.0	0.0
Building 303	0.0	0.0	0.0	0.0
Building 304	0.0	0.0	0.0	0.0
Building 402	0.8	0.0	0.0	0.0
Building 421	0.0	0.0	0.0	0.0
Concrete Canister Storage Facility	0.0	0.0	0.0	0.0
Shielded Facilities (HCF & IFTF)	45.6	0.0	7.5	0.1
Waste Handling Area	0.0	0.0	0.0	0.0
Waste Management Area	14.2	0.0	3.00	0.0
LLW Bunker 6	0.0	9.0	0.0	0.0
LLW Bunker 5	0.0	360.0	0.0	70.0
Affected Lands	0.0	0.0	0.0	0.0
Soil Storage Compound	0.0	0.0	0.0	0.0
Total	**62.1 (5.0)[a]**	**1244.6**	**11.0[b]**	**70.1**
Total after Compaction	**1249.6**		**81.1**	

a This volume of compactable waste was reduced to 5.0 m^3. It is not possible to determine accurate post consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

b This volume of compactable waste was not reduced due to the WL Supercompactor being taken off-line for future disassembly and re-use at CRL.

Table 46: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m^3)	
	2021	2022
Affected Lands	0.0	0.0
Building 200	77.5	0.0
Shielded Facilities (HCF & IFTF)	0.0	0.02
Total	77.5	0.02

Table 47: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2021		2022	
	LLW Volume (m^3)	ILW Volume (m^3)	LLW Volume (m^3)	ILW Volume (m^3)
Building 402	0.0	0.2	0.0	0.0
Shielded Facilities (HCF & IFTF)	0.0	0.0	0.1	0.02
WMA (Legacy Sources)	39.0	0.0	0.0	0.0
Soil Storage Compound	0.0	0.0	0.0	0.0
LLW Bunker 6	6	3	0.0	0.0
LLW Bunker 5	0.0	0.0	240.0	0.0
Building 200	876	0	101.5	2.5
LLW Quonsets (B431, B432, B433)	0	0	0.0	0.0
Total	921	3.2	341.6	2.52

WL continues to utilize external vendors for selected waste requiring treatment. Table 48 summarizes the amount of hazardous waste collected and transferred off-site for processing.

Table 48: Summary of Amounts of Hazardous Waste Shipped Off-Site

Waste Type	Volume (m^3) (Weight (kg))	
	2021	2022
Solid Hazardous Waste Shipped Off-Site For Disposition	8.20 (4,859.5)	14.22 (7605.4)
Liquid Hazardous Waste Shipped Off-Site for Disposition	3.88 (2,948.0)	6.02 (670.8)
Total	12.08 (7,807.5)	9.24 (826.2)

Clearable waste from Controlled Areas was monitored in-situ. Clean bagged waste was monitored using the bag monitor located in Building 300; all bagged waste met the screening criteria and was deemed to be suitable for unconditional release in 2022.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable, consistent with CNL's Integrated Waste Strategy; this includes both recyclable materials sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

Table 49 summarizes the routes of non-active wastes and breaks it down by amount, material type, of recyclable waste shipped off-site.

Table 49: Clean and Recycled Waste Shipped Off-Site

Material[a]	Volume (m^3) (Weight (kg))	
	2021	**2022**
Dispositioned in WL Inactive Landfill	0	0
Dispositioned in Off-Site Landfills [a]	130 (39,070)	64 (47,810)
Batteries	0	0
Concrete (reuse off-site)	1454 (1,789,448)	1783 (1,943,450)
Fluorescent Lights	0.5 (170)	1 (265)
Office Recycling (Cardboard, Containers) [b]	5 (1,390)	4 (1,800)
Metal Recycle	470 (197,880)	153 (71,690)
Shredded Paper Recycled	38 (6,750)	13 (2,250)
Waste Electrical and Electronic Equipment	9 (3,464)	0 (0)
Asbestos Containing Material Dispositioned in WL Asbestos Disposal Site [c]	0	0
Asbestos Containing Material Dispositioned in Off-Site Landfills	526 (532,920)	334 (367,000)
Total	2,632.5 (2,571,092)	2,352.0 (2,434,265)

a WL Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted a municipal recycling facilities.

c The WL Asbestos Disposal Site stopped receiving waste in 2019 to support the environmental risk assessment. Non-active asbestos is directed to off-site licensed landfills.

Improvements continue to be addressed for processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes of radioactive wastes generated from decommissioning activities. Mitigation measures put in place in 2022 included leveraging the Recoverable Surface Storage and Staging Area, for the interim storage of cargo containers containing radioactive wastes in the WMA awaiting further processing, characterization and/or packaging to be considered compliant for off-site disposition.

11.1.1.1 Liquid Waste Generation

During 2022, 117.3 m^3 of low-level liquid was processed in the Building 300 LLLWTS and 2.3 m^3 in the Building 100 LLLWTS, for a total of 119.6 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Whiteshell Laboratories adheres to the CNL Cleanup Functional Support Area. See Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Progress on Decommissioning and Environmental Remediation activities with an update on the associated regulatory documents as guided by the Cleanup Function is summarized in the sections that follow.

As per the Licence Conditions Handbook for WL [2], CNSC are notified of revisions to the Detailed Decommissioning Plans (DDPs) for WL.

11.2.1 Decommissioning and Demolition Program

Table 50 lists the WL DDPs and their status as of 2022.

Table 50: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use (revision planned for 2023).
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned. End-state report completed.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned. End-state report completed.

Facility	DDP Document Title	Document #	Status
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility has been decommissioned. Demolition complete – site cleanup remains to be completed. End-state report in development. DDP available for use.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach)	Facility has been shut down and currently under monitoring and surveillance – Storage-with-surveillance plan under revision. Complete Dismantlement and Removal approach has been approved by the CNSC (Revision 3). Environmental Assessment process for in situ decommissioning is in progress, Revision 4 to be revised with final Environmental Assessment submission (note: copy of Revision 5 submitted for review of comment disposition to CNSC prior to final Environmental Assessment submission). DDP Volume (Revision 3) is available for use.
		WLDP-26400-DDP-001, Revision 5, 2021 (In Situ Decommissioning Approach)	
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC and comments received (to be dispositioned).
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 2: Intermediate - Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 5, 2021	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.

Facility	DDP Document Title	Document #	Status
R&D Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use (revision planned for 2023).
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned. End-state report completed.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001, Revision 2, 2020	Decommissioning activities ongoing. Demolition complete – site cleanup remains to be completed. End-state report in development. DDP Volume is available for use.
DDP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer Area Buildings and Facilities	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

11.2.1.1 Detailed Decommissioning and Execution

No WL facility DDPs were revised in 2022. Table 51 provides a summary of decommissioning and demolition statuses for WL in 2022.

Table 51: Summary of WL Decommissioning and Demolition Status by Facility in 2022

Facility	Decommissioning and Demolition Status
B402/305	Building Demolished
B200	Building Demolished
WMA	Active Decommissioning
Site Affected Lands and Contaminated Structures	Active Decommissioning

Two buildings were demolished in 2022, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition where feasible.

Demolition of Buildings 402 and 305 was completed in early 2022. The demolition of the buildings included remediation and abatement of asbestos-containing materials, specifically the mastic tar adhered between the masonry and exterior wall, and PCBs found within window glazing and exterior caulking and general demolition of construction and demolition materials.

Legacy wastes stored in the LLW Quonsets (Building 431, 432 and 433) and LLW Bunker 5 continued to be retrieved in 2022. Wastes are undergoing visual examination, destructive and non-destructive characterization, and packaging to ensure transportation and waste criteria compliance are met, before waste can be dispositioned to CRL. This work is scheduled to be complete in 2023.

Operational cleanout of B405 was completed in 2022 in preparation for its future demolition scheduled in 2023. Materials removed included repurposed office furniture which were distributed throughout the site for reuse, and general office waste, which consisted mostly of paper which was routed for recycling. The exterior and interior of the building were also radiologically surveyed for clearance.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

11.2.1.2 End State Reporting

There were no end-state reports completed in 2022.

12 Security

12.1 Security Program

Whiteshell Laboratories adheres to CNL's Security Functional Support Area. See Section 12 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Whiteshell Site Security Report [48] outlines the security arrangements that are in place at the WL site. The Security Functional Support Area consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Functional Support Area and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in REGDOC-2.2.4, *Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness* [49].

CNL-WL received notification from the CNSC on the closure of all seven (7) enforcement items from a 2021 Type II Security inspection. Notices of Non-Compliance closure was granted as CNL-WL completed all actions required to address the enforcement items listed in them.

12.1.1 Security Events

In 2022, there were 0 security events that affected WL.

13 Safeguards and Non-Proliferation

13.1 Safeguards Program

Whiteshell Laboratories adheres to CNL's Nuclear Materials and Safeguards Management Functional Support Area. See Section 13 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

13.1.1 IAEA Activities

The IAEA conducted various types of activities as part of the safeguards approach for CNL, including, but not limited to, IAEA safeguards seals changes, human surveillance, implementation and/or maintenance of IAEA safeguards monitoring equipment, and technical visits. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2, Management System of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1], with WL inspections discussed below and in Section 1.3.2.

A Physical Inventory Verification inspection was completed by the IAEA on 2022 May 02. This inspection was a sampling of accessible items containing Special Fissionable Material.

The IAEA also completed a Design Information Verification inspection on 2022 May 03. The activities associated with the Design Information Verification included:

- Verification of the Design Information Questionnaire:
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

Two actions were raised and have been completed based on the Physical Inventory Verification and Design Information Verification inspections.

The IAEA requested a Complimentary Access at the Whiteshell site on 2022 June 01. The purpose of a Complimentary Access is to assure the absence of undeclared nuclear materials and activities, to resolve a question or an inconsistency relating to correctness and completeness of the information provided in Canada's annual update to the IAEA, and to confirm the decommissioned status of a facility. This activity included a tour of the Building 300 Shielded Facilities and Laboratories and the former sites of Building 200 and Building 402 which have been demolished.

14 Packaging and Transport

14.1 Packaging and Transport Program

Whiteshell Laboratories adheres to CNL's Transportation of Dangerous Goods Functional Support Area, which includes the requirements of the Packaging and Transport SCA. See Section 14 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

Activities in 2022 included:

- Transportation of 342 m^3 of low-level waste and 2.5 m^3 intermediate-level waste consigned off-site and safely delivered to CRL;
- In early 2022, the Used Fuel Transportation Package (UFTP) Safety Analysis Report (SAR) Addendum was approved by the CNSC [Certification Number CDN/2052/B(U)-96 (Rev. 9)]. The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations from WL to the CRL site. The certificate issued by the CNSC in 2022 includes the non-enriched CANDU[9] fuels only. In support of the second phase of the UFTP licensing, the Nuclear Waste Management Organization will submit the UFTP SAR for Mixed Fuel Types to the CNSC in early 2023.

14.1.1 Shipments

At WL, 42 radioactive transport packages making up 28 loads were safely and successfully sent off-site in 2022.

[9] Canada Deuterium Uranium, registered trademark of AECL

15 Other Matters of Regulatory Interest

15.1 Public Information and Disclosure Program

Whiteshell Laboratories adheres to the Corporate Public Information Program. See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [1].

The Public Information Program document [50] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure* [51].

15.1.1 Outreach and Stakeholder Engagement

CNL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events (see Table 52). Employees are CNL's greatest ambassadors, they are kept informed of developments so that they can also share information with relatives, friends, and neighbours. In 2022 June, following the safety pause, WL began holding weekly all staff meetings. The meetings have proved to be effective in keeping staff informed.

Table 52: Public Engagements for Whiteshell Laboratories

Date	Location	Activity
January 18, 2022	Webinar	Regulatory Process for the NPD and WR1 In Situ Disposal Projects - 2022 January
March 22, 2022	Webinar	NPD & WR-1 Webinar - The design of the WR-1 and NPD reactors and In-Situ Disposal
May 10, 2022	Webinar	NPD/WR-1 Webinar: Overview of the Environmental Impact Statements
May 12, 2022	Virtual	Public Liaison Committee meeting
September 8-10, 2022	Thunder Bay	FireCon Trade Show – booth to communicate about transportation of waste
September 28, 2022	Webinar	NPD and WR-1 Webinar Who Supports an Environmental Assessment Project
November 2, 2022	WL	Take Our Kids to Work Day – 16 students attended for presentations, activities and tours
November 22, 2022	Webinar	Whiteshell Laboratories: Past, Present & Future
November 30, 2022	WL	Public Liaison Committee meeting

CNL engaged with the public on WL using a number of avenues. Notably, the Public Liaison Committee meeting was held in person in 2022 November for the first time since the onset of COVID. The members, several of whom had changed since the fall municipal election, were first given a presentation on WL. The presentation gave a brief history of the site for the benefit of the new members and then highlighted progress on the project and looked into the site's future. The Public Liaison Committee members then went on a bus tour of the main campus and the WMA.

15.1.2 Public Consultation

CNL actively works to engage local stakeholders on matters related to WL activities. In 2022, a number of methods were deployed to gain feedback from and create discussion with interested parties including: public polls, webinars, social media, and feedback forms available online and at external events, and responses provided to inquiries. CNL strives to create open and transparent communication with all identified stakeholders, and to address concerns and respond to all inquiries.

CNL engaged a consultant to conduct a public attitude survey in 2022 December, in advance of engagement planned for spring 2023 on the WL Land Use and End State plan. The purpose of the survey was to gauge public opinion and understanding about the WL Restoration Project. Results indicated generally positive attitudes towards CNL and the WL Restoration Project.

Completed by phone with 368 residents in Eastern Manitoba, the public attitude survey revealed that 60% of respondents view CNL as trustworthy, 59% view CNL as capable, and 56% view CNL as transparent. The survey also found that 51% are very or somewhat familiar with CNL, 62% are familiar with the WL site, 60% consider CNL very or somewhat approachable, and 53% believe that CNL is somewhat or very committed to the best interests of the region.

Results showed that people in the communities surrounding the WL site are most concerned about the environmental impact of the decommissioning process, particularly the effects on plants and wildlife, and how nuclear waste will be managed. They are also worried about the economic impact on local jobs. CNL uses the results of the public attitude survey to tailor its communications and engagement approach.

Throughout 2022, CNL received 36 community inquiries related to WL (see Table 53), largely through the public webinars.

Table 53: Whiteshell Laboratories Restoration Project Public Inquiries

Nature of Enquiry	Number
Transportation	6
Health	1
Environmental Protection	22
Small Modular Reactors (SMRs)	1
Whiteshell Laboratories Restoration Project	6

15.1.3 Traditional and Online Communications

15.1.3.1 Website

CNL's Whiteshell Decommissioning external web page had 2,864 page views in 2022, while the WR-1 Reactor Decommissioning page had 1,407.

To support the Whiteshell projects and site, CNL's use of social media was an effective tool to promote events, share and receive information, and generally engage with the public. As Table 54 through Table 56 show, social media has been an effective tool to reach and engage stakeholders. Table 58 shows that CNL also shared information through a community information bulletin.

Community updates and announcements are made on the external CNL.ca website, as noted in Table 57 and Table 58.

Table 54: Facebook Metrics for WL-related Posts

Date of Post	Engagement[a]	Shares[b]
March 03, 2022	28	1
July 11, 2022	18	1
October 03, 2022	55	1
November 02, 2022	10	1
November 16, 2022	4	0
December 22, 2022	6	0

a Measures how much and how often others interact with you and your content in social media.

b Measures how often the message was shared or forwarded.

Table 55: Twitter Metrics for WL-related Posts*

Date of Post	Engagement[a]	Retweets[b]	Clicks
May 05, 2022	133	0	2
November 02, 2022	163	2	2
December 22, 2022	164	0	6

a Measures how much and how often others interact with you and your content in social media.

b Measures how often the message was shared or forwarded.

Table 56: YouTube Videos

Date of Post	Title	Views
January 21, 2022	Regulatory Process for the NPD and WR1 In Situ Disposal Projects - 2022 January	49
January 21, 2022	Le processus de réglementation des projets l’élimination in situ de NPD et du réacteur WR1	11
April 5, 2022	NPD & WR-1 Webinar - The design of the WR-1 and NPD reactors and In-Situ Disposal	78
April 5, 2022	NPD & WR-1 Webinaire - La conception des réacteurs WR-1 et NPD et le stockage définitif in situ	22
May 19, 2022	NPD/WR-1 Webinar: Overview of the Environmental Impact Statements	50
May 19, 2022	NPD/WR-1 Webinaire: Aperçu des énoncés des incidences environnementales	12
September 28, 2022	NPD and WR 1 webinar Who Supports an Environmental Assessment Project	29
September 28, 2022	NPD et WR 1 Webinaire Qui soutient un projet d'évaluation environnementale	5
November 28, 2022	Whiteshell Laboratories: Past, Present & Future - November 2022	94
November 28, 2022	Les Laboratoires de Whiteshell Passé, présent et futur - 2022 novembre	12

Table 57: Community Information Bulletins

Date	Bulletin
June 10, 2022	Employee receives minor shock conducting work at Whiteshell Laboratories

Table 58: WL News & Announcements on cnl.ca

Date	News	Page Views
July 11, 2022	WR-1 Closure Project submits the revised draft Environmental Impact Statement (EIS)	284
December 12, 2022	We want to hear from you	63
December 14, 2022	Sagkeeng First Nation, CNL and AECL Launch Collaborative Environmental Monitoring Program	93

15.1.3.2 Newsletters

CONTACT is CNL’s external, bilingual newsletter. It is distributed to community stakeholders, businesses and approximately 8,000 homes in the region surrounding WL, and is available online at CNL.ca. This publication informs the reader on activities undertaken at CNL’s WL and profiles CNL’s community activities. Two issues of *CONTACT* were distributed in 2022 (Fall 2022, Winter 2021 was distributed in February 2022) and included the following topics:

- WL Restoration Project and WR-1 updates
- Link to the public survey

- Highlights of public and Indigenous engagement activities
- CNL initiatives in the community, demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- Workforce Employee transition plans
- Standpipes/Bunkers Waste Retrieval System updates
- Waste transportation information
- In fall 2022, CNL re-introduced the newsletter for WL employees called The Loop. The newsletter features Whiteshell-specific news for all staff, as well as personal announcements and other topics of interest to employees. Electronic versions were distributed by email and were available on CNL's intranet, and printed copies were posted throughout the site. Two issues were produced 2022.
- Media Releases

CNL issued one media release in 2022, announcing WL's new environmental monitoring program, Niigan Aki (see Table 59).

Table 59: Media Releases for 2022

Date	Title	Sent via
December 14, 2022	Sagkeeng First Nation, CNL and AECL Launch Collaborative Environmental Monitoring Program	Global News Wire The Clipper

During 2022, there were six articles written by media on the Whiteshell Laboratories Restoration Project (see Table 60).

Table 60: Media Coverage for 2022

Date	Article	Title of Publication
July 20, 2022	CNL moves forward on Whiteshell decommissioning	North Renfrew Times
July 26, 2022	WR-1 Bulletin – June 28 Submission of the revised draft EIS	CNSC
November 24, 2022	Shipping containers Aid fire training	The Clipper
December 14, 2022	Sagkeeng First Nation, CNL and AECL Launch Collaborative Environmental Monitoring Program	JWN Energy
December 14, 2022	Sagkeeng First Nation, CNL and AECL Launch Collaborative Environmental Monitoring Program	Yahoo! Finance
December 14, 2022	Sagkeeng First Nation, CNL and AECL Launch Collaborative Environmental Monitoring Program	Turtle Island News

15.1.4 Education/Science & Technology Communities

In 2022, WL attended one event at FW Gilbert School in Pinawa and hosted students of staff members in person for Take Our Kids to Work Day (see Table 61).

Table 61: School Tours/Presentations

Date	Location	School
November 1, 2022	Pinawa	FW Gilbert School - for community recognition ceremony
November 2, 2022	WL	Take Our Kids to Work Day – 16 students attended for presentations, activities and tours
November 2, 2022	WL	Take Our Kids to Work Day – 16 students attended for presentations, activities and tours

15.1.5 Ongoing Projects

15.1.5.1 WR-1 In Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning project is a key part of CNL's overall integrated approach to safely manage and reduce Canada's legacy liabilities. The Environmental Assessment process for the project includes a requirement that WR-1 project information be made available to neighbouring communities, Indigenous communities and organizations, and stakeholder groups through a variety of mechanisms to ensure access to fact-based information. Engagement activities conducted in support of this requirement included social media and website content, presentations, meetings, site tours and fulfilling stakeholder requests for information. In 2022, CNL submitted the revised draft EIS for the WR-1 Project to the Canadian Nuclear Safety Commission (CNSC).

Project-specific webpages and content were produced for the WR-1 Project and included: fact sheets, info-graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages at www.cnl.ca/wr-1.

15.2 Engagement with Indigenous Communities

CNL recognizes the importance of, and places value on, ongoing engagement with Indigenous communities and organizations. CNL's engagement efforts follow the guidance in CNSC REGDOC-3.2.2, *Indigenous Engagement* [52].

CNL seeks to provide Indigenous communities and organizations with effective access to timely information about ongoing activities at the WL site and the possible effects of these activities to community members and the environment, and to seek feedback from the communities regarding traditional and current uses in the vicinity of the WL site, planned and ongoing project-related activities, programs, timelines, environmental protection and mitigation measures, long-term benefits and economic opportunities.

Through engagement activities on the WLRP, CNL continues to build on years of engagement with Indigenous Nations including Sagkeeng First Nation, Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation, Wabaseemoong Independent Nations, Grand Council Treaty #3, and the Red River Métis (engaged via the Manitoba Métis Federation (MMF)). Major project updates are shared with Iskatewizaagegan #39 Independent First Nation, Shoal Lake

Independent Nation #40, and Northwest Angle #33, with opportunities for further engagement available to those communities at their discretion.

Table 62 lists the engagement activities from 2022. Further details on Indigenous Engagements are available through the Indigenous Engagement Report [53].

Although the COVID-19 pandemic limited in-person/on-site engagements in 2022, ongoing bilateral working group meetings with members from First Nations and the Red River Métis were productive. While virtual platforms will remain a tool of engagement, CNL expects to see a return to more on-site engagements in 2023, giving community members a first-hand look at project operations and opportunities.

Areas of interest identified by First Nations and the MMF in 2022 included employment and contracting opportunities, and environmental monitoring and protection programs. In response, CNL shared various job opportunities directly with the Indigenous community employment and training staff where identified. CNL developed corporate strategies related to reconciliation actions and to procurement opportunities for Indigenous businesses, and will request input from First Nations and the Red River Métis on these strategies in 2023.

During the 2021 Regulatory Oversight Report meeting, Sagkeeng First Nation (SFN) and the MMF provided recommendations on how CNL can continue to progress its relationship with the communities through more active involvement of community members in CNL's environmental monitoring activities. CNL values these recommendations, and is working with First Nations and the Red River Métis communities to co-develop well-defined, community led environmental monitoring programs that focus on sampling and analyzing results identified by the communities as most important to them. In 2022 December, leadership from Sagkeeng First Nation, CNL and AECL participated in a traditional signing ceremony for the new independent Sagkeeng Community Environmental Monitoring Program. Sagkeeng First Nation named the program Niigan Aki, meaning Land First, through a cultural ceremony.

CNL has and will continue to work closely with the SFN to support and fund monitoring initiatives including Niigan Aki. The program is currently under development by SFN and their technical/environmental advisors, and it is understood that it will focus on their traditional and cultural values including country foods. The monitoring is planned for both on-site at the WL Restoration Project and in SFN's traditional territory away from the project site. To promote more in-depth, ongoing communication with SFN, CNL also funds monthly working group meetings, the SFN Community Liaison Committee, and a part time Community Liaison Officer position.

CNL has also committed to collaborating with other communities including a MMF wildlife and environmental monitoring program for the WL site.

Through ongoing communication and engagements, and with direction from Indigenous community representatives, CNL modified the WL environmental monitoring program to include Valued Components, identified by the communities, such as the harvesting of wild mushrooms, wild berries and wild rice, and the potential to sample sturgeon and traditional medicinal plants in the project area. Adding these elements builds CNL's knowledge and increases the confidence of community members that traditional foods and medicines on and near the Whiteshell site can be safely harvested and consumed. With the aforementioned Niigan Aki (CEMP) and MMF-led programs, the expectation is that this list of Valued Components could grow as the community-based environmental monitors get out onto the lands, both within the project area as well as the surrounding area, with the full support of CNL staff.

CNL recognizes the importance of Traditional Knowledge and Land Use Studies and has supported the development of these studies in the context of the WR-1 project. CNL is interested in developing Long-Term Relationship Agreements with Nations that support their capacity to participate meaningfully in the WLRP. While recent focus has been on the WR-1 project EIS, environmental monitoring and other matters, CNL is committed to developing these agreements when the Nations are ready to move forward with these discussions.

Further to these initiatives, CNL supports and provides funds to all Indigenous communities including the Red River Métis' participation on the Indigenous Advisory Committee. These initiatives have and will continue to improve communication about site activities, and provide another avenue for open and transparent discussion about the project. In addition, CNL remains committed to notifying First Nations and the Red River Métis of WL events that may impact traditional activities off site.

15.2.1 Engagement Objectives

As part of its corporate, environmental, and social responsibility, CNL recognizes the value of ongoing engagement with the First Nations and the Red River Métis (represented by the MMF) through the course of the environmental assessment process for the WR-1 Project and engagement on the overall site restoration project. Through two-way information-sharing and other engagement activities, CNL seeks to build awareness of its plans and activities, and, learn about interests and concerns of the First Nations and the Red River Métis in an effort to strengthen mutual understanding, and pursue opportunities for collaboration and long-term relationships.

CNL engages with First Nations and Red River Métis leadership, representatives and members on the potential effects of the WR-1 Project and the WLRP on the environment and on Indigenous and/or treaty rights including rights to trap, hunt, fish, gather and conduct cultural ceremonies.

CNL has five overarching Indigenous engagement goals:

- **Build awareness and mutual understanding**, and demonstrate CNL's long-term commitment and approach to safe and responsible management of AECL's radioactive waste and decommissioning liabilities (e.g., through project and site monitoring activities), by supporting and facilitating opportunities for mutual learning, including current and traditional land use, and values and perspectives on nuclear decommissioning, environmental remediation and radioactive waste management.

- **Share information on the project, including the potential effects on the environment.** This includes developing meaningful, user-friendly information and communication products for the First Nations and the Red River Métis, and providing accessible and current information on Project activities.
- **Seek input and feedback from the First Nations and the Red River Métis** regarding Project-related activities, and traditional and current uses of the land surrounding the WL site. Initiate early and meaningful two-way communication between CNL and the First Nations and the MMF to determine the best methods for sharing information and to provide opportunities for Indigenous peoples to provide input on Project considerations including design, the environmental assessment process, and assessment of effects. This includes exploring opportunities for Indigenous economic participation on the Project.
- **Develop long-lasting relationships with the First Nations and the Manitoba Métis Federation** to support their continued involvement in the Project, as well as community healing and reconciliation. These relationships will extend beyond the scope of the environmental assessment process for the WR-1 project.
- **Meet or where possible exceed all regulatory-based communication and engagement requirements** and facilitate engagement that reflects current memorandums of understanding and contribution agreements, that takes into account the interests, needs and capacity of each Indigenous Nation.

15.2.2 Identified Indigenous Communities

CNL developed a list of the Indigenous communities and organizations with a potential interest in the WR-1 Project and the WLRP. The identification of the First Nations and the Red River Métis was based on consultation with the CNSC, through CNL's previous Indigenous engagements, and through the use of publicly available sources of information including:

- First Nation and the Red River Métis and organization websites;
- The Aboriginal and Treaty Rights Information System (ATRIS; Government of Canada and INAC 2016); and
- Crown-Indigenous Relations and Northern Affairs Canada First Nation community profiles.

The list was based on the identified potential or established Indigenous or treaty rights of the First Nations and the Red River Métis and is provided in Table 62 with a brief rationale for inclusion. The inclusion of specific Nations considers the nature of the established and/or claimed rights, and potential effects on those rights caused by the proposed project, based on a preliminary assessment of existing and available information. As such, the working list is subject to change based on information and dialogue with the identified First Nations, the Red River Métis, and Indigenous organizations. Involvement in CNL engagement is at the discretion of each community and subject to community preferences and availability.

Table 62: Identified Indigenous Communities

First Nations, the Red River Métis or Organizations	Identification Rationale
Sagkeeng First Nation (Treaty No. 1 and 3)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Occupy one reserve located 52 kilometres (km) north of the WL site, and downstream along the Winnipeg River. Existing relationship and interest in the WL site. The WL site is within the boundaries of the area over which Sagkeeng claims unsurrendered Aboriginal title, a proceeding for which is ongoing in the Manitoba Court of King's Bench.
Brokenhead Ojibway Nation (Treaty No. 1)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Occupy three reserves: 44 km northwest, 55 km northwest and 73 km southwest of the WL site respectively. Interest expressed comments on Project Description.
Manitoba Métis Federation	The MMF is the official democratic and self-governing political representative for the Métis Nation's Manitoba Métis Community. The MMF is considered the government of the Red River Métis. Potential asserted and/or established Métis harvesting rights in the vicinity of the Project. Interest expressed comments on Project Description.
Black River First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Occupy one reserve 75 km north of the WL site.
Hollow Water First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Occupy one reserve, 113 km north of the WL site.
Shoal Lake No. 40 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy three reserves: 94 km southeast, 110 km southeast and 140 km southeast of the WL site, respectively.
Iskatewizaagegan No. 39 Independent First Nation (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy four reserves: 93 km southeast, 102 km southeast, 110 km southeast and 140 km southeast of the WL site, respectively.
Northwest Angle No. 33 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy three reserves: 111 km southeast, 140 km southeast and 176 km southeast of the WL site, respectively.

First Nations, the Red River Métis or Organizations	Identification Rationale
Wabaseemoong Independent Nations (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the WL site. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy four reserves: 80 km east, 85 km east, 95 km east and 140 km southeast of the WL site, respectively.
Grand Council of Treaty 3	Umbrella treaty organization which represents 28 First Nations and 5 with potential interest in the Project. Treaty 3 territory includes parts of eastern Manitoba, including the WL site.
Chiefs of Ontario	First Nations umbrella organization that represents 133 First Nations and 4 with potential interest in the Project

15.2.3 Summary of Engagement

Environmental monitoring and environmental protection are consistent and important topics of discussion meetings between CNL and First Nations and the Red River Métis. CNL has provided an open invitation for Indigenous community participation in the WL Environmental Protection Program. CNL has also shared the annual Environmental Protection Program schedule for monitoring activities so that interested Nations can identify and participate in activities that are of specific interest to them.

In 2022, CNL hosted five environmental monitoring activities that included mushroom collecting, blueberry picking, a bat survey and field monitoring with the MMF, Black River First Nation and Hollow Water First Nation. CNL also participated in 43 virtual meetings, including monthly working group meetings with Sagkeeng First Nation, Manitoba Métis Federation, Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation Wabaseemoong Independent Nations, and Grand Council of Treaty #3.

Over the year, CNL and SFN focused on the development of the community-led CEMP at WL, which was recognized through a traditional signing ceremony for SFN, CNL and AECL in December. The SFN Community Liaison Committee and Liaison Officer had sought out guidance from local SFN Elders and, through the passing of tobacco, the CEMP received a traditional name, Niigan Aki, meaning Land First. It is expected that SFN will begin activities under the CEMP in 2023, which will have the full support of CNL and AECL.

CNL also continued to work closely with the MMF with a focus on developing a *Harvesting Sample Collection Program* led by the Red River Métis. Both parties are working toward finalizing this program in 2023 with the expectation that MMF monitoring will begin soon after.

Environmental monitoring discussions have been ongoing with Black River First Nation and Hollow Water First Nation, as well as with Grand Council Treaty #3, with expectations for more positive progress as we work toward more formal monitoring programs that involve the communities to the degree they wish.

Through engagements, and with direction from Indigenous community representatives, CNL modified the WL environmental monitoring program to include Valued Components identified by the communities such as the harvesting of wild mushrooms, wild berries and wild rice, and the potential to sample sturgeon and traditional medicinal plants in the project area. Adding these elements builds CNL's knowledge and increases the confidence of community members that traditional foods and medicines on and near the Whiteshell site can be safely harvested and consumed. With the aforementioned Niigan Aki (CEMP) and MMF-led programs, the expectation is that this list of Valued Components could grow as the community-based environmental monitors get out onto the lands, both within the project area as well as the surrounding area, with the full support of CNL staff.

Table 63 lists all Indigenous engagement activities related to the WLRP from 2022, with further details available in the Indigenous Engagement Report [53].

Table 63: CNL Indigenous Engagement Activities for 2022

Date	Event	Location
Sagkeeng First Nation		
January 5, 2022	CNL held a teleconference to go over Sagkeeng's comments on WR-1 EIS Section 4.0 (Indigenous Engagement) and to confirm the list of interests and concerns was complete.	Virtual
January 31, 2022	CNL sent Sagkeeng a revised copy of Section 4.0 (Indigenous Engagement) and Section 6.7 (Human Ecological Health).	Virtual
February 03, 2022	Sagkeeng provided CNL with drafts of Sagkeeng's Community Environmental Monitoring Program and Healing and Resiliency Action Plan.	N/A
February 22, 2022	Technical Working Group Meeting with AECL and Sagkeeng.	Virtual
March 02, 2022	SFN provided an overview of the Healing and Resiliency Action Plan.	Virtual
March 09, 2022	CNL, AECL, and Sagkeeng held further discussions on Sagkeeng's scope of work for the Community Environmental Monitoring Program.	Virtual
March 22, 2022	Two CNL representatives met with Sagkeeng's community liaison committee to get to know each other and learn more about the WR-1 Project.	Virtual
April 06, 2022	Technical Working Group Meeting with Sagkeeng First Nation to discuss the scope of work for SFN's Community Environmental Monitoring Program and repackaging of SFN's interests and concerns table.	Virtual
May 10, 2022	CNL, AECL, and Sagkeeng walked through Sagkeeng interests and concerns table and discussed the upcoming in-person workshop on Sagkeeng's Community Environmental Monitoring Program.	Virtual
May 20, 2022	CNL and Sagkeeng discussed the logistics of the Guardianship Workshop.	Virtual

Date	Event	Location
June 15, 2022	CNL representatives met with Sagkeeng and AECL representatives for a workshop to negotiate on Sagkeeng's Community Environmental Monitoring Program that would help to reduce fear and stigma associated with the WL site and its surroundings.	In-person, Winnipeg
June 16, 2022	Day 2 of a tri-lateral workshop involving AECL, CNL and Sagkeeng representatives to agree on the terms of Sagkeeng's Community Environmental Monitoring Program and confirmed the interest and concerns table accurately Sagkeeng's state interests and concerns.	In-person, Winnipeg
July 19, 2022	Sagkeeng Community Liaison Committee WR-1 Tour involving nine community members.	In-person, WL Site
July 13, 2022	Informed the community that CNL has officially submitted the revised EIS to the CNSC.	Email/Letter
August 25, 2022	Sagkeeng Technical Working Committee Budget Meeting.	Virtual
September 07, 2022	CNL-AECL-Sagkeeng First Nation consultation meeting.	Virtual
September 20, 2022	Sagkeeng confirmed they accepted CNL's final edits to the contribution agreement to support SFN's Community Environmental Monitoring Program	Email
October 20, 2022	CNL sent a letter and email informing SFN where to access relevant portions of the updated sections of the WR-1 EIS for review and validation.	Email/Letter
November 02, 2022	CNL-AECL-SFN Technical Working Group meeting.	Virtual
November 16, 2022	Letter sent regarding the beginning of the Land Use End State community engagement and polling kick-off.	Letter/Email
November 18, 2022	Email from SFN indicating that they have reviewed Section 4 and the Engagement Log of the EIS and encourage submission of the document to the CNSC	Email
December 05, 2022	Meeting with SFN to discuss and plan for upcoming Community Environmental Monitoring Program signing ceremony.	Virtual
December 07, 2022	CNL-AECL-SFN Technical Working Group meeting.	Virtual
December 12, 2022	CNL-AECL-SFN Historical signing ceremony at the Sagkeeng Healing Lodge for the community based Environmental Monitoring Program given the traditional name Niigan Aki.	In-person – Sagkeeng FN
December 16, 2022	CNL sent an email indicating that the WR-1 EIS was resubmitted to the CNSC for review.	Email
Manitoba Métis Federation		
January 06, 2022	Meeting with the MMF to discuss their review of the EIS.	Virtual
January 06, 2022	The MMF send feedback on the draft relationship agreement.	Virtual

Date	Event	Location
February 18, 2022	CNL provided MMF with a revised draft for the relationship agreement.	N/A
February 27, 2022	Provided a donation to support the Manitoba Métis Federation's Annual General Assembly and registered for a booth.	N/A
March 02, 2022	CNL and MMF's communication director met to discuss co-developing an infographic in preparation for MMF's Annual General Assembly.	Virtual
March 24-27, 2022	CNL participated in the MMF's Annual General Assembly. CNL had a booth at the event and engaged with Red River Métis citizens on the WL Restoration Project.	In-person- Winnipeg
March 29, 2022	CNL walked MMF and their consultants through the repackaged interest and concerns table, and discussed their review and timeline. CNL and the MMF also discussed Red River Métis rights, claims, and interests.	Virtual
April 25, 2022	Teleconference with MMF to walk through Interest and Concerns table.	Virtual
May 18, 2022	CNL walked through Interests and Concerns table based on the MMF's suggestions.	Virtual
May 25, 2022	Discussion with the MMF on their Relationship Agreement Clause.	Virtual
May 26, 2022	Environmental Monitoring discussion.	Virtual
July 6, 2022	Manitoba Métis Federation Monthly Meeting.	Virtual
July 28, 2022	MMF representative attended Groundwater Monitoring Collection and looked at nesting locations.	In-person, WL site
August 10, 2022	CNL participated in MMF Community Consult Meeting in Lac du Bonnet. CNL shared information on their environmental monitoring program.	In-person, Lac du Bonnet
August 17, 2022	Métis Citizens participated in a bat survey at the WL Site	In-person, WL site
September 07, 2022	MMF/CNL working group meeting.	Virtual
October 14-16, 2022	Attended and set-up CNL booth at the MMF Annual General Assembly	In-person – Winnipeg
October 20, 2022	CNL sent a letter and email informing MMF where to access relevant portions of the updated sections of the WR-1 EIS for review and validation.	Email/Letter

Date	Event	Location
November 16, 2022	Letter sent regarding the beginning of the Land Use End State community engagement and polling kick-off	Letter/Email
November 16, 2022	Meeting held with MMF Environmental staff re: future monitoring at WLRP.	Virtual
November 22, 2022	MMF-CNL Monthly working group meeting.	Virtual
December 01, 2022	Environmental field monitoring with MMF.	In-person, WL site
December 07, 2022	Meeting with MMF - focused on EIS submission and future MMF led Harvesters Sampling/Monitoring Plan.	Virtual
December 16, 2022	CNL sent an email indicating that the WR-1 EIS was resubmitted to the CNSC for review.	Email
Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation		
February 08, 2022	WR-1 Project Update with Black River First Nation (BRFN) and Hollow Water First Nation (HWFN) and discussion of next steps for engagement.	Virtual
February 16, 2022	Co-developing infographics with BRFN and HWFN.	Virtual
March 15, 2022	CNL informed BRFN and HWFN that CNL would be repackaging their interests and concerns table as a result of CNSC feedback on a similar project.	Email
April 13, 2022	BRFN and HWFN Monthly Teleconference.	Virtual
May 10, 2022	CNL Met with BRFN and HWFN to discuss the status of the WR 1 submission	Virtual
May 11, 2022	Monthly Update with BRFN and HWFN that included a walk-through of the revised interests and concerns table.	Virtual
May 25, 2022	Discussion with BRFN and HWFN on the upcoming tour.	Virtual
June 9, 2022	Site tour with BRFN/HWFN Core Engagement Team.	In-person, WL Site
June 13, 2022	CNL requested confirmation from the communities that the interests and concerns table reflected their feedback.	Email
July 13 2022	Discussion about CNL's participation in BRFN and HWFN Treaty Days.	Virtual
July 13, 2022	Monthly meeting with BRFN/HWFN.	Virtual
July 13, 2022	Informed the community that CNL has officially submitted the revised EIS to the CNSC.	Email/Letter
July 28, 2022	BRFN/HWFN Berry Picking at Underground Research Lab Site.	In-person, WL Site
August 17, 2022	BRFN/HWFN Monthly Meeting.	Virtual

Date	Event	Location
September 08, 2022	BRFN and HWFN participated in mushroom collection from three locations around the WL Site.	In-person, WL site
September 14, 2022	CNL-BRFN-HWFN Monthly working group meeting. CNL, BRFN, and HWFN discussed extending the existing relationship agreement and coordinating future environmental monitoring activities.	Virtual
September 20, 2022	CNL sent an invitation to BRFN, HWFN and Brokenhead Ojibway Nation to participate in a webinar on the WR-1 Decommissioning Project.	Email
September 29, 2022	Nine members and knowledge holders from BRFN and HWFN participated in a medicinal plant walk at the Whiteshell Laboratories site.	In-person, WL site
October 20, 2022	CNL sent a letter and email informing BRFN and HWFN where to access relevant portions of the updated sections of the WR-1 EIS for review and validation.	Email/Letter
October 27, 2022	CNL-BRFN-HWFN Monthly working group meeting.	Virtual
November 16, 2022	Letter sent regarding the beginning of the Land Use End State community engagement and polling kick-off.	Letter/Email
November 17, 2022	CNL-BRFN-HWFN Monthly working group meeting.	Virtual
December 13, 2022	CNL provided a copy of the commitments list to BRFN and HWFN for discussion and review at the monthly meeting.	Email/Attachment
December 14, 2022	CNL-BRFN-HWFN Monthly working group meeting.	Virtual
December 16, 2022	CNL sent an e-mail indicating that it had resubmitted the WR-1 EIS to the CNSC for review.	Email
Wabaseemoong Independent Nations (WIN)		
May 06, 2022	Walk through of changes CNL made to Interests and concerns table based WIN's feedback.	Virtual
July 13, 2022	Informed the community that CNL has officially submitted the revised EIS to the CNSC.	Email/Letter
October 20, 2022	CNL sent a letter and email informing WIN where to access relevant portions of the updated sections of the WR-1 EIS for review and validation.	Email/Letter
November 12, 2022	Discussion with WIN Liaison to discuss Whiteshell activities and if WIN were still interested in engagement with WL. Liaison indicated that they will work with GCT3 going forward.	Phone call

Date	Event	Location
November 16, 2022	Letter sent regarding the beginning of the Land Use End State community engagement and polling kick-off.	Email/Letter
December 16, 2022	CNL sent an email indicating that it had resubmitted the WR-1 EIS to the CNSC for review.	Email
Grand Council Treaty 3 (GCT3)		
June 29, 2022	CNL informed GCT3 that the draft EIS had been submitted.	Telephone call
July 13, 2022	Informed the community that CNL has officially submitted the revised EIS to the CNSC.	Email/Letter
September 23, 2022	Working group meeting held with GCT3 with a focus on waste transportation.	Virtual
October 21, 2022	CNL provided an update to GCT3 on the status of the WR-1 EIS.	Email/Letter
November 10, 2022	CNL-GCT3 Working group meeting.	Virtual
November 16, 2022	Letter sent regarding the beginning of the Land Use End State community engagement and polling kick-off.	Letter/Email
December 15, 2022	CNL-GCT3 monthly working group meeting.	Virtual
December 16, 2022	CNL sent an email indicating that it had resubmitted the WR-1 EIS to the CNSC for review.	Email
December 19, 2022	CNL provided detailed responses to GCT3 to questions submitted following the December monthly meeting.	Email

15.2.4 CNL’s Long-Term Relationship with Indigenous Peoples

CNL recognizes First Nations and the Red River Métis as stewards of the land and is working towards developing meaningful long-term relationships with each Nation that occupies and has traditional territories and/or modern-day interests near its site operations. CNL recognizes each Nation has its own unique set of interests and concerns associated with both the WR-1 decommissioning project and the WLRP.

As such, CNL is committed to taking a holistic, relationship-based and distinctions-based approach to engagement to ensure each Nation’s interests and concerns are addressed appropriately. CNL also works closely with AECL, the federal Crown Corporation responsible for oversight of the WLRP, to address interests and concerns regarding all aspects of the project.

This shift in CNL’s approach from project-based to relationship and distinction-based engagement supports more meaningful actions to build foundations for trust, understanding, and mutually beneficial relationships, including addressing broader issues and concerns such as the historical selection of the WL site.

CNL is currently working with each Nation to formalize these relationships through relationship-building and corresponding agreements. These agreements are intended to help enable greater integration of Traditional Knowledge, ceremony, and cultural and stewardship practices in the decommissioning, monitoring, and closure of the project. These agreements will also enable dialogue and participation through the development of monitoring programs, culturally appropriate communications, and trauma-informed engagement. In addition, the agreements help to enhance community engagement, build trust and strengthen relationship-building, and provide mechanisms that facilitate Indigenous participation and input into CNL's environmental monitoring program, economic development and procurement opportunities, future land use, and other areas of collaboration.

CNL is currently negotiating separate relationship agreements with Black River First Nation, Hollow Water First Nation, Sagkeeng First Nation and the Red River Métis, and is committed to ongoing meaningful engagement that leads to finalizing these agreements.

16 Acronyms

α	Alpha
ACMR	Annual Compliance Monitoring Report (formerly Annual Safety Review (ASR) or Annual Compliance Report (ACR))
AECL	Atomic Energy of Canada Limited
ALARA	As Low as Reasonably Achievable
ALWTC	Active Liquid Waste Treatment Centre
ATG	Analytical Test Group
β/γ	Beta-Gamma
BOD	Biochemical Oxygen Demand
Bq	Becquerels
BRFN	Black River First Nation
CANDU	Canada Deuterium Uranium
CBOD	Carbonaceous Biochemical Oxygen Demand
CCSF	Concrete Canister Storage Facility
CEMP	Community Environmental Monitoring Program
CRL	Chalk River Laboratories
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COVID-19	Novel Coronavirus Disease 2019
Cs	Cesium
CSA	Canadian Standards Association
CSD	Criticality Safety Document
DCP	Dose Control Point
DDP	Detailed Decommissioning Plans
EIS	Environmental Impact Statement
EOC	Emergency Operations Centre
ERM	Environmental Remediation Management
GCT3	Grand Council Treaty 3
GHG	Greenhouse Gas

HCF	Hot Cell Facility
HWFN	Hollow Water First Nation
IAEA	International Atomic Energy Agency
ICP	Inductively Coupled Plasma Spectrometry
IFTF	Immobilized Fuel Test Facility
ILW	Intermediate-Level Waste
ImpAct	Improvement Action
ISO	International Standards Organization
LLD	Lower Limit of Detection
LLLW	Low-Level Liquid Waste
LLLWTS	Low-Level Liquid Waste Treatment System
LLW	Low-Level Waste
LMDL	Laboratory Method Detection Limit
MMF	Manitoba Métis Federation
MPNU	Most Probable Number Unit
MRAD	Multi-Media Radiochemistry
NEW	Nuclear Energy Worker
NNC	Notice of Non-Compliance
NPRI	National Pollutant Release Inventory
OSH	Occupational Safety and Health
PAD	Personal Alarming Dosimeter
PCB	Polychlorinated Biphenyl
PIP	Periodic Inspection Plan
PM	Particulate Matter
REGDOC	Regulatory Document
RMDL	Regulation Method Detection Limit
RP	Radiation Protection
SAR	Safety Analysis Report
SCA	Safety and Control Area
SF	Shielded Facilities

SFN	Sagkeeng First Nation
SMAGS	Shielded Modular Above Ground Storage
TLD	Thermoluminescent Dosimeters
TSS	Total Suspended Solids
UFTP	Used Fuel Transportation Package
WBC	Whole Body Counter
WIN	Wabaseemoong Independent Nations
WL	Whiteshell Laboratories
WMA	Waste Management Area

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Appendix A Concrete Canister Storage Facility

A.1 Operations

The Concrete Canister Storage Facility is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [54]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2022, routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2022, with the exception of air sampling from Canister C-8 – see Section A.2.1 for more information.

In 2022, training two of three Operations Technologist trainees continued with one trainee assigned to Site operations for the year. A new Facility Authority was appointed for the WMA and CCSF. Total Site and Nuclear Operations personnel for the CCSF and WMA included a Facility Authority, a Facility Manager, a Facility Supervisor/Operator, two Operator trainees and two WMA Utility workers.

In 2022, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [54]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the CCSF in 2022. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities operating procedures. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023. A revised Facility Authorization document was sent to CNSC along with the Nuclear Safety Note for fuel retrieval (see Section 4.1.1), and will be further revised in 2023 to address CNSC comments.

A.2 Compliance Monitoring

A.2.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in September. Despite multiple attempts flow could not be established in the Canister 8 air lines, these air lines have had issues in previous years obtaining flow. The normal approach to establishing air flow through lines was unsuccessful. During each air sampling period in 2022 attempts were made to recover a sample.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters that were measured.

There was no visible moisture detected from the internal canister space during 2022 monitoring from the canister with air circulation, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.2.2 Monitoring of Ground and Surface Water

Figure 15 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, and compliance results for the CCSF are described below.

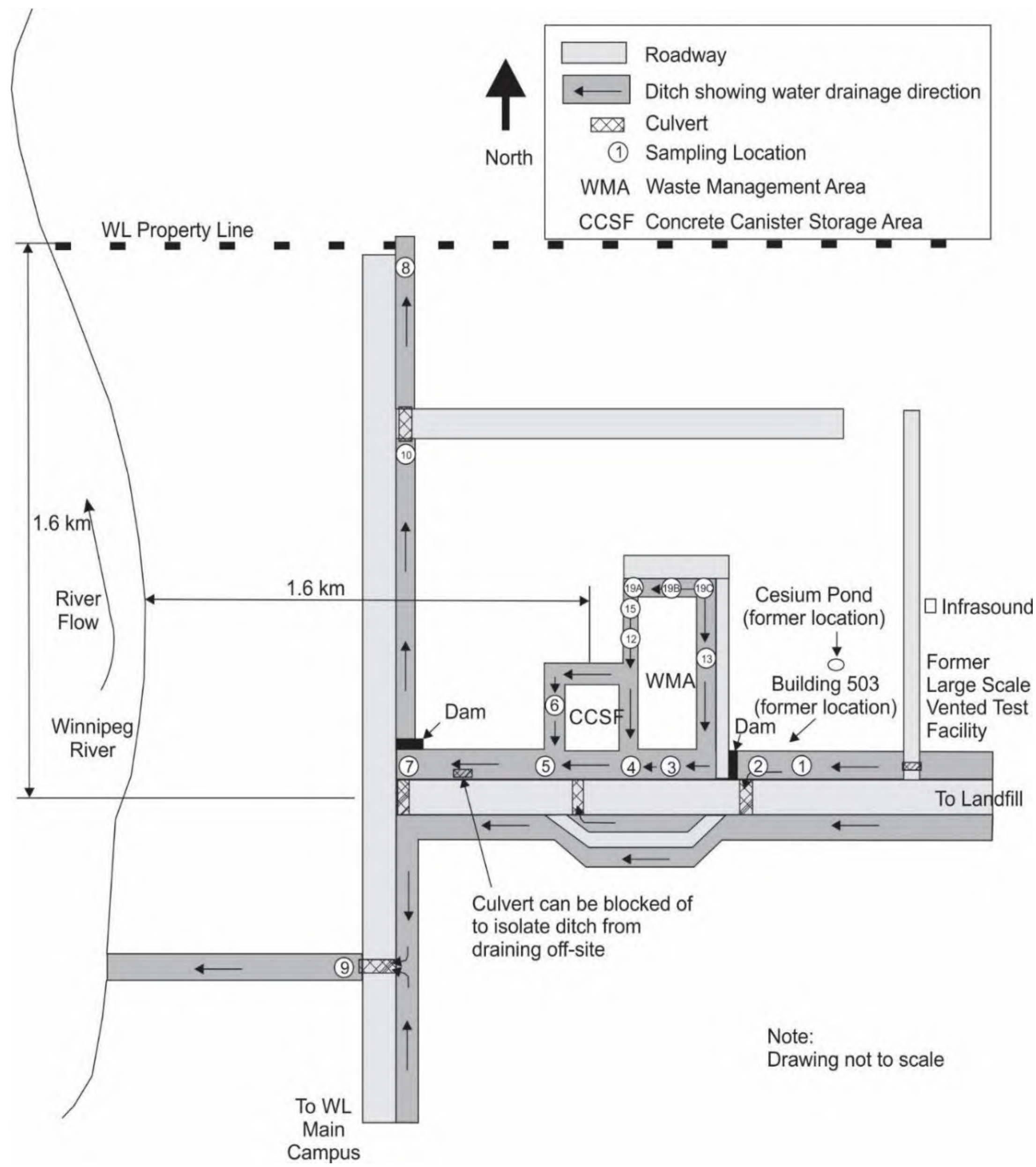

Figure 15: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Appendix D of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

Table 64, Table 65, Table 66 and Table 67 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2022. Operational control-monitoring data from previous years has been included for completeness.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Strontium (Sr)-90. Gamma spectrometry analysis provides individual results for Cobalt (Co)-60, Niobium (Nb)-94, Antimony (Sb)-125, Cs-134, Cs-137 (Barium (Ba)-137m), Promethium (Pm)-147 and Americium (Am)-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [37]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Ditch Location 5 and Ditch Location 6 samples (see Figure 15 for sampling locations) receive surface drainage from the CCSF. The alpha activities at Location 5 and 6 were below the trigger level of 0.5 Bq/L, except for Location 5 on May 03 where a sample measurement indicated 0.62 Bq/L. The uranium analysis for the sample indicated 10.5 ppb. The average for this location is 8.55 ppb for 2022, which is lower than values measured in the last five years Table 66.

The ditch sample collected and points 5 and 6 contained elevated levels of tritium when compared to background measures obtained remote from the WMA (see Table 66), which did not exceed the associated Maximum Acceptable Drinking Water concentration of 7,000 Bq/L [37]. The activity seen is from the WMA as discussed in Appendix D.

Table 64: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2022									
Locations	**11-Apr**	**28-Apr**	**03-May**	**10-12 May**	**01-Jun**	**22-Jun**	**12-Jul**	**19-Jul**	**03-Aug**	**16-18 Aug**
1	IF	IF	0.30	IF	0.30	IF	IF	IF	IF	0.22
2	IF	IF	0.27	IF	0.30	0.44	0.30	0.24	0.22	0.31
3	IF	IF	IF	1.25	2.17	IF	IF	IF	IF	1.13
4	IF	IF	IF	4.88	0.93	IF	IF	IF	IF	0.88
5	3.23	IF	2.74	3.55	2.51	IF	IF	0.39	2.45	1.83
6	IF	IF	IF	0.54	0.70	IF	IF	IF	IF	0.49
7	IF	1.32	1.38	IF	1.89	IF	IF	1.03	IF	0.99
19 A	IF	IF	0.37	0.93	IF	IF	IF	IF	IF	0.24
19 B	IF	IF	0.28	1.15	IF	IF	IF	IF	IF	0.35
19 C	IF	IF	0.26	0.52	IF	IF	IF	IF	IF	0.16
Background	0.37	IF	IF	0.25	IF	0.39	0.46	0.46	0.23	0.34

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
5	1.02	2.37	0.69	0.61	IF	2.39

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 65: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2022									
Locations	**11-Apr**	**28-Apr**	**03-May**	**10-12 May**	**01-Jun**	**22-Jun**	**12-Jul**	**19-Jul**	**03-Aug**	**16-18 Aug**
1	IF	IF	0.16	IF	0.24	IF	IF	IF	IF	0.18
2	IF	IF	0.28	IF	0.18	0.33	0.21	0.31	0.21	0.20
3	IF	IF	IF	0.31	0.30	IF	IF	IF	IF	0.28
4	IF	IF	IF	0.45	0.22	IF	IF	IF	IF	0.25
5	0.44	IF	0.62	0.35	0.28	IF	IF	0.48	0.20	IF
6	IF	IF	IF	0.35	0.29	IF	IF	IF	IF	IF
7	IF	0.80	0.33	IF	0.36	IF	IF	0.41	IF	IF
19 A	IF	IF	0.56	0.88	IF	IF	IF	IF	IF	0.19
19 B	IF	IF	0.40	0.70	IF	IF	IF	IF	IF	0.18
19 C	IF	IF	0.24	0.64	IF	IF	IF	IF	IF	0.22
Background	0.26	IF	IF	0.10	IF	0.31	0.31	0.35	0.49	0.20

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
5	0.24	0.29	0.27	0.36	IF	0.37

a The reference nuclide for total alpha is total Uranium.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 66: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	19-Jul	03-Aug	16-18 Aug
1	IF	IF	13.7	IF	5.8	IF	IF	IF	IF	3.8
2	IF	IF	4.3	IF	5.4	4.4	3.8	4.2	4.3	3.7
3	IF	IF	IF	295.8	219.9	IF	IF	IF	IF	347.7
4	IF	IF	IF	165.0	194.7	IF	IF	IF	IF	321.9
5	59.3	IF	152.5	153.9	164.2	IF	IF	196.0	218.9	IF
6	IF	IF	IF	252.4	226.5	IF	IF	IF	IF	IF
7	IF	6.59	69.1	IF	107.5	IF	IF	34.0	IF	IF
19 A	IF	IF	393.8	1066.5	IF	IF	IF	IF	IF	149.1
19 B	IF	IF	547.9	796.6	IF	IF	IF	IF	IF	256.4
19 C	IF	IF	568.3	404.0	IF	IF	IF	IF	IF	208.0
Background	4.0	4.4	4.1	4.3	4.66	IF	4.3	3.8	4.8	4.2

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	2017	2018	2019	2020	2021	2022
5	699	111	117	67	IF	157

a Arithmetic average of samples collected.

IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 67: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	18-19 Jul	03-Aug	16-18 Aug
1	IF	IF	0.24	IF	0.33	IF	IF	IF	IF	0.51
2	IF	IF	0.29	IF	0.39	1.66	1.06	0.89	2.82	2.95
3	IF	IF	IF	13.50	8.55	IF	IF	IF	IF	3.44
4	IF	IF	IF	16.50	12.10	IF	IF	IF	IF	3.49
5	6.90	IF	10.50	13.90	10.70	IF	IF	7.89	4.75	IF
6	IF	IF	IF	15.80	11.10	IF	IF	IF	IF	IF
7	IF	3.13	11.20	IF	8.96	IF	IF	3.87	IF	IF
19 A	IF	IF	18.20	42.60	IF	IF	IF	IF	IF	3.15
19 B	IF	IF	11.20	42.70	IF	IF	IF	IF	IF	4.194
19 C	IF	IF	8.42	29.00	IF	IF	IF	IF	IF	2.27
Background	1.8	IF	0.70	1.31	0.69	0.86	0.80	1.86	0.69	0.49

Historical Uranium Data[a] (Uranium ppb)						
Sample Point	2017	2018	2019	2020	2021	2022
5	NR	24.70[b]	13.8	11.3	IF	8.55

a Arithmetic average of samples collected.
b Single Value
IF Insufficient flow, water was stagnant in the ditch or ditch was dry
NR Analysis not required

A.3 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [16]. There were no Category 1 and 2 changes in 2022.

A.4 Equipment Performance, Planned Maintenance Testing and Inspections

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2022. None of the canisters had a deviation greater than 1°. In 2022, Canister C5 had a deviation of 0.8° to the east and 0.9° to the south. This deviation and those observed on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2022.

As required by Section 8 of the Facility Authorization [54], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2022. Minor fence repairs and infilling was done along the base of the fence to meet security requirements as required.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes and it has been noted that edges of many pour pockets are more brittle as has been noted since 2020. No patching or coating of canisters was done in 2022. No increased radiation field was noted from the canisters.

A.4.1 Canister Site Monitoring and Surveillance

GAMMA FIELD SURVEYS

Gamma exposure rates from the canisters were measured quarterly in 2022. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No gamma field anomalies were found during 2022.

Table 68 shows the averaged gamma near contact exposure rates measured during 2022, and for the previous four years.

Table 68: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.08	0.05	0.05	0.07	2022	C13	0.16	0.15	0.15	0.18	2022
	0.08	0.08	0.07	0.08	2021		0.16	0.18	0.12	0.14	2021
	0.07	0.08	0.06	0.09	2020		0.16	0.25	0.15	0.14	2020
	0.11	0.08	0.10	0.12	2019		0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
C6	0.05	0.08	0.07	0.06	2022	C14	0.08	0.13	0.12	0.10	2022
	0.08	0.08	0.08	0.08	2021		0.11	0.09	0.09	0.07	2021
	0.08	0.09	0.07	0.09	2020		0.11	0.17	0.15	0.13	2020
	0.09	0.11	0.10	0.08	2019		0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
C7	0.14	0.13	0.11	0.15	2022	C15	0.24	0.33	0.27	0.31	2022
	0.11	0.14	0.09	0.14	2021		0.20	0.32	0.23	0.21	2021
	0.15	0.12	0.13	0.14	2020		0.29	0.37	0.27	0.29	2020
	0.18	0.16	0.14	0.16	2019		0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
C8	0.07	0.09	0.08	0.12	2022	C16	0.19	0.17	0.13	0.13	2022
	0.11	0.12	0.10	0.10	2021		0.17	0.21	0.15	0.15	2021
	0.11	0.12	0.10	0.09	2020		0.16	0.21	0.15	0.17	2020
	0.11	0.13	0.11	0.11	2019		0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
C9	0.18	0.16	0.12	0.17	2022	C17	0.10	0.10	0.19	0.18	2022
	0.23	0.18	0.16	0.18	2021		0.12	0.12	0.20	0.20	2021
	0.23	0.21	0.14	0.22	2020		0.15	0.13	0.23	0.22	2020
	0.26	0.23	0.17	0.21	2019		0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
C10	0.15	0.22	0.15	0.11	2022	C18	0.65	0.64	1.39	0.49	2022
	0.16	0.20	0.17	0.13	2021		0.52	0.70	0.94	0.55	2021
	0.23	0.20	0.19	0.42	2020		0.67	0.49	1.05	0.55	2020
	0.24	0.28	0.22	0.21	2019		0.69	0.76	1.25	0.62	2019

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018
C11	0.18	0.18	0.20	0.24	2022	C19	0.17	0.13	0.17	0.19	2022
	0.25	0.17	0.21	0.27	2021		0.16	0.18	0.16	0.17	2021
	0.19	0.21	0.23	0.28	2020		0.16	0.17	0.20	0.17	2020
	0.25	0.24	0.29	0.29	2019		0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
C12	0.16	0.17	0.14	0.11	2022	C20	0.16	0.09	0.12	0.14	2022
	0.16	0.15	0.12	0.08	2021		0.11	0.09	0.13	0.13	2021
	0.16	0.19	0.10	0.13	2020		0.14	0.12	0.14	0.16	2020
	0.19	0.21	0.13	0.13	2019		0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h =1 mrem/h

AIR MONITORING

Air monitoring was conducted on each of the canisters in the CCSF in 2022. This involved an air pump that circulates air from an outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero. Only 5 measurements were made (May through September due to colder weather in October). As discussed above in Section A.2.1, flow could not be established in the Canister 8 air lines in 2021 or 2022. Attempts to clear the lines were unsuccessful.

Table 69 shows the averaged beta readings on each filter measured during 2022, and for the previous four years.

Table 69: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	5	<0.02	2022	C13	5	0.02	2022
	7	<0.02	2021		7	0.25	2021
	6	<0.02	2020		6	<0.02	2020

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C6	5	<0.02	2022	C14	5	0.02	2022
	7	0.02	2021		7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C7	5	<0.02	2022	C15	5	<0.02	2022
	7	<0.02	2021		7	0.12	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C8	5	No Flow	2022	C16	5	0.02	2022
	7	No Flow	2021		7	0.16	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C9	5	<0.02	2022	C17	5	<0.02	2022
	7	0.02	2021		7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C10	5	<0.02	2022	C18	5	0.02	2022
	7	<0.02	2021		7	0.03	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
C11	5	<0.02	2022	C19	5	<0.02	2022
	7	0.03	2021		7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
	6	<0.02	2019		6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
C12	5	0.02	2022	C20	5	<0.02	2022
	7	<0.02	2021		7	1.81	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018

A.5 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

See Section 11.1 Waste Management Program for summaries of any volume of radioactive solid and/or liquid waste generated in the CCSF in 2022.

A.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the CCSF as part of routine operations.

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix B Active Liquid Waste Treatment Center

B.1 Operations

The Active Liquid Waste Treatment Center in Building 200 did not operate in 2022, as the building was previously demolished.

Demolition of Building 200 above grade and 1.5m below grade were completed in 2021 October. The demolition footprint is still fenced and protected. The fence will remain until the potentially contaminated ground can be remediated.

Appendix C Shielded Facilities

C.1 Operations

The WL Shielded Facilities (SF) operates under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [55]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shut down and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of high-efficiency particulate air filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

There were no organizational changes in 2022. The minimum staffing requirements outlined in the SF Facility Authorization [55] were maintained at levels to provide the needed operational and safety support.

No program changes were made for the SF in 2022. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities operating procedures. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023.

C.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [16]. There were no Category 1 and 2 changes in 2022.

C.3 Equipment Performance, Planned Maintenance Testing and Inspections

Issues with missed and archived preventive maintenance activities was identified in 2021 and previously reported to the CNSC. A corrective action plan was developed, and continues to be implemented in order to fix the issues and prevent recurrence. Equipment tests and inspections were completed. Monthly housekeeping and fire prevention inspections were completed.

VENTILATION SYSTEM

Maintenance activities requiring part of the ventilation system to be taken down occurred without incident. The IFTF ventilation system has two active exhaust fans, one being a backup in case of failure. The backup exhaust fan was taken out of service while its corresponding air flow damper is being replaced.

The required annual routine Poly-Alpha-Olefin testing of the HCF high-efficiency particulate air filters were successfully conducted.

C.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of the volume of radioactive solid and liquid wastes generated in the SF in 2022.

LOW-LEVEL SOLID WASTE

In 2022, the SF generated 7.5 m^3 of compactable low-level radioactive solid waste and 0.1 m^3 of non-compactable waste.

Table 70 lists the annual low-level solid waste generated in the SF for 2022 and the previous four years.

Table 70: Solid Wastes Generated

Total Volume	2018	2019	2020	2021	2022
Low-Level Solid Waste (m^3)	73.3	64.3	10.9	45.6	7.5
Medium-Level Solid Waste (m^3)	0	0	0	0	0

MEDIUM-LEVEL SOLID WASTE

In 2022 the SF generated 0.02 m^3 of medium-level (intermediate-level) radioactive solid waste. Table 70 lists the annual medium-level solid waste generated for 2022 and the previous four years.

LOW-LEVEL LIQUID WASTE SYSTEM

In 2022, 117.3 m^3 of low-level liquid waste was processed through the Building 300 low-level liquid waste system (see Appendix E).

MEDIUM-LEVEL LIQUID WASTE SYSTEM

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2022, there were no transfers of medium level liquid waste.

Table 87 lists the annual liquid waste generated for 2022 and for the previous four years.

C.5 Effluents Released

Liquid radioactive and hazardous effluents were discharged from the SF as part of routine operations are provided and discussed in Section 9, Environmental Protection.

Appendix D Waste Management Area

D.1 Operations

The Waste Management Area operated under the WL Site Licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [56]. During 2022, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2022, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, Facility Supervisor, WMA Operators and two WMA-based utility workers, with support from other Site and Nuclear Operations, Radiation Protection, and Environmental Monitoring personnel as required.

In 2022, training of two of three Operations Technologist trainees continued with one trainee temporarily assigned to Site Operations starting in 2022 May. A new Facility Authority was appointed for the WMA and CCSF.

In 2022, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [56]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the WMA in 2022. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities operating procedures. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023.

D.1.1 Inventory Additions And Deletions

Changes in inventory are reported in Table 71 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.2 Low-Level Solid Waste

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. The stored volume of waste is listed in Table 71.

D.1.3 Industrial Waste

There were no additions of industrial chemical waste during 2022.

Table 71: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2021 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433.	18,798.84	1,967.38	330.58
Additions for 2022	Buildings 431 to 433	0	0	0
Removals for 2022	LLW Bunker 6	0	0	0
	LLW Bunker 5	360	1.14	0
	Buildings 431 to 433	65.8*	2.54	0
Total Accumulation as of 2022 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433	18,373.04	1,963.70	330.58

* Reflux Boiler

D.2 Compliance Monitoring

D.2.1 Monitoring And Surface Water

SURFACE WATER

Figure 15 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present but only once in a given week during flow events. This avoids putting particular emphasis on a given week for sample results. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

In 2022, there were ten sampling periods where the ditch flow met the required flow conditions in at least some sample locations. In spring the runoff was larger than in 2021 due to a series of snowfall events in late winter and a series of rain storms in spring to summer. This is in notable contrast to 2021 when light snow and limited precipitation was received. A recorded amount of precipitation of 687 mm occurred in 2022, in contrast to 395 mm in 2021, which was a ten year low for recorded precipitation.

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, as was the case last several years, all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [37]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity at ditch sample Locations 1 to 7 (Table 72) all remained below 10 Bq/L. Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. While some locations showed beta activity levels in the ditch water remaining below the drinking water screening level of 1 Bq/L, all were below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137 [57]. Compliance with Guidelines for Canadian Drinking Water [37] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. There were exceedances of the Canadian Drinking Water [37] standard of 1.0 Bq/L gross beta (Table 72) in 2022 at sample points 3, 4, 5, and 7.

The alpha activity levels in the surface water are presented in Table 73, and were below 0.5 Bq/L except for Location 7 on 2022 April 28 (0.8 Bq/L). Uranium results are presented in Table 74.

Locations 19 A, B and C had been established to monitor for the uranium values believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation as well as Cs-137 from the soil recovered from the former Cesium Pond that was stored in the area. Lac du Bonnet Batholith granitic rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018. The Lac du Bonnet Batholith granite is noted to have elevated naturally occurring uranium. Sample results were obtained in 2022, and indicated uranium values greater than background values and higher than other sample points surrounding the WMA (Table 74).

As shown in Table 75, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [37]. Locations 19 A, B and C were, while originally chosen for sampling for the potential migration of Cs-137 due to the presence of the Cesium Pond soil pile, also show elevated tritium levels, with the highest values at location 19A with a sample result of 1067 Bq/L. It is believed the source relates to waste stored in Trench 19 near the northwest corner of the WMA.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [58], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is elevated at some locations immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 5.6 Bq/L in 2022).

The data includes continuing documentation of a spill incident that occurred in 1979 near ILW Bunker 3, from the reference sample point (Location 3) in the southeast section of the WMA, as shown in Figure 15 and Figure 16. In 2017, sampling Location 3 was reconfigured to allow preparations for future bunker and standpipe remediation. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater are below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of $1.27x10^7$ Bq/L [59]. Gross alpha and gross beta at Location 3 remained low. Table 72 through Table 75 include the historical monitoring at Ditch Locations 19 A, B and C, water flow permitting.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. Table 76 reflects this circumstance and shows that no migration of Cs-137 to these ditches had occurred.

As Trench 16 has a known quantity of Technetium-99 (Tc-99), Tc-99 measurements were performed as part of ditch water monitoring in 2022. The values in (Table 77) are at or below limit of detection. The Tc-99 limit for drinking water is 200 Bq/L [57]. Due to the low values Tc-99 is not measured at the control point.

Table 72: Gross Beta Activity of Surface Water Samples from Ditches Around the Concrete Canister Storage Facility and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	19-Jul	03-Aug	16-18 Aug
1	IF	IF	0.30	IF	0.30	IF	IF	IF	IF	0.22
2	IF	IF	0.27	IF	0.30	0.44	0.30	0.24	0.22	0.31
3	IF	IF	IF	1.25	2.17	IF	IF	IF	IF	1.13
4	IF	IF	IF	4.88	0.93	IF	IF	IF	IF	0.88
5	3.23	IF	2.74	3.55	2.51	IF	IF	0.39	2.45	1.83
6	IF	IF	IF	0.54	0.70	IF	IF	IF	IF	0.49
7	IF	1.32	1.38	IF	1.89	IF	IF	1.03	IF	0.99
19 A	IF	IF	0.37	0.93	IF	IF	IF	IF	IF	0.24
19 B	IF	IF	0.28	1.15	IF	IF	IF	IF	IF	0.35
19 C	IF	IF	0.26	0.52	IF	IF	IF	IF	IF	0.16
Background	0.37	IF	IF	0.25	IF	0.39	0.46	0.46	0.23	0.34

Historical Beta Data (Average[b] Bq/L)						
Sample Point	2017	2018	2019	2020	2021	2022
3	1.62	1.24	IF	1.96	IF	1.52
19 A	0.69	0.36	0.44[c]	IF	IF	0.51
19 B	0.72	0.24	0.43[c]	IF	IF	0.59
19 C	0.58	0.38	IF	IF	IF	0.31

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 73: Gross Alpha Activity of Surface Water Samples from Ditches Around the Concrete Canister Storage Facility and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	19-Jul	03-Aug	16-18 Aug
1	IF	IF	0.16	IF	0.24	IF	IF	IF	IF	0.18
2	IF	IF	0.28	IF	0.18	0.33	0.21	0.31	0.21	0.20
3	IF	IF	IF	0.31	0.30	IF	IF	IF	IF	0.28
4	IF	IF	IF	0.45	0.22	IF	IF	IF	IF	0.25
5	0.44	IF	0.62	0.35	0.28	IF	IF	0.48	0.20	IF
6	IF	IF	IF	0.35	0.29	IF	IF	IF	IF	IF
7	IF	0.80	0.33	IF	0.36	IF	IF	0.41	IF	IF
19 A	IF	IF	0.56	0.88	IF	IF	IF	IF	IF	0.19
19 B	IF	IF	0.40	0.70	IF	IF	IF	IF	IF	0.18
19 C	IF	IF	0.24	0.64	IF	IF	IF	IF	IF	0.22
Background	0.26	IF	IF	0.10	IF	0.31	0.31	0.35	0.49	0.20

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	2017	2018	2019	2020	2021	2022
3	0.28	0.31	IF	0.06	IF	0.30
19 A	0.53	0.92	0.26[c]	IF	IF	0.54
19 B	0.74	0.24	0.51[c]	IF	IF	0.43
19 C	1.05	0.39	IF	IF	IF	0.36

a The reference nuclide for total alpha is total Uranium
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 74: Uranium of Surface Water Samples from Ditches Around the Concrete Canister Storage Facility and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	18-19 Jul	03-Aug	16-18 Aug
1	IF	IF	0.24	IF	0.33	IF	IF	IF	IF	0.51
2	IF	IF	0.29	IF	0.39	1.66	1.06	0.89	2.82	2.95
3	IF	IF	IF	13.50	8.55	IF	IF	IF	IF	3.44
4	IF	IF	IF	16.50	12.10	IF	IF	IF	IF	3.49
5	6.90	IF	10.50	13.90	10.70	IF	IF	7.89	4.75	IF
6	IF	IF	IF	15.80	11.10	IF	IF	IF	IF	IF
7	IF	3.13	11.20	IF	8.96	IF	IF	3.87	IF	IF
19 A	IF	IF	18.20	42.60	IF	IF	IF	IF	IF	3.15
19 B	IF	IF	11.20	42.70	IF	IF	IF	IF	IF	4.19
19 C	IF	IF	8.42	29.00	IF	IF	IF	IF	IF	2.27
Background	1.8	IF	0.70	1.31	0.69	0.86	0.80	1.86	0.69	0.49

Historical Uranium Data (Average[a] ppb)						
Sample Point	2017	2018	2019	2020	2021	2022
3	NR	21	IF	10.06	IF	8.50
19 A	24	52[a]	13[b]	IF	IF	21.32
19 B	39	NR	16[b]	IF	IF	19.36
19 C	67	47[a]	IF	IF	IF	13.23

a Arithmetic average of samples collected
b Based on single sample analyses
ND- Not Detected/Below Detection Limit
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
NR Analysis not required

Table 75: Tritium Activity of Surface Water Samples from Ditches Around the Concrete Canister Storage Facility and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2022									
Locations	11-Apr	28-Apr	03-May	10-12 May	01-Jun	22-Jun	12-Jul	19-Jul	03-Aug	16-18 Aug
1	IF	IF	13.7	IF	5.8	IF	IF	IF	IF	3.8
2	IF	IF	4.3	IF	5.4	4.4	3.8	4.2	4.3	3.7
3	IF	IF	IF	295.8	219.9	IF	IF	IF	IF	347.7
4	IF	IF	IF	165.0	194.7	IF	IF	IF	IF	321.9
5	59.3	IF	152.5	153.9	164.2	IF	IF	196.0	218.9	IF
6	IF	IF	IF	252.4	226.5	IF	IF	IF	IF	IF
7	IF	6.59	69.1	IF	107.5	IF	IF	34.0	IF	IF
19 A	IF	IF	393.8	1066.5	IF	IF	IF	IF	IF	149.1
19 B	IF	IF	547.9	796.6	IF	IF	IF	IF	IF	256.4
19 C	IF	IF	568.3	404.0	IF	IF	IF	IF	IF	208.0
Background	4.0	4.4	4.1	4.3	4.66	IF	4.3	3.8	4.8	4.2

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	2017	2018	2019	2020	2021	2022
3	1,335[b]	178	IF	348	IF	288
19 A	5,535	459	543[b]	IF	IF	536
19 B	8,123	325[b]	777[b]	IF	IF	534
19 C	9,610	405	IF	IF	IF	393

a Arithmetic average of samples collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 76: Cesium-137 Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample	Sampling Data (Total Cs-137 Bq/L) in 2022									
Locations	**11-Apr**	**28-Apr**	**03-May**	**10-12 May**	**01-Jun**	**22-Jun**	**12-Jul**	**19-Jul**	**03-Aug**	**16-18 Aug**
19 A	IF	IF	<1	<1	IF	IF	IF	IF	IF	<1
19 B	IF	IF	<1	<1	IF	IF	IF	IF	IF	<1
19 C	IF	IF	<1	<1	IF	IF	IF	IF	IF	<1
Background	<1	NR	NR	<1	NR	<1	<1	<1	<1	<1

Historical Cs-137 Data (Average[a] Bq/L)						
Sample Point	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
19 A	ND	ND	<1[b]	IF	IF	<1
19 B	ND	ND	<1[b]	IF	IF	<1
19 C	ND	ND	IF	IF	IF	<1

a Arithmetic average of sample collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 77: Technetium-99 Results from Surface Water Samples from Ditches Around the Concrete Canister Storage Facility and Waste Management Area

WMA Sample	Sampling Data (Total Technetium-99 Bq/L) in 2022									
Locations	**11-Apr**	**28-Apr**	**03-May**	**10-12 May**	**01-Jun**	**22-Jun**	**12-Jul**	**19-Jul**	**03-Aug**	**16-18 Aug**
1	IF	IF	1.58	1.61	1.33	IF	IF	IF	IF	1.49
2	IF	IF	1.58	1.50	1.38	1.60	1.38	1.41	0.76	1.40
3	IF	IF	1.64	ND	0.78	IF	IF	IF	IF	1.29
4	IF	IF	IF	ND	1.42	IF	IF	IF	IF	1.60
5	1.35	IF	ND	1.26	1.31	IF	IF	1.27	0.76	IF
6	IF	IF	IF	1.12	1.39	IF	IF	IF	IF	IF
7	IF	1.39	1.59	IF	0.81	IF	IF	1.35	IF	IF
19 A	IF	IF	1.58	1.19	IF	IF	IF	IF	IF	1.50
19 B	IF	IF	1.61	1.17	IF	IF	IF	IF	IF	1.61
19 C	IF	IF	1.09	1.14	IF	IF	IF	IF	IF	1.38
Background	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND Not Detected/Below Detection Limit
NM Not measured for at the location

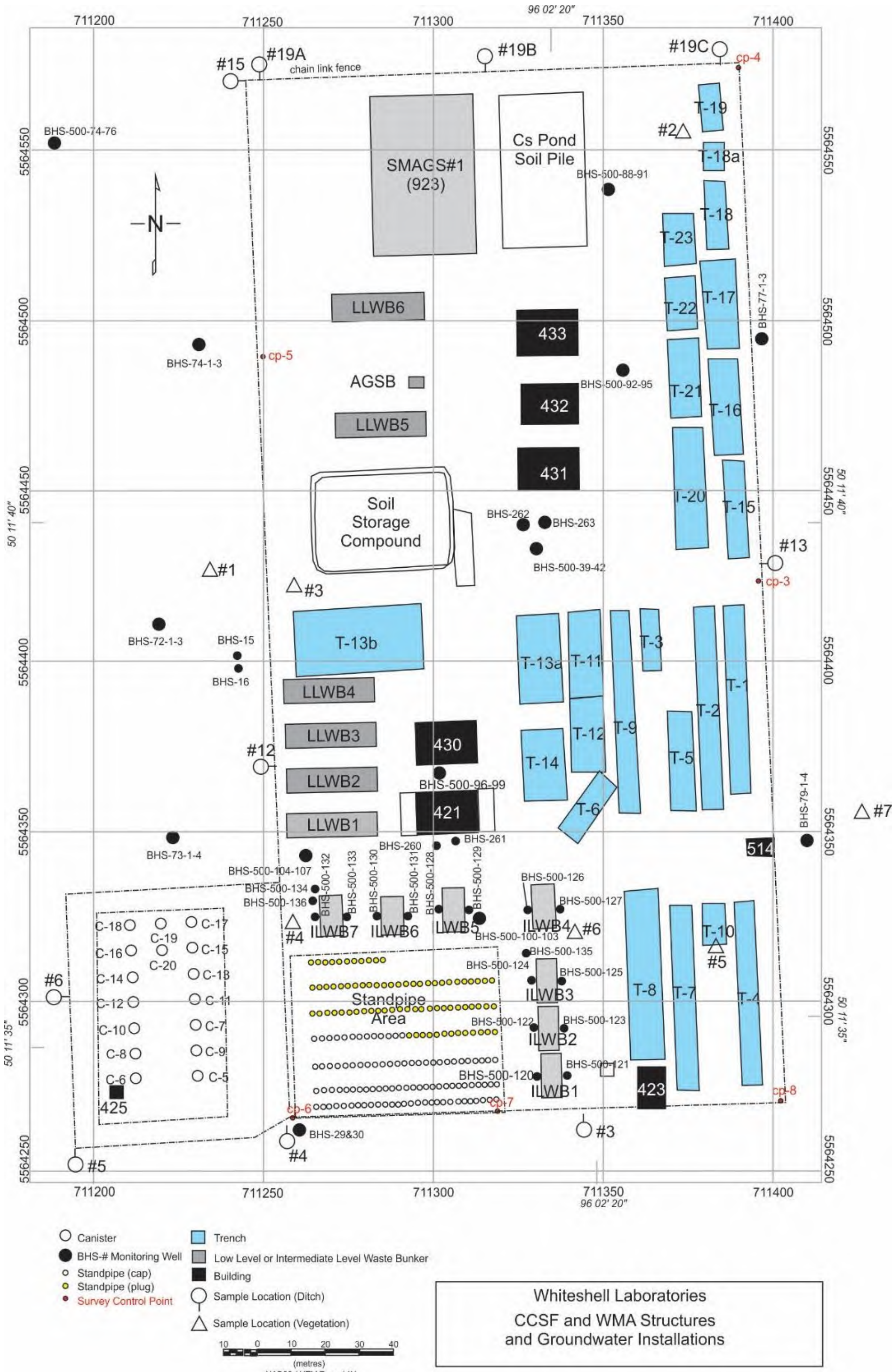

Figure 16: Ground Water Sample Points

INTERMEDIATE - LEVEL WASTE BUNKERS NEAR FIELD WELLS

A series of shallow near field wells were installed adjacent to the ILW bunkers in the WMA in 2015 (Figure 15). Groundwater samples were taken from the wells and from water in the ILW Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile but will bond with sand, and tritium is the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2022, Sr-90 was noted to be a maximum of 26 Bq/L adjacent to ILW Bunker 1, and 39 Bq/L adjacent to ILW Bunker 3. For all other locations, the Sr-90 and Cs-137 levels were minor or negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 78) from the ILW Bunkers, and Sr-90 (Table 79) and tritium levels (Table 80) that are orders of magnitude below the levels observed in the water in the adjacent ILW Bunkers. At ILW Bunker 3, the tritium results remain high (a maximum of 150411 Bq/L) and moderately high at ILW Bunker 5 (a maximum of 7092 Bq/L).

A series of water measurements had been made as a confirmatory check in 2020 for the presence of base neutral chemicals (e.g., benzenes, ethylenes) and PCBs. These measurements indicated these chemicals were not present in the water around the bunkers. The measurement was not repeated in 2022.

Table 78: Cesium-137 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2018	2019	2020	2021	2022
ILW Bunker 1	31,762					
BHS 500-120	-	<1	<1	<1	<1	<1
BHS 500-121	-	<1	<1	<1	<1	<1
ILW Bunker 2	1,170					
BHS 500-122	-	<1	<1	<1	<1	<1
BHS 500-123	-	<1	<1	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	<1	<1	<1	<1	<1
BHS 500-125	-	<1	<1	<1	<1	<1
BHS 500-135	-	<1	<1	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	<1	<1	<1	<1	<1
BHS 500-127	-	<1	<1	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	<1	<1	<1	<1	<1
BHS 500-129	-	<1	<1	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	<1	<1	<1	<1	<1
BHS 500-131	-	<1	<1	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	<1	<1	<1	<1	<1
BHS 500-133	-	<1	<1	<1	<1	<1
BHS 500-136	-	<1	<1	<1	<1	<1

a Bunker values from 2015 samples
ND Not detected

Table 79: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2018	2019	2020	2021	2022
ILW Bunker 1	98,300					
BHS 500-120	-	15.30	22.10	24.9	33.9	25.7
BHS 500-121	-	4.44	2.92	5.19	4.15	6.91
ILW Bunker 2	865					
BHS 500-122	-	0.21	0.14	0.5	0.68	0.38
BHS 500-123	-	2.55	1.59	1.84	1.08	1.57
ILW Bunker 3	26,950					
BHS 500-124	-	11.3	6.58	12.6	19.8	38.9
BHS 500-125	-	<0.10	<0.10	<0.10	0.69	<0.10
BHS 500-135	-	0.74	1.32	0.84	0.75	1.61
ILW Bunker 4	2,485					
BHS 500-126	-	0.24	0.30	0.21	0.7	0.21
BHS 500-127	-	0.28	0.35	0.24	0.56	0.15
ILW Bunker 5	3,850					
BHS 500-128	-	<0.10	<0.10	<0.10	<0.10	<0.10
BHS 500-129	-	<0.10	<0.10	<0.10	<0.10	<0.10
ILW Bunker 6	157,500					
BHS 500-130	-	<0.10	<0.10	<0.10	<0.10	<0.10
BHS 500-131	-	<0.10	<0.10	<0.10	<0.10	<0.10
ILW Bunker 7	3,335					
BHS 500-132	-	<0.10	<0.10	<0.10	<0.10	<0.10
BHS 500-133	-	<0.10	<0.10	<0.10	<0.10	<0.10
BHS 500-136	-	<0.10	<0.10	<0.10	<0.10	<0.10

a Bunker values from 2015 samples
ND Not detected

Table 80: Tritium Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2018	2019	2020	2021	2022
ILW Bunker 1	42,000					
BHS 500-120	-	279	258	410	700	105
BHS 500-121	-	2,788	2,355	1,509	1,230	1,514
ILW Bunker 2	6,100					
BHS 500-122	-	475	4,274	3,587	966	6,697
BHS 500-123	-	2,554	2,834	1,640	2,942	2,833
ILW Bunker 3	4,600,000					
BHS 500-124	-	83,604	128,534	179,094	126,326	150,411
BHS 500-125	-	2,512	39	2,484	2,349	2,457
BHS 500-135	-	3,536	47	2,737	3,372	7,579
ILW Bunker 4	41,000					
BHS 500-126	-	24	39	225	20	36
BHS 500-127	-	< 4	47	37	45	ND
ILW Bunker 5	5,500,000					
BHS 500-128	-	2,674	2,655	2,793	2,748	2,916
BHS 500-129	-	9,100	9,633	9,601	11,051	7,092
ILW Bunker 6	210,000					
BHS 500-130	-	29	5	37	50	19
BHS 500-131	-	19	5	38	4	20
ILW Bunker 7	970,000					
BHS 500-132	-	131	100	NR	94	93
BHS 500-133	-	<4	6	158	20	4
BHS 500-136	-	78	72	58	97	87

a Bunker values from 2015 samples
ND Not detected

WATER TABLE WELLS AND DEEP WELLS

Water samples were collected from wells in and around the WMA (Figure 16) in the spring and fall of 2022. The gross alpha and gross beta results are summarized in Table 81. The beta activity levels in the clay, and basal zone wells remained below the drinking water screening level of 1 Bq/L. The clay till showed a result slightly above 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs-137 (10 Bq/L) [37]. The average alpha activity in the samples collected from the clay-till wells showed a slight increase compared to results from the past five years.

Uranium concentrations in the basal zone wells ranged from 0 to 0.27 Bq/L. The concentrations in the Clay zone wells ranged from 0.26 to 2.32 Bq/L, and in the clay till from 0 to 4.05 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [60], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (9.02 Bq/L) and clay-till (12.78 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA. The basal layer showed 4.77 Bq/L which is close to the limit of detection.

Table 81: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2020 Avg. (Bq/L)	2021 Avg (Bq/L)	2022 Avg (Bq/L)	2022 Avg. Range (Bq/L)
Total Beta [a]						
Clay	0.29	0.42	0.26	0.43	0.48	0.24 – 1.13
Clay Till	0.25	0.26	0.30	0.45	1.23	0.23 – 16.00
Basal	0.13	0.34	0.11	0.25	0.46	0.25 – 3.12
Total Alpha [b]						
Clay	1.03	0.87	0.52	0.67	0.64	0.28 – 1.38
Clay Till	0.72	0.75	0.80	0.58	3.44	0.21 – 61.9
Basal	0.12	0.22	0.14	0.19	0.32	0.21 – 0.47
Total Uranium [c]						
Clay	0.88	0.86	0.70	0.82	0.76	0.26 – 2.32
Clay Till	0.62	0.60	0.71	0.55	0.77	0.003 – 4.05
Basal	0.04	0.01	0.06	0.03	0.02	0.003 – 0.27
Total Tritium						
Clay	11.36	8.07	7.56	10.37	9.02	3.52 – 47.82
Clay Till	13.51	14.07	21.31	11.33	12.78	3.29 -69.25
Basal	4.63	5.66	3.48	3.59	4.77	3.09 - 21.32

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value calculated from the concentration of uranium in the water sample

HIGH-LEVEL LIQUID WASTE TRAY WATER

Monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. This is sampled in the summer months. The sample results indicated no leakage has occurred from the tanks. The data are

summarized in Table 82. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 82: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2020 Avg (Bq/L)	2021 Avg (Bq/L)	2022 Avg (Bq/L)	2022 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	13.8	12.1	11.2	17.7	7.0	(0.2 – 12.8)
Total Alpha [b]						
Tank Tray Water	0.69	1.5	0.95	0.2	0.2	(0.1 – 0.3)

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13 Bq/L of the gross beta activity is due to K-40.
b The reference nuclide for total alpha is Pu-239

D.2.1.1 RADIATION FIELD MEASUREMENTS

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2022 radiation field measurements were similar to those in 2021. The data is summarized in Table 83.

Table 83: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2018 Avg	2019 Avg	2020 Avg	2021 Avg	2022 Avg	2022 Range
Spring Survey						
South Fence	0.2	0.2	0.3	0.2	0.1	0.1 - 0.2
West Fence	0.4	0.4	0.3	0.3	0.3	0.1 - 0.6
North Fence	0.2	0.2	0.4	0.2	0.2	0.1 – 0.4
East Fence	0.3	0.3	0.2	0.4	0.3	0.1 – 0.5
Fall Survey						
South Fence	0.2	0.2	0.4	0.3	0.1	0.1
West Fence	0.4	0.5	0.3	0.4	0.3	0.0 – 0.5
North Fence	0.2	0.2	0.3	0.3	0.3	0.1 – 0.4
East Fence	0.3	0.4	0.3	0.2	0.3	0.1 – 0.4

D.2.1.2 VEGETATION

In 2022, vegetation samples were collected at monitoring locations within the WMA (Figure 16), and at a control location unaffected by WL operations. The gross beta results are

summarized in Table 84. Potassium (K)-40 represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. The average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90). Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 84: Waste Management Area Vegetation Monitoring Data

WMA Sample Locations	Average Gross Beta[a] (Bq/kg)				
	2018 Avg	2019 Avg	2020 Avg	2021 Avg	2022 Avg
North-East Area[d]	672	450	196	207	205
Mid-West Area	411	155	173	190	183
South-West Area	414	NA	296	243	340
South-East Area	409	441	230	246	325
Control Sample[b]	187	210	162	171	102
Background Sample[c]	324	317	203	157	115
East of ILW Bunkers 3 and 4	672	450	NA	218	224

a The reference nuclide for beta is Sr-90
b Adjacent to the WMA outside of the fence boundary
c Ambient Radiation monitor Stations Background Samples
d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area.

D.3 Facility Changes

All facility changes are performed as per the approved Engineering Change Control procedure [16]. Category 1 and 2 changes are discussed below.

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2022 with most of the physical preparatory work done with continued fabrication of extraction equipment off site. Design documents were being prepared for modifications to the grounds surrounding the ILW bunkers and Standpipes to facilitate waste recovery. No modifications were made in those areas in 2022.

The surface pad to the east of the north access road within the WMA was placed into service as the Recoverable Surface Staging and Storage Area and is used to store Seacan containers containing waste, and also allows for oversized items. The Seacan containers or oversized items are those awaiting processing, characterization and packaging for off-site shipment. This was required to allow Building 923 (SMAGS) to be converted to a Cask Loading Facility.

Building 923 is in the process of being converted to the Cask Loading Facility. The Cask Loading Facility took delivery of the components of a waste transfer station. The station was delivered as components to be assembled on site. Due to the need to provide a level concrete pad and the requirement for warm weather, installation of the pad and subsequent installation of the transfer station was delayed until 2023. Work to commission the 15 ton crane installed in 2021 began in 2022.

The process to convert Low Level Waste Bunker #6 to the Intermediate-Level Liquid Waste Treatment Centre, Building 202, began in 2022. This primarily focussed on roof coating and coating of the walls of the future tank area in the west end of the structure.

D.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2022, the bunkers and other structures in the WMA remained fit for service. Building 923 and Low Level Waste Bunker #6 remain removed from operations pending their conversion to the Cask Loading Facility and Intermediate Level Liquid Waste Treatment Centre respectively. Building 421 continued to operate as a waste examination and re-packaging area, making use of the Temporary Ventilated Enclosure. Modifications are required to the placement of the portable high-efficiency particulate air filter to meet fire program requirements and the Engineering Change Control process is being followed to effect the change. The building remains in a safe modified operational status while this change is being made.

Medium-Level Waste Bunker 4 did not have new waste placed in 2022 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues. Medium-Level Waste Bunker 7 is ~86% full. The percentage full values are estimates only. Road transportable totes of liquid waste remain in the heated Building 430 pending future processing. Building 431 contains historic waste which is in the process of being characterized and packaged. Building 432 and Building 433 also contain various historic wastes and wastes held in various stages of characterization and repacking operations.

A small seepage of an oily substance first noted in 2020 was again noted at the central gasket, near the south wall base of LLW Bunker 1. The substance was sampled in 2020 and found to contain oil and likely degraded liquid organic. The volume was small in 2020 and remained so in both 2021 and 2022. Seepage only occurred during hot weather, and as weather cooled the seepage stopped. The area will continue to be monitored. The bunker is slated for remediation of its waste in the next few years.

The Soil Storage Compound remained empty of stored waste. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018 and 2021. No caulking was done in 2022.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.2.1 under “Intermediate - Level Waste Bunkers Near Field Wells”, and indicates limited migration of tritium beside the ILW bunkers, in particular ILW Bunker 3. There is no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have found limited levels of contaminants, mainly tritium in the north WMA ditch, but still below drinking water guidelines, suggesting the waste storage structures and natural barriers of low permeability clay soil and upwards groundwater flow are performing as expected.

As required by Section 8 of the Facility Authorization [56], most routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, however, two tests, both on transformers were not completed (see Section 6.1.2). These will be completed in 2023. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [19], and is further discussed in Section 6.

D.5 Wastes Generated

Solid radioactive waste was generated in the WMA as part of routine operations. This was mostly bagged waste generated from routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of radioactive solid waste generated in the Waste Management Area in 2022.

Liquid radioactive waste was generated in the WMA as part of routine operations.

In 2022, a total of 858 L of water was pumped from ILW Bunker 6, no water was pumped from ILW Bunker 4 or ILW Bunker 7. The sumps are pumped out by Site and Nuclear Operations personnel using a WMA tanker with pump rig. The water collected in the tanker is later transferred to double walled totes. There totes are retained in Building 430 pending future processing.

The Building 923 sump tank and the Soil Storage Compound were both sampled as required and their water found not to be active in all cases. Water was directed to the WMA ditches from these locations. No other storage facilities and collection sumps at the WMA required pumping.

D.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the WMA as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection. There are no liquid effluents generated from this facility.

Appendix E Auxiliary Operation Facilities

E.1 Operations

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2022. There were no organizational changes.

No program changes were made for the auxiliary facilities in 2022. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities operating procedures. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023.

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contained experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops were located in the South High Bay.

During 2022, WL Site and Nuclear Operation's staff and user groups in Building 300 carried out routine operations which included:

- Non-radiological laundry activities.
- Respirator fit test / maintenance activities.
- Sample management office lab.
- Environmental lab.
- Cleanup activities associated with decommissioning.
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

Health and Safety Facilities (Buildings 402 and 305)

Building 402 had three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

Demolition of Buildings 402 and 305 worked around the Whole Body Counter until the Whole Body Counter structure was moved into its new location, Building 543 in 2022 January. Building 543 is still waiting for services (electrical) to be connected and turned over to Radiation Protection Branch so that the Whole Body Counter instrumentation can be set-up, commissioned and put back into service. Demolition of Building 402 was completed in 2022

March. The B402 footprint is still waiting to be cleaned up and verified clean before the fence will be removed and the site released from decommissioning.

E.2 Facility Changes

All facility changes were performed using the Engineering Change Control procedure [16]. There were no Category 1 and 2 changes in 2022.

E.3 Equipment Performance, Planned Maintenance Testing and Inspections

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed.

E.4 Wastes Generated

There were minimal amounts of radioactive and/or hazardous wastes generated in the facilities as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the facilities in 2022.

Building 300 generated 0.0 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2022.

Building 402 generated 0.0 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2022.

After processing at the Waste Handling Area, all waste would be shipped to the WMA for storage.

See Table 85 for a summary of solid wastes for the last five years.

Table 85: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2018	2019	2020	2021	2022
Building 300 (m^3)	4.5	0.4	0.3	0.0	0.0
Building 402 (m^3)	1	0.7	0.2	0.8	0.0
Building 411 (m^3)	7.6*	0.2*	0.0	0.0	0.0

* Legacy waste processed in 2018 for Building 411 that was decommissioned in 2017.

There was no liquid radioactive and/or hazardous waste generated in 2022 in this facility.

RESEARCH AND DEVELOPMENT (BUILDING 300) LOW-LEVEL LIQUID WASTE SYSTEM

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in Building 300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2022, 117.3 m^3 of low-level liquid was processed through the Building 300 LLLWTS. Table 86 shows the historical volumes of LLLW processed through the Building 300 LLLWTS and also the total volume of Building 300 and Building 100 LLLW processed.

Table 86: Historical Records of Low-Level Liquid Waste Processed

	2018	2019	2020	2021	2022
Total Combined Low-Level Waste Liquid Processed (m^3)	131.5	189.3	107	88.2	119.6
Low-Level Waste Liquid Processed in Building 300 (m^3)	123	186.5	99	78.3	117.3

The total activities given below are the combination of the Shielded Facilities, Building 300, and Building 100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the Building 300 and Building 100 LLLWTS during 2022 was 0.01 GBq, compared with 0.01 GBq released during 2021. The maximum release in a month during the year was 0.001 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.001 GBq for 2022 compared with 0.001 GBq released during 2021. The maximum release in a month during the year was 3.2E-04 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Am-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 87 provides a summary of the total activity released for both the Building 100 and Building 300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [33].

Table 87: Building 100 and Building 300 LLLWTS Radioactive Releases

Radionuclide	Total 2022 Effluent (GBq)	Annual Release Limit[a] (GBq/a)	Total 2022 Effluent as a % of Annual Release Limit	Peak Release	
				Max. Monthly Release (GBq)	% of[b] Monthly DRL
Total (Total-Beta Analysis)[c]	0.01	–	–	0.001	–
Sr-90	1.05×10^{-3}	1.56×10^{2}	0.67×10^{-3}	1.49×10^{-4}	1.14×10^{-3}
Cs-137	4.03×10^{-3}	1.39×10^{2}	2.89×10^{-3}	8.66×10^{-4}	7.47×10^{-3}
Total Alpha (As Pu-239 Equivalent)[d]	1.2×10^{-3}	1.33×10^{1}	9.02×10^{-3}	3.16 x 10-4	2.85×10^{-2}
Historical Data Total Effluent (GBq)					
	2018	2019	2020	2021	2022
Total (Total-Beta Analysis)[c]	0.02	0.01	0.01	0.01	0.01

a The annual release limit is calculated by multiplying the DRL by 12.

b DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [33].

c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.

d DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11 GBq/month [33].

E.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in Building 300 Room B-33.

Any liquid and/or gaseous releases from the facilities are provided and discussed in Section 9, Environmental Protection.

Appendix F WR-1 Facility

F.1 Operations

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [61]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [62]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [61]. *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [61] is in the process of being updated.

Routine operations in the WR-1 facility, as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [61], were carried out by the three (two and one trainee) Site and Nuclear Operations Technologists assigned to Building 100. Throughout the course of 2022, the number of Building 100 staff increased to four (two and two trainees). Staffing was maintained at levels to provide the needed operational and safety support and maintain the minimum staffing requirements outlined in *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [61].

In 2018, approximately 20 m^3 of low concentration (3.4 E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained. Investigation is also ongoing to determine what the impact would be if this water is left in situ as part of the proposed in situ disposal of WR-1.

No program changes were made for WR-1 in 2022. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities operating procedures. WL is behind in the 5 year procedure updates and are scheduled to complete the updates in 2023.

F.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [16]. There were no Category 1 and 2 changes in 2022.

F.3 Equipment Performance, Planned Maintenance Testing and Inspections

During 2022, the operations status of WR-1 remained unchanged. There were no changes to the reactor’s equipment.

Issues with missed and archived preventive maintenance activities was identified in 2021 and previously reported to the CNSC. A corrective action plan was developed, and continues to be implemented in order to fix the issues and prevent recurrence. All monthly housekeeping and fire prevention inspections were completed.

F.4 Wastes Generated

Solid Radioactive and/or Hazardous Wastes

See Section 11.1 Waste Management Program for summaries of the volume of any volume of radioactive solid and/or liquid waste generated in WR-1 in 2022.

Solid radioactive waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

During 2022, 0.5 m^3 of low-level radioactive compactable waste and no non-compactible waste were generated from Building 100/WR-1 operations and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

Liquid Radioactive and/or Hazardous Wastes

During 2022, 2.3 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.5 Effluents Released

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix G Non-Nuclear Facilities

G.1 Operations

The WL non-nuclear facilities status and changes for 2022 are as noted in Table 88.

Table 88: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
304	Waste Clearance Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
306	Waste Clearance Facility	Removed in 2016	None	None	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Shut down	None	None	All Site/Visitors	Operational cleanup in preparation for demolition
408	Stores	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Shut down	None	None	Security and Common Services	Preparing for demolition

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
415	Warm Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Shut down	None	None	Transportation, Security and Stores	Preparing for demolition
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Removed in 2020	None	None	Facilities	Building removed,, End-State Report to be completed
426	Quonset: Cold Storage	Shut down	None	None	Utility	Preparing for demolition
427	Cold Mechanical Storage	Removed in 2016	None	None	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Shut down	None	None	Maintenance	Preparing for demolition
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
540	Modular Office Complex	Operational	None	New	Facilities	Modular Trailer office complex installed in parking lot
543	Dosimetry Building	Under Construction	None	New	Facilities	Start of construction 2021 To be completed 2022

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	Relocated from Building 402 to near Building 300 Shielded Facilities. Placed back in Operation.
597	Portable Boiler Building 1	Out of Operation	None	None	Powerhouse Operators and Maintenance	Taken out of Service due to shutdown of Building 200
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hyd ro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

[a] Security personnel perform regular patrols of all site buildings

There were no policy, program or procedural changes for the non-nuclear facilities in 2022. There were no changes in organization in 2022.

In 2022, the Facility continued to maintain the minimum staffing requirements to provide the needed operational and safety support.

G.2 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [16]. There were no Category 1 and 2 changes in 2022.

G.3 Equipment Performance, Planned Maintenance Testing and Inspections

Leaks occurred in the fire/ process water mains west of Building 543 and south of the site substation systems. Leaks were isolated by closing valves, no systems were impaired and no compensatory measures were required. Other equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2022.

G.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the non-nuclear facilities as part of routine operations.

G.5 Effluents Released

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the facilities as part of routine operations.

There was 1.45E+09 L of effluent released from buildings Building 422 (Outfall Monitoring Station) and 4.15E+07 L of effluent released from Building 907 (Sewage Lift Station and Lagoons). There was one lagoon discharge in the fall of 2022. Results are discussed in Section 9.

Landfill Dugout Water Monitoring

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2022, the total precipitation was 687 mm over the year, an increase from 2021 (395 mm). The location of the dugouts are shown in Figure 17. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

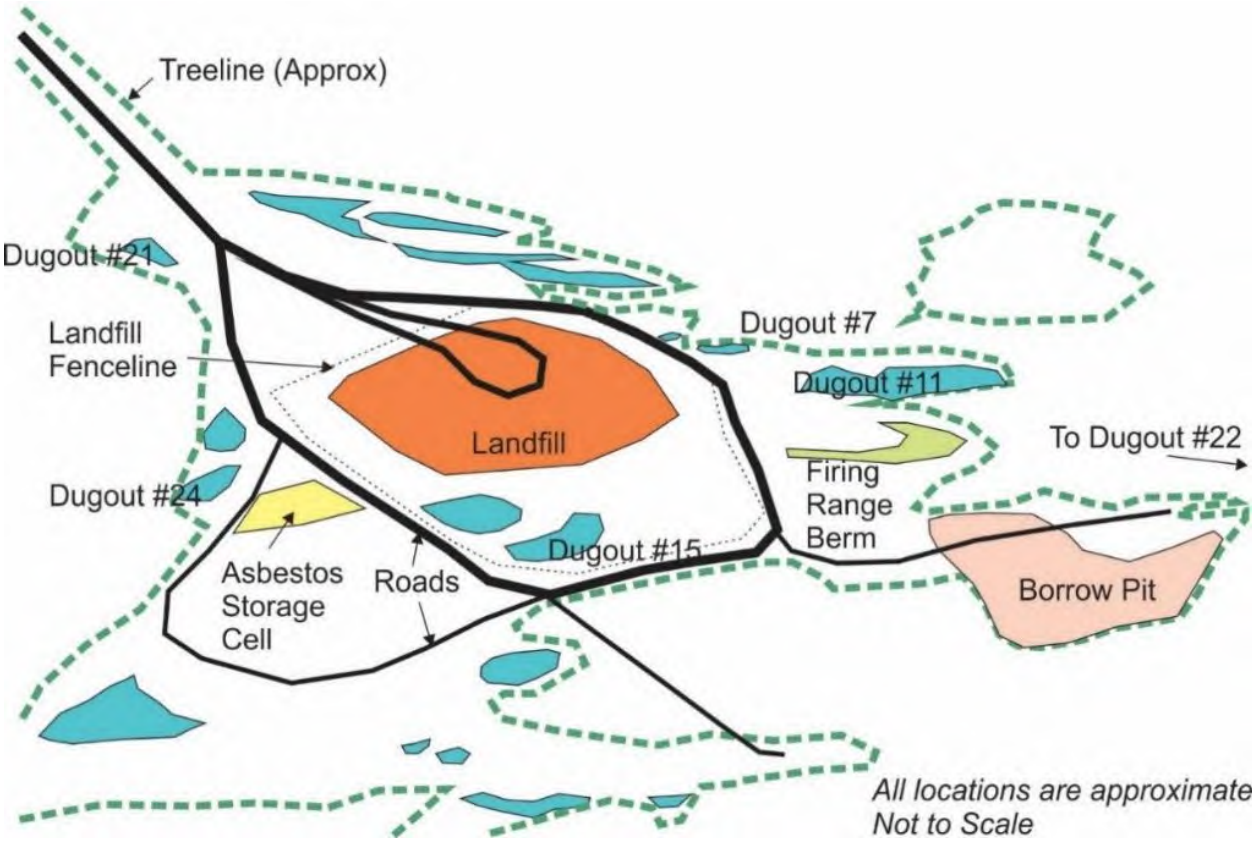

Figure 17: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a low value was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there through 2022. The tritium level in Dugout 15 was 25 Bq/L, following a decreasing trend since 2020. All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2022 that contain < 5 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 91.

Table 89 and Table 90 respectively. All alpha results for 2022 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. The Beta result in Dugout 7 was above the drinking water screening level of 1.0 Bq/L. Other Beta results were lower. Other than the Dugout 7 Beta result, results for 2022 are consistent with previous results obtained from 2017 to 2021. The increase has been noted and monitoring will be continued next year.

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water

measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a low value was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there through 2022. The tritium level in Dugout 15 was 25 Bq/L, following a decreasing trend since 2020. All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2022 that contain < 5 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 91.

Table 89: Gross Alpha Results from the Landfill Dugouts

Sample	Gross Alpha (Bq/L)					
Location	2017	2018	2019	2020	2021	2022
Dugout #7	<0.17	<0.17	0.07	<0.05	<0.05	0.13
Dugout #11	<0.14	<0.14	<0.05	<0.05	0.05	0.03
Dugout #15	0.10	0.10	0.28	<0.05	0.05	<0.05
Dugout #21	0.07	0.07	Dry	<0.05	<0.05	0.18
Dugout #22	<0.14	<0.14	0.11	<0.05	<0.05	NA
Dugout #24	<0.19	<0.19	0.29	<0.05	<0.05	0.05

NA sample not available

Table 90: Gross Beta Results from the Landfill Dugouts

Sample	Gross Beta (Bq/L)					
Location	2017	2018	2019	2020	2021	2022
Dugout #7	0.17	0.17	0.11	0.07	0.08	1.42
Dugout #11	0.02	<0.10	<0.05	<0.05	0.01	0.20
Dugout #15	<0.07	<0.07	0.12	0.16	0.30	<0.05
Dugout #21	<0.05	<0.05	Dry	<0.05	0.13	0.23
Dugout #22	<0.13	0.13	<0.05	0.05	0.05	NA
Dugout #24	0.08	<0.08	0.25	0.06	0.10	0.38

NA sample not available

Table 91: Results from the Landfill Dugouts

Sample	Tritium (Bq/L)					
Location	2017	2018	2019	2020	2021	2022
Dugout #7	< 4	< 4	< 3	< 4	< 5	< 3
Dugout #11	< 4	< 4	< 4	18	< 5	< 4

Dugout #15	82	105	212	54	93	25
Dugout #21	NA	< 4	Dry	< 3	< 5	< 4
Dugout #22	< 4	< 4	< 4	< 3	< 5	NA
Dugout #24	< 4	76	< 4	< 4	< 5	< 4

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill had been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing conducted in 2018 included Sr-90 and Tc-99, two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. In 2019, only Sr-90 was tested, and was found to be at the detection limit. In 2020, both Sr-90 and Tc-99 were again measured. Sr-90 was at the detection limit and Tc-99 was not detected. In 2022 (see Table 92), as in 2021, no Sr-90 analysis was conducted as per the instructions provided to lab to only analyze if gross Beta exceeded 5 Bq/L. Tc-99 was again below the detection limit. The water from these dugouts and wells is not used for human consumption. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99.

Table 92: Sr-90 and Tc-99 Results from the landfill Dugouts in 2022

Sample Location	(Bq/L)	
	Sr-90	Tc-99
Dugout #7	NA	ND
Dugout #11	NA	ND
Dugout #15	NA	ND
Dugout #21	NA	ND
Dugout #22	NA	NA
Dugout #24	NA	ND

NA – No Analysis Gross Beta below analysis trigger limit.

ND – Non Detect

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia (N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron were detected in Dugout #15, a continuation of results from 2018 onwards (Table 93). The value in 2022 remained under the Drinking Water Guideline for Boron (5,000 µg/L). Dugout #24 showed 264 µg/L in 2022, and all other dugouts showed values below detection limits.

Table 93: Boron Results from the Landfill Dugout #15

Sample Location	(µg/L)				
	2018	2019	2020	2021	2022
Dugout #15	5,460	8,460	2,040	3,760	1,170

Molybdenum remained at detection limits from 2020 through 2022. In 2022, Manganese remained higher than drinking water guidelines of 50 µg/L in Dugout #15 (58 µg/L). No other parameters were detected at concentrations of concern.

Groundwater results will be discussed in the annual Environmental Monitoring report [32]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [31].

Landfill Dugout Sediment Monitoring

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the Landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, and as such, sediment sampling was conducted in 2022. Molybdenum was still slightly elevated in Dugout 24.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program [31].

Landfill Radiological Monitoring

Annual radiological monitoring of the Landfill surface was performed as a confirmatory measure in the past. As of 2022, this monitoring was no longer required from the Radiation

Protection Program as the Landfill had not been physically opened to accept waste for several years. Bins for accepting radiologically clean scrap metal and scrap wood had been installed in 2020. Two years of monitoring showed no change, with the results showing readings consistent with background levels at the Landfill fence line. Table 94 provides survey results at the top of the Landfill. For some years monitoring was performed at the base of the pile, and more recently monitoring was performed around the perimeter of the fenced area of the Landfill.

Table 94: Landfill Radiological Monitoring

Sample Location	(μR/h)				
	2018	**2019**	**2020**	**2021**	**2022**
Landfill Top Surface	8 - 10	6 -12	6 - 12[2]	10	NA
Landfill Base	NR	5 - 8[1]	5 - 8[1]	10	NA

NR – Not recorded

NA – Not available - discontinued

[1] Taken at the fence line instead of base of Landfill

[2] Metal waste collection bins sited at top of Landfill

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Annual Compliance Monitoring Report

Whiteshell Laboratories Annual Compliance Monitoring Report for 2021

WL-514300-ACMR-2021

Revision 0

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Reviewed by:	S. Cotnam Senior Director, Compliance – Chief Regulatory Officer	2022/04/28 Date
Approved by:	J. Gilbert Head, WL Closure Project	2022/04/28 Date

UNRESTRICTED

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
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D2	2022/04/04	Issued for "Review and Comment".	R. Swartz	S. Cotnam J. Gilbert S. Brewer C. Gallagher	
D1	2022/03/07	Issued for "Review and Comment".	A. Stelko R. Swartz	B. Scott A. Coulas R. Swartz A. Rehman A. Caron N. Deighton S. McLean Z. Barnicoat S. Khan J. deRuiter D. Fillion V. Golovko J. Hayter L. Rasmussen R. Bilinsky P. Vilks J. Betteridge A. Bilton C. Oversby T. Rosentreter C. McGregor J. Reynolds S. Mynhardt C. Clark J. Turcotte D. Koopman M. MacKay A. Mahabir J. Martino T. Reimer	

EXECUTIVE SUMMARY

This annual compliance monitoring report for the 2021 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 and CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* as a summary report of annual compliance monitoring and operational performance.

Canadian Nuclear Laboratories (CNL) would like to acknowledge Canada's Indigenous Peoples and their traditional territories upon which CNL carries out its work. CNL also wishes to confirm its commitment to being an active participant in Canada's journey towards healing and reconciliation.

This annual compliance report provides CNL 2021 performance data for WL and is organized by 14 Safety and Control Areas (SCAs)[1], as well as a report on each of the WL nuclear and non-nuclear facilities.

The following provides overall performance highlights for 2021 activities:

- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2021 were below their respective Derived Release Limits (DRL).
- Demolition of Building 200, the former Active Liquid Waste Treatment Centre (ALWTC), is complete, and Building 402/305, the former Health and Safety Facilities, is partly demolished.
- The WL site maintained safe and compliant performance under COVID-19 Pandemic conditions and protocols.

Below is a summary of the annual compliance report for calendar year 2021.

- **SCA - Management System**: WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning. After having no Canadian Nuclear Safety Commission (CNSC) inspections in 2020, four inspections were carried out in 2021.
- **SCA - Human Performance Management**: A significant effort towards training individuals in human performance related areas continued as a result of the fieldwork pause in 2020 November. Another outcome of the fieldwork pause was the development and delivery of the initial Annual General Employee Training which goes

[1] The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas.

over site and project updates, as well as review of policies and procedures. This will be updated and delivered annually to all employees.

- **SCA - Operating Performance**: WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of "events". The total number of internal event reports raised continues to show a strong reporting culture. There were six CNSC reportable events in 2021.
- **SCA - Safety Analysis**: Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL's nuclear facilities, helping meet health, safety, security, environmental and regulatory requirements. Safety analyses continue to be developed for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and Cask Loading facilities being constructed in the Waste Management Area.
- **SCA - Physical Design**: The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba. The new revised WL Pressure Boundary Quality Assurance Plan was accepted by Inspection and Technical Services Manitoba and a new Certificate of Authorization was issued.
- **SCA - Fitness for Service**: The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. Regular preventative or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Missed maintenance of safety-related systems was reported to CNSC, and a corrective action plan was developed that will fix the issues and prevent recurrence.
- **SCA - Radiation Protection**: No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 0.6 mSv and collective doses remained below 50 person-mSv (19.0 person-mSv) for 2021. Members of the public received no measureable radiation doses.
- **SCA - Conventional Health and Safety**: Implementation of CNL's Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture. Safety advisories are regularly issued to staff about imminent issues that could impact their safety. There were no lost-time injuries at WL in 2021.
- **SCA - Environmental Protection**: The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment. Radiological emissions were 0.00019% of the Derived Release Limit (DRL) for air emissions and 0.47% of the DRL for liquids. The monitoring program confirms that the WL site is operating in a manner that protects workers, the

public, and the environment. WL maintained their ISO-14001 registration, and are compliant to a number of CSA environmental standards.

- **SCA - Emergency Management and Fire Protection**: The Emergency Management program at WL continued to be focussed on supporting COVID-19 planning and coordination efforts, providing procedures and guidance to enable work to continue safely in this dynamic situation. A third party Fire Protection Audit was conducted, and resolution to findings will be tracked through the corrective action program.
- **SCA - Waste Management**: WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 924 m^3 of radioactive waste to Chalk River Laboratories (CRL), and 271 m^3 (37,145 kg) of recycled waste shipped off-site. The WL Site Overview Detailed Decommissioning Plan was revised and accepted by CNSC.
- **SCA – Security**: The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for high-security sites. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC.
- **SCA - Safeguards**: There were no issues identified with International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL. The IAEA also provided human surveillance and IAEA seal verification, removal and reapplication during canister inspection activities.
- **SCA - Packaging and Transport**: There were 68 radioactive transport packages making up 53 loads that were safely and successfully sent off-site, including approximately 921 m^3 of low-level waste and 3 m^3 of intermediate-level waste shipped to CRL.
- **Other matters of regulatory interest**: Two virtual meetings of the WL Public Liaison Committee took place. Numerous public information sessions and Indigenous engagements (mainly virtual) were held on the Whiteshell Reactor 1 (WR-1) in-situ decommissioning and overall activities of the WL Closure Project, including four Webinars.
- **Facilities** (operating nuclear facilities, permanently shut down facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: the Active Liquid Waste Treatment Centre, Building 200, completed demolition, and significant progress was made in demolition of the Health and Safety Facilities, Building 402/305.

CNL is committed to achieve high standards of operational safety and security. The information and data presented in this report support the conclusion that safe and secure performance was achieved at the Whiteshell Laboratories site, while enhancements were implemented to further improve results.

ACKNOWLEDGEMENT

The “Author” of this document would like to thank the many Whiteshell Laboratories authors and reviewers from the various Functional Support Areas and Facilities for their production of the individual sections of the report.

CNL’s Continued COVID Pandemic Response

For a detailed description of CNL’s robust mitigation initiatives and controls to protect its employees, contractors, visitors and Site operations from the COVID pandemic, see the Executive Summary in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories*.

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FIGURES

TABLES

INTRODUCTION

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the eastern bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL. This work transitioned to Canadian Nuclear Laboratories (CNL) who are carrying out the work to achieve site closure on behalf of the site owner, AECL.

Activities are now underway to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see the Decommissioning Strategies Section below).

Name:	Whiteshell Laboratories
Location:	*1 Ara Mooradian Way* *Pinawa, Manitoba* *R0E 1L0*

Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook (LCH) for Whiteshell Laboratories,* herein referred to as “Licence Conditions Handbook” [2], and section 3 Annual Compliance Monitoring Report of CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2021 January 01 to December 31.

This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to 14 Safety and Control Areas as they are applied across all of CNL.

The intent of this report is to provide sufficient detail to demonstrate how Whiteshell Laboratories programs are meeting the regulatory requirements as specified in the licence [1] and the LCH for Whiteshell Laboratories [2].

Facilities Included in this Report

Appendices Appendix A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities included in this report are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and Building 305), and WR-1 Reactor.

Summary of Licensed Activities

There are no new licenced activities.

Decommissioning Strategies

As discussed since 2015, work is underway to complete decommissioning of the entire WL site (current schedule is to be complete in 2027). This includes leaving in-situ the selected WMA trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this proposed change. The Environmental Impact Statement supporting this is in progress.

Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [5], advising that as an agent of Her Majesty in Right of Canada, AECL’s liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee remains valid and in effect, as per the communication issued on 2020 August 25 [6].

1 Management System

1.1 Management System Program

Whiteshell Laboratories adheres to the Corporate Management System. See Section 1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL Quality Assurance Plan [7] supports the CNL Management System Manual [8] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to CSA N286-12 [9] and N286.6-98 [10].

1.2 Audits, Inspections and Self-Assessments

As per the requirements of the Management System [8], both Safety Control Areas and Facilities conduct various audits, inspections, and self-assessments to ensure that the management system is functioning according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate actions taken to resolve them.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Corrective Action Program.

1.2.1 Audits

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL-wide Audits for the reporting year 2021.

1.2.1.1 External Audits

The external audits conducted at Whiteshell Laboratories are summarized in the table below.

Table 1: External Audits

Title	Type of Audit	No. of Non-Compliances Raised	No. of Non-Compliances Completed
SAI Global Recertification Audit of the WL Environmental Management System	14000:2015	0	Not applicable
PLC Fire Safety Solutions Audit of the Fire Protection Program	CSA N393	31	0

For the Fire Protection Program audit, the non-compliances related mostly to missing documentation for inspection, testing and maintenance activities. The audit report was received late in 2021, and a corrective action plan is to be submitted to CNSC staff in early 2022.

1.2.1.2 Internal Quality Audits

There were no internal audits completed by the Quality Audits and Processes branch specific to Whiteshell Laboratories in 2021.

1.2.2 Inspections

CNSC Inspections

The following CNSC Inspections were conducted at Whiteshell Laboratories.

Table 2: CNSC Inspections for 2021

Inspection No.	Area Inspected	No. of NNC[a]s	No. of NNC[a]s Completed
CNL-WL-2021-01	Human Performance Management	2	2
CNL-WL-2021-02	Management System	6	6
CNL-WL-2021-03	General	3	0
CNL-WL-NSD-T2-2021-001	Security	7	0

a NNC – Notice of Non-Compliance

Inspections by Other Regulatory Bodies

A Physical Inventory Verification (PIV) inspection was carried out by the IAEA on 2021 May 26. This inspection was a sampling of accessible items containing Special Fissionable Material. A Design Information Verification inspection was carried out by the IAEA on 2021 May 25-27. This inspection verified the information provided in the Design Information Questionnaire.

Transport Canada conducted a virtual Transport of Dangerous Goods (TDG) inspection at WL in 2021 and did not find any non-conformances.

1.2.3 Self-Assessments

In 2021, there were 18 self-assessments conducted at Whiteshell Laboratories covering various aspects of the management system, including both safety and control areas, and various facilities.

Table 3: List of Self-Assessment Conducted at Whiteshell Laboratories in 2021

Title	Facility/Department
Effectiveness of Industrial Hygiene Instrumentation	WL Occupational Safety and Health (OSH)
Workload on the SMO	WL Environmental Management (EM)
WL Integrated Work Control	WL Site and Nuclear Operations
TDG Requirements	WL Waste Management

Movement of Radioactive and Non-Radioactive Materials	WL Waste Management
Registration and control of radiation sources	WL Radiation Protection (RP)
WL RP Program Compliance Review	WL RP
WL-510400-OI-366-01 - WL Lock Out Tag Out (LOTO)	WL Site and Nuclear Operations
900-510400-MCP-032 - Work Permit	WL Site and Nuclear Operations
WL EM QA Plan WL-514200-QAP-001 to 17025, Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Risk Assessment Process	WL EM
Compliance to ISO/IEC 17025:2017 Improvement	WL EM
WL Radiation Dose Reporting to NEW Workers for 2020 Doses	WL RP
Manager Dose Control Points and RP Training Designation Annual Reviews for 2021	WL RP
REGDOC 2.12.1, High Security Sites: Nuclear Response Force Section 7	WL Emergency Services
REGDOC 2.10.1 Section 2.2.1, Emergency Response Organization and Staffing	WL ES
Impairment Notification and Compensatory Measures	WL ES

1.3 Management Reviews

The Quality Assurance Program/Management System Review for 2018/19 and 2019/20 was completed. The review identified 6 actions, all of which are completed.

2 Human Performance Management

2.1 Human Performance Program

Whiteshell Laboratories adheres to the Corporate Human Performance (HU) Program. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.1.1 Program Improvements and Accomplishments

The effectiveness of the HU program at WL has been enhanced through the following improvements:

- Following the 10 week fieldwork pause in 2020 November to address an adverse trend in human performance, WL gradually increased fieldwork throughout 2021 February. WL executed an extensive Corrective Action Plan, which included comprehensive reviews and updates to procedures and a significant investment in employee training. Improvements implemented included increased supervisor presence in the field, in depth review of proper use of tools and equipment, procedure awareness and compliance, sharing of lessons learned, and better pre- and post-job briefs. WL also performed several self-assessments through the integrated assessment plan and implemented new work control metrics.
- In 2021 May, Performance Assurance reintroduced the two-level rigorous review of ImpAct records by re-instating the Management Screening Team (MST) weekly meeting. MST's mandate is to provide management level review and oversight of the ImpAct record and ensure it has sufficient and accurate information to let the Management Review Meeting (MRM) team conduct their review. The MST assesses and recommends the significance level, cause determination effort, cause statement and the Responsible Manager. MRM provides Director level (and above) oversight for the ImpAct Corrective Action Program. The MRM team confirms, or modifies as appropriate, decisions made by the MST.
- In 2021 August, a three day TapRooT® Essentials Course was delivered to nine (9) WL Employees. The virtual sessions were taught by an external root cause analysis and investigation expert who guided immersive learning activities using interactive presentation technology, group exercises, and two-way interaction. TapRooT® is a powerful tool in conducting investigations and has already been used to augment CNL's current cause analysis techniques.
- WL enlisted the support of the recently formed CNL Strike Team, comprised of experts from across CNL, to conduct a causal analysis for a discovered adverse condition regarding the WL Preventative Maintenance program (see ERM-21-3009 in Table 5). Unlike the usual Apparent Cause Analysis or Root Cause Analysis processes, the Strike Team's causal analysis used a Facts Issues Causes Actions table. Doing the investigation in this manner allowed the team to develop the causal analysis and corrective actions in

a concise and timely manner. This tool will be beneficial for future investigations that may need to be conducted.

2.2 Training programs

Whiteshell Laboratories adheres to the Corporate Training and Development Functional Support Area. See Section 2 of the Annual Compliance *Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.2.1 Program Improvements and Accomplishments

The effectiveness of WL Training Program has been enhanced through the following improvements:

- Revisions to the content for the New Employee/Contractor Orientation to reflect current policies and procedures for working on site.
- WL introduced the Integrated Work Control Core 5 Elements course, which provides contractors with training that combines the 5 core courses delivered during the safety stand down: Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls.
- Development of the initial Annual General Employee Training to review site and project updates, as well as policies and procedures. This will be updated and delivered annually to all employees.
- Updates and improvements to the content and media for the Radiation Group 4 Training delivered to all employees and contractors coming to site.
- Major revisions to the Delivering Practical Training course. Content now includes adult learning and learning principles content. This course is required for any employee who conducts on-the-job training and functional checkouts for skills assessments.
- Redevelopment of the Waste Management & Fundamentals courses to include updates to policies and procedures in our Waste Management Program.
- Revisions to the content and materials for Vehicle Spotter Training. Delivery to all staff who are required to have spotter training.
- Development of the 'Training Matrix tool' which allows managers and supervisors to quickly look up the training status of their teams.

2.2.2 Systematic Approach to Training

CNL maintains a list of positions and roles requiring Systematic Approach to Training (SAT) training programs in compliance with REGDOC-2.2.2, Personnel Training [11].

Training and Development evaluated the training programs for listed positions and roles at WL against the main elements of SAT. The results led to initial individual action plans which are being managed and further evaluated by the Curriculum Review Committees. Additional corrective actions and program improvements will be identified and managed by the

Curriculum Review Committees going forward. Since the initial analysis of the listed positions, dedicated Training and Development personnel have been hired and assigned to support WL in the completion of the action items identified. Curriculum Review Committees for the WL WMA and Shielded Facilities have been established and progress on the actions is underway.

2.2.3 Required Training

Some WL listed positions and roles require additional training documentation development to achieve full SAT-compliance. Current workers are qualified based on existing training programs combined with their years of experience in the role. Existing training programs include classroom training, practical training, computer-based training, and mentor style training. These experienced workers will assist as Subject Matter Experts (SMEs), in the development of training documentation that is required to achieve full SAT-compliance.

All Whiteshell Laboratories personnel, both employees and contractors, are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work under the licence [1]. Section 2 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories [4] provides the 2021 CNL Employee and Manager/Supervisor required training. Table 4 provides a list of federally/provincially legislated training courses that appear in position-specific training plans at Whiteshell Laboratories.

Table 4: Whiteshell Laboratories Operating Staff Training in 2021

Course Code	Course Title	No. of Attendees
OSH-1001-Online	Crane (Safe Indoor Hoist) – Theory	44
OSH-1002-Online	Lift Truck Operation – Theory	40
OSH-1003-Online	Aerial Work Platform – Theory	59
OSH-1004-Online	Lock Out / Tag Out Exam	28
OSH-1004-Virtual	Lock Out / Tag Out (Virtual)	28
OSH-1005-Online	Working at Heights – Theory	84
OSH-1006	Confined Space Entry	14
OSH-1006-Online	Confined Space Exam	15
OSH-1006-Virtual	Confined Space Entry (Virtual)	25
OSH-1007	Asbestos Module 6E	51
OSH-1033-Online	Ladder Safety	27
OSH-1034-Online	Hazard Prevention Program	31
OSH-1042-Online	WHMIS – 2015	40
OSH-1046-Online	Heat Stress	7
OSH-3001-E	Crane – Safe Indoor Hoist – Practical – Jib Crane	3
OSH-3001-F	Crane – Safe Indoor Hoist – Practical – Bridge Crane	3

OSH-3001-J	Crane – Safe Indoor Hoist – Practical Gantry Crane	2
OSH-3001-K	Crane – Safe Indoor Hoist – Practical	1
OSH-3001-L	Crane – Safe Indoor Hoist Only	13
OSH-3001-MULTI	Crane – Safe Indoor Hoist – Practical – All Equipment Codes	8
OSH-3002-C	Lift Truck Practical – Counter Balance	18
OSH-3002-MULTI	Lift Truck Operation – Practical/All Equipment Codes	4
OSH-3003-B	Aerial Work Platform Practical – Articulating Boom 60 ft (or less)	21
OSH-3003-C	Aerial Work Platform Practical – Rough Terrain Scissor Lift	27
OSH-3003-D	Aerial Work Platform Practical – Scissor Lift	25
OSH-3003-E	Aerial Work Platform Practical – Single Person Up-Up	1
OSH-3003-Multi	Aerial Platform – Practical (All Equipment Codes)	34
OSH-3005	Working at Heights – Practical	88
HU-1036-Online	Pre job Brief	12

2.2.4 Contractor Training

Before accessing the Whiteshell Laboratories, contractors are required to complete the following training:

- Contractor Safety Orientation
- Radiation Protection Group 4
- Integrated Work Control Core 5 Elements (Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls)
- CNL COVID Awareness

WL utilizes the contract terms and conditions, in addition verifying and approving the contractor company's safety programs and training records, to ensure contractors are qualified to work at WL.

WL oversees contractors' work in the field and all WL work control protocols apply.

2.2.5 Training Evaluations Summary

In 2021 WL continued to utilize trainee feedback forms to capture learner input as part of training program improvement and maintenance activities. Also, there were 16 documented Observation and Coaching sessions related to training events. These evaluations are reviewed weekly by Training and Development staff and training program improvements are managed through applicable training change processes.

3 Operating Performance

3.1 Operating Program

Whiteshell Laboratories adheres to the Operating and Decommissioning Functional Support Areas. See Section 3.1 and Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review board and other internal assessment activities such as self-assessments and audits (see Section 1.2).

3.1.1 Operations / Decommissioning Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [12] for Whiteshell Laboratories are given in Appendix A through F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [13] processes.

Relevant modifications to WL facilities are given in Appendix A through G.

3.2 Reporting Requirements

3.2.1 Reportable Events to CNSC

In 2021, there were 6 events that occurred at Whiteshell Laboratories that were deemed reportable to the CNSC. They are listed in Table 5.

Table 5: Reportable Events to the CNSC at Whiteshell Laboratories in 2021

Event No.	Title	SCA	Facility (if applicable)
ERM-21-3585	WL Injury - Medical Aid - Slip, Trip, Fall (Leg Injury)	Operating Performance	WL Building 300 (Research and Development)
ERM-21-3009	WL Reportable Event – Missed maintenance of safety related systems as per the Shielded Facilities Facility Authorization	Operating Performance	WL Shielded Facilities

HSSE-21-1772	WL - Radiation Source Found in Area Radiation Monitor Removed from B305 Electron Accelerator	Radiation Protection	WL Building 402 (Health and Safety)
ERM-21-1732	WL Environmental Protection: Hydraulic Leak at the Building 200 Demolition site involving a contractor's Hyster 550 Fork Lift (Rental Unit)	Environmental Protection	WL Building 200 (Active Liquid Waste Treatment Centre)
ERM-21-1651	WL Reportable Event - Building 402 Fire Protection System Impairment	Fire Protection	WL Building 402 (Health and Safety)
ERM-21-1036	WL - Incomplete Inventory Results in Misclassification of Shipment	Packaging and Transport	

3.2.2 Reportable Events to Other Regulators

Reports to other regulatory agencies consisted of:

- 1 Hazardous Occurrence Investigation Reports (HOIR) was made to Employment and Social Development Canada (see Section 8.1.3 for further details)
- 2 reports made to Environment and Climate Change Canada (see Section 9.5.2.4 for further details).

3.2.3 Trending of Events Related to Operational Activities

As events at Whiteshell Laboratories occur, they are recorded in the Improvement Action (ImpAct[2]) system. This information is regularly reviewed and analyzed to identify any trends. To identify trends Event Code based trend reports are also prepared to analyse ImpAct data on monthly bases. Monthly site wide and WL specific trend reports are prepared by CRL Performance Assurance and shared with WL. WL specific trends are also specified in the monthly Contractor Assurance System scorecard.

The following trends were identified and raised as ImpActs:

- ERM-21-1299, WL TREND – No Purchase Order in Place Prior to Commitments of Contract Service Providers Coming to Site
- ERM-21-3088, WL TREND - Misuse of WHMIS (Workplace Hazardous Materials Information System) when labelling or storing hazardous waste.
- ERM-21-3132, WL TREND – Increased Vehicle Accident Incident Reports (VAIR), Equipment and/or Passenger Vehicles on site and in main parking lot at WL.
- HSSE-21-3283, WL TREND – Barrier Crossings.

[2] ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

The use of the ImpAct process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

In 2021, a total of 424 ImpActs were raised by CNL employees at WL.

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

The following table summarizes ImpActs raised over the past 5 years by Significance Level[3].

Table 6: Number of ImpActs raised at Whiteshell Laboratories

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2017	5	0	0	42	448	496
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609
2020	13	0	3	58	276	350
2021	5	0	2	81	336	424

a Level 0 will be assigned if the ImpAct is deemed to be a "non- problem" and a recommendation to close the Impact will be given.

3.2.4 Notification of Conflicts or Inconsistencies

In 2021, there were no conflicts or inconsistencies identified between licence conditions, codes or standards, operations, programs, methods, or regulatory documents referenced in the Whiteshell Laboratories Licence [1] or *Licence Conditions Handbook* [2].

3 Significance Level: Levels assigned to an event (SL1 being most significant, SL4 being least significant) based on the actual or potential result in safety, environmental, or business consequences.

4 Safety Analysis

4.1 Safety Analysis Program

Whiteshell Laboratories adheres to the Corporate Safety Analysis Functional Support Area. See Section 4.1 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories for details [4].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, three facilities have SARs and Facility Authorizations: Shielded Facilities (SF), WMA and Concrete Canister Storage Facility (CCSF). The ALWTC SAR and Facility Authorization documents were previously obsoleted in 2020 [14]. Assessments are in progress to determine if the SF and WMA SARs need to be revised. The CCSF SAR is being updated to address upcoming fuel retrieval activities.

A SAR is being prepared for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and conversion of the SMAGS building to a Cask Loading Facility. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC before these facilities are operated.

4.2 Nuclear Criticality Safety Program

Whiteshell Laboratories adheres to the Corporate Nuclear Criticality Functional Support Area. See Section 4.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

As the Nuclear Criticality Safety Program is a companywide program, enhancements and improvements made were intended to target all sites including WL and are identified in [4].

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSDs) for the Waste Management Area (CSD-27), the Cask Loading Facility (formerly the Whiteshell Laboratories SMAGS Building B923) (CSD-73) were conditionally accepted and the Intermediate-Level Liquid Waste Processing Centre (CSD-74), Concrete Canister Storage Facility (CSD 11), and the Fuel Basket Transfer Flask (CSD-54) are in progress to allow retrieval of waste from the WMA and CCSF. The remaining WL CSDs have not been updated during this review period.

5 Physical Design

5.1 Design Program

Whiteshell Laboratories adheres to the Corporate Design Functional Support Area. See Section 5.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Design Authority and Design Engineering Functional Support Area maintains and controls the design basis for all design activities performed at WL.

In 2021 March, the Certificate of Authorization was renewed with Engineers Geoscientists Manitoba. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of The Engineering and Geoscientific Professions Act.

5.1.1 Safety Related Structures Systems and Components

In 2021, the Design Authority and Design Engineering Program ensured that any structures, systems and components important to safety met and maintained their design basis, and any changes made were controlled through the Engineering Change Control Process [13].

5.2 Pressure Boundary Program

Whiteshell Laboratories adheres to the Corporate Pressure Boundary Functional Support Area. See Section 5.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Pressure Boundary Functional Support Area applies to design, procurement, fabrication, installation, examination, testing, repair, modification, construction and maintenance of pressure retaining systems and components performed by CNL at WL.

The *WL Pressure Boundary (PB) Quality Assurance (QA) Plan* [15] details the specific scopes of pressure boundary work carried out at WL, as permitted by the Certificates of Authorization issued by Inspection and Technical Services (ITS) Manitoba, describes the controls, authorities, and responsibilities applicable at the WL site, and is consistent with CNL's PB Program requirements.

The revised *PB QA Plan* [15] was accepted by ITS and a new Certificate of Authorization was issued on 2021 August 10. The new certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Plan until expiry in 2024 August.

The CNSC has previously been notified of revisions to the *PB QA Plan* [15], as per the *Licence Conditions Handbook.*

6 Fitness for Service

6.1 Fitness for Service Program

Whiteshell Laboratories adheres to a Fitness for Service Program through its Maintenance Functional Support Area. See Section 6.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Site and Nuclear Operations Branch provides monitoring and operation of building's processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedure reviews are conducted on a five year cycle. Currently the Operating Procedures are under review; some of these procedures have reached the five-year timeline for review and those are being prioritized for review and updating. As facilities are decommissioned procedures related to those buildings or processes are obsoleted. Procedures to operate the facilities in order to enable decommissioning efforts are prepared as required.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service, WL staff ensure that critical systems, structures and components related to the safe decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities ensures that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the facility's Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to

assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plan are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed as they are identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed and is being implemented that will fix the issues and prevent recurrence. The effectiveness of the corrective action plan will be investigated upon completion of the actions.

6.1.3 Condition of Structures

Waste storage structures include the WMA bunkers and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [16] was developed in 2007 and continues to be implemented to confirm the ongoing fitness-for-service of the concrete storage facilities (termed "bunkers") at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done, to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site, they will be removed from the inspection process. The 2021 annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [16].

Although the SMAGS building (Building 923) is not a bunker it has been included in the bunker inspection. Building 923 is being converted to the Cask Loading Facility, and during this conversion and subsequent re-commissioning for its new purpose, it will not store waste. A repair, conducted in 2016, to the north wall of Building 923 that extended into the core of the slab, remained stable through 2021 with no new crack expressions (the walls of Building 923 are pre-cast concrete slabs). All other repair items for the bunkers and Building 923 were minor in nature and were tracked through the WL work request system.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however existing cracks and pour pockets were regularly checked for changes. Requests for patching were placed in 2021, and several canisters will require more extensive patching of pour pockets that have gradually become more noticeable over time, however no increased radiation field was noted.

Environmental monitoring was conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers, SMAGS or concrete canisters.

7 Radiation Protection

7.1 Radiation Protection Program

Whiteshell Laboratories adheres to the Corporate Radiation Protection Functional Support Area. See Section 7 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories uses the Chalk River Laboratories (CRL) licensed Dosimetry Service Provider for external and internal dosimetry for site/facility staff and contractors.

Whiteshell Laboratories staff and contractors who work at the WL site are assigned Thermoluminescent Dosimeters (TLDs) to monitor for external radiation exposures.

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2021 included:

- Radiological hazard and precaution sheets were reviewed and updated as required to remove statements such as “at the Surveyor’s discretion” or “as directed by RP Surveyor”.
- Enhanced personal protective clothing and equipment requirements were implemented for work in Radiological Safety Zone 2 and 3 work areas.
- Guidelines were developed and implemented for field RP staff for consistent completion of radioactive material transit/storage tags.
- Radiological surveys completed in WL nuclear facilities to confirm absence or identify unknown and unmarked historical or legacy contaminated materials and areas.
- Facility review completed for the adequacy of radioactive material storage areas.
- Field compliance check list developed and implemented for use by field RP staff during facility housekeeping inspections.
- Guidelines provided for RP staff when knee pads or other additional measures are needed to prevent inadvertent knee contaminations when working in contaminated environments.
- New CNL RP program requirement for formal registration of long term radioactive material storage areas was implemented for any new storage areas, and work started on registration of pre-existing facility storage areas.
- WL site procedure developed for the dose monitoring program for WL workers, contractors and visitors.

WL RP performance metrics are measured and tracked weekly through WL Closure Project status reports and quarterly through the WL Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies and

opportunities for improvement, establish and effectively implement corrective and preventative action plans.

7.1.2 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2021, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to TLD badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition. Table 7 summarizes maximum daily recorded doses and dose rates for PAD work in 2021 and the previous four years, and a summary of PAD alarms. In 2021, the maximum PAD recorded daily dose received by a worker was 0.22 mSv and the highest dose rate measured in the year was 3.1 mSv/h. These were associated with planned exposures associated with decommissioning activities in the Building 200 ALWTC, and removal and packaging hot cell roughing filters in the WL Shielded Facilities. There were no PAD dose alarms and 78 PAD dose rate alarms in 2021. The distribution of PAD dose rate alarms over the past 5 years is summarized in Table 8.

There was an increase in the number of low level dose rate alarms in 2021 due to increased decommissioning and operations activities in the WMA associated with the removal, characterization and packaging of low level radioactive waste from waste storage buildings. These low level dose rate alarms helped alert workers of dose rate areas they did not need to be working in, and thus helped to maintain low doses to workers.

Table 7: Personal Alarming Dosimeter Summary

	2017	2018	2019	2020	2021
PAD – Maximum Daily Dose (mSv)	0.17	0.24	0.42	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.10

Table 8: Distribution of Number of PAD Dose Rate Alarms 2017-2021

Year	Dose Rate Alarm Set Point (mSv/h)							
	≤0.10	>0.10 - <0.25	0.25 - < 0.50	0.50 - < 1.0	1.0 – < 2.5	2.5 - < 5.0	5.0 - < 10	≥ 10
2021	11	20	22	16	7	2	0	0
2020	10	2	1	5	9	1	1	0
2019	9	0	2	12	4	2	0	0
2018	22	0	13	5	31	3	0	0
2017	22	3	26	2	5	0	0	0

At the beginning of 2021, managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by managers and supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified. At the end of 2021, there were no individuals with an assigned DCP higher than 2 mSv, 28 individuals with an assigned DCP of 2, and the remainder of workers with a DCP of 1 mSv. No worker dose exceeded their assigned DCP in 2021.

7.1.3 Contamination Control

Regular contamination surveys of workplaces, material transfers, and personnel exiting nuclear facilities and controlled areas, are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls, and to warn of abnormal or unplanned airborne contamination conditions.

Table 9 shows the number of personnel, workplace and material contamination events identified in 2021 and over the past five years. None of the contamination events in 2021 resulted in a recordable whole-body, skin or internal dose.

Material contaminations increased from 1 in 2020 to 11 in 2021. This increase was due to historical surplus equipment being found with low level contamination during operational cleanup activities (8), building decommissioning waste disposition (1), and as a result of operational activities (2). There were no worker skin or clothing contaminations in 2021.

In 2021, there were no airborne contamination exposure events and no radioactive material spills.

The following table outlines contamination events that occurred at Whiteshell Laboratories in 2021:

Table 9: Contamination Events

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	Personal Clothing[a]	Radiological Work Clothing[b]	Total	Surface[c,d]	Vehicle / Materials [b, c]
2017/18 FY	0	0	1	1	3	
2018/19 FY	1	0	5	6	6	0
2019 CY	3	0	4	7	2	4
2020 CY	2	0	3	5	1	1
2021 CY	0	0	0	0	1	11

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area.

b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area.

c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas

d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2021, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2021 December 31, the total number of registered sealed or contained sources at WL, was 53. One Cesium (Cs)-137 source was added to the registry, and one mixed Cs-137 liquid standard and one Cs-137 gamma irradiator were removed from the registry. The liquid standard was evaporated and dispositioned as radioactive waste. The Cs-137 calibrator was transported back to the manufacturer.

7.2 Dosimetry

7.2.1 Interpretation of Reported Dose Quantities

WL uses the CRL licensed Dosimetry Service Provider for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory document REGDOC 2.7.2, *Dosimetry*, Volume II [17] requires external exposure measurements to meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective

dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[4].

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a committed effective dose from occupational intakes exceeding 1 mSv per year.

7.2.2 Radiation Doses to Personnel

Table 10 to Table 13 summarize the monitored radiation doses at the WL site for 2021. Doses are summarized for employees, contractors and visitors and are subdivided into Nuclear Energy Worker (NEW) and non-NEW status. Doses in the tables of this report do not include doses received by WL employees and contractors working at sites other than WL. Two visitors had NEW status that were associated with prior NEW requirements and visits within CNL as a whole, these two instances were CNSC and IAEA staff.

In 2021, there were no exceptions for individual monitoring of non-CNL employees and visitors at WL, other than drivers of delivery trucks and building demolition debris haulers in radiological Supervised Areas.

There were no operations of exposure devices in 2021 which required employees or contractors to be placed on a two-week dosimetry period, and there were no formal dose calculations required during 2021 for local area skin contamination.

No neutron dosimeters were assigned to employees during 2021.

In 2021, 180 individuals underwent internal bioassay, which involved urinalysis and/or whole-body counting. Eleven individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective dose estimates were necessary as a result of any bioassay sampling in 2021.

In May of 2021 the building (B402) that housed the WL Whole Body Counter (WBC) began decommissioning and demolition and a new building (B543) is currently being commissioned to house the WBC. It is anticipated that the new facility will be ready for occupancy sometime in the spring of 2022. During this outage, workers who normally participate in annual or bi-annual WBCs were evaluated against the site's current radiological activities to determine which

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[4] Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.2).

workers required alternative monitoring. Workers with reasonable potential for an intake which warranted alternate monitoring were placed on a gamma spectrometry in urine analysis (provided by CRL Dosimetry Services) which provides similar minimum detectable doses to the WBC analysis. Additional random (biased toward likelihood of an intake) urine bioassay monitoring of workers who did not meet the alternative monitoring criteria is being undertaken until the new facility is ready.

Table 10: Effective Dose for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	393	100	292	1	-	-	-	-	0.57	0.06	0.05	17.98
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
	Totals	861	546	314	1	0	0	0	0				18.99

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.

b Average of all measured doses that include the zero dose value, rounded to two decimal places.

c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 11: Distribution of Equivalent Dose to the Skin for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	393	99	287	7	-	-	-	-	0.94	0.08	0.06	22.46
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
Totals		861	545	309	7	0	0	0	0				23.47

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 12: Distribution of Equivalent Dose to the Hands and Feet for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv) 0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00	Individual Dose (mSv) Max	Ø Avg[a]	Avg All[b]	Collective Dose (p·mSv)
			Number of Persons										
NEW	Employee	16	4	8	1	3	-	-	-	1.86	0.61	0.45	7.26
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor[c]	0	-	-	-	-	-	-	-	-	-	-	-
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Totals		16	4	8	1	3	0	0	0				7.26

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.

b Average of all measured doses that include the zero dose value, rounded to two decimal places.

c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 13: Summary of Dose Components Received as a Result of Licensed Activities for 2021 [a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	393	17.98	0.57	0.06	0.05	393	22.46	0.94	0.08	0.06	16	7.26	1.86	0.61	0.45
	Contractor	77	0.74	0.19	0.04	0.01	77	0.74	0.19	0.04	0.01	0	-	-	-	-
	Visitor[c]	2	0.00	0.00	-	0.00	2	0.00	0.00	-	0.00	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	148	0.17	0.11	0.06	0.00	148	0.17	0.11	0.06	0.00	0	-	-	-	-
	Visitor	241	0.10	0.10	0.10	0.00	241	0.10	0.10	0.10	0.00	0	-	-	-	-
Total		**861**	**18.99**				**861**	**23.47**				**16**	**7.26**			

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor[d]	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Total		0	0.00				0.00					0	0.00			

a All quantities are measured in mSv unless otherwise noted.

b Average of all measured doses that exclude the zero dose value, rounded to two decimal places.

c Average of all measured doses that include the zero dose value, rounded to two decimal places.

d Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

7.2.2.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2021 was 0.57 mSv and the site collective dose was 18.99 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the current five-year dosimetry period from 2021 to 2025 at WL was 0.57 mSv.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2021 was 0.94 mSv and the site collective dose was 23.47 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2021 was 1.86 mSv and the site collective dose was 7.26 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2021, the maximum individual effective dose from the time the pregnancy was declared to the end of the pregnancy term was 0.05 mSv.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2021, the maximum individual effective dose to a non-NEW at WL was 0.11 mSv.

Table 14 provides a summary of radiation doses by worker group in 2021. The majority of radiation doses were received by RP, Nuclear Operations and Trades staff.

7.2.2.2 Radiation Dose Changes or Trends

Table 15 shows external whole body dose received from 2017 to 2021, and Figure 1 displays the maximum individual and collective dose from 2001-2021.

Worker doses decreased in 2021 with the completion of higher dose extensive decommissioning activities in Building 200 (ALWTC) in 2020. The site collective dose decreased from 33 p-mSv in 2020 to 19 p-mSv in 2021. The number of workers receiving occupational doses above 0.2 mSv in a calendar year decreased from 25 workers in 2020 to 11 workers 2021. This a significant decrease compared to a maximum number of 42 workers in 2017. There were no workers receiving an annual radiation dose above 1 mSv in 2021.

Main contribution to radiation dose in 2021 was radioactive tanks removal during B200 demolition activities, and operational replacement of hot cell roughing filters. There was increased waste handling in 2021 with the start of the removal, characterization and packaging of low level radioactive waste packages from storage facilities in the WMA. However, these activities had only a small contribution to site worker doses.

7.2.3 Program Exceedances

During 2021, radiation dose to all persons working at WL were below the WL dose Action Levels [2] and the respective CNSC regulatory limits [18]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 14: Summary of Worker Group Radiation Doses at WL for 2021

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	p·mSv	p·mSv	p·mSv
Nuclear Facilities:						
SF Staff (HCF and IFTF)[c]	5	0.18	0.49	0.91	0.92	1.83
WR1 and ALWTC Staff	5	0.07	0.14	0.37	0.37	0
WMA and CCSF Staff[c]	6	0.07	0.21	0.39	0.39	0
Support Workgroups:						
Radiation Protection Staff [d]	41	0.11	0.43	4.43	6.02	1.06
Trades Staff [e]	48	0.09	0.57	4.31	6.35	4.37
All Remaining Staff:						
Other Staff [f]	513	0.02	0.19	8.48	9.32	0
WL Site[g]:	618	0.03	0.57	18.89	23.37	7.26

a Includes photon and neutron; there were no tritium committed effective doses for 2021.

b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.

c SF= Shielded Facilities; HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; ALWTC= Active Liquid Waste Treatment Center; WMA= Waste Management Area; CCSF= Concrete Canister Storage Facilities; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.

d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.

e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL

site in general.

f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.

g WL Site includes 393 CNL staff (WL and staff visiting from other CNL sites) and 225 contractors working at the WL site during 2021. This tally does not include visitor doses.

Table 15: WL External Whole-Body Dose Performance 2017 to 2021

Performance Metric	2017	2018	2019	2020	2021
Site Collective Worker Dose (p-mSv)	19.9	40.2	49.6	33.4	18.9
Max Individual Worker Dose (mSv)	1.41	1.65	3.09	2.97	0.57
Number of Workers > 0.2 mSv in a year	42	39	38	25	11
Number of Workers > 1 mSv in a year	1	12	14	8	0
PAD[a] – Maximum Daily Dose (mSv)	0.17	0.24	0.40	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.1

a Personal Alarming dosimeter.

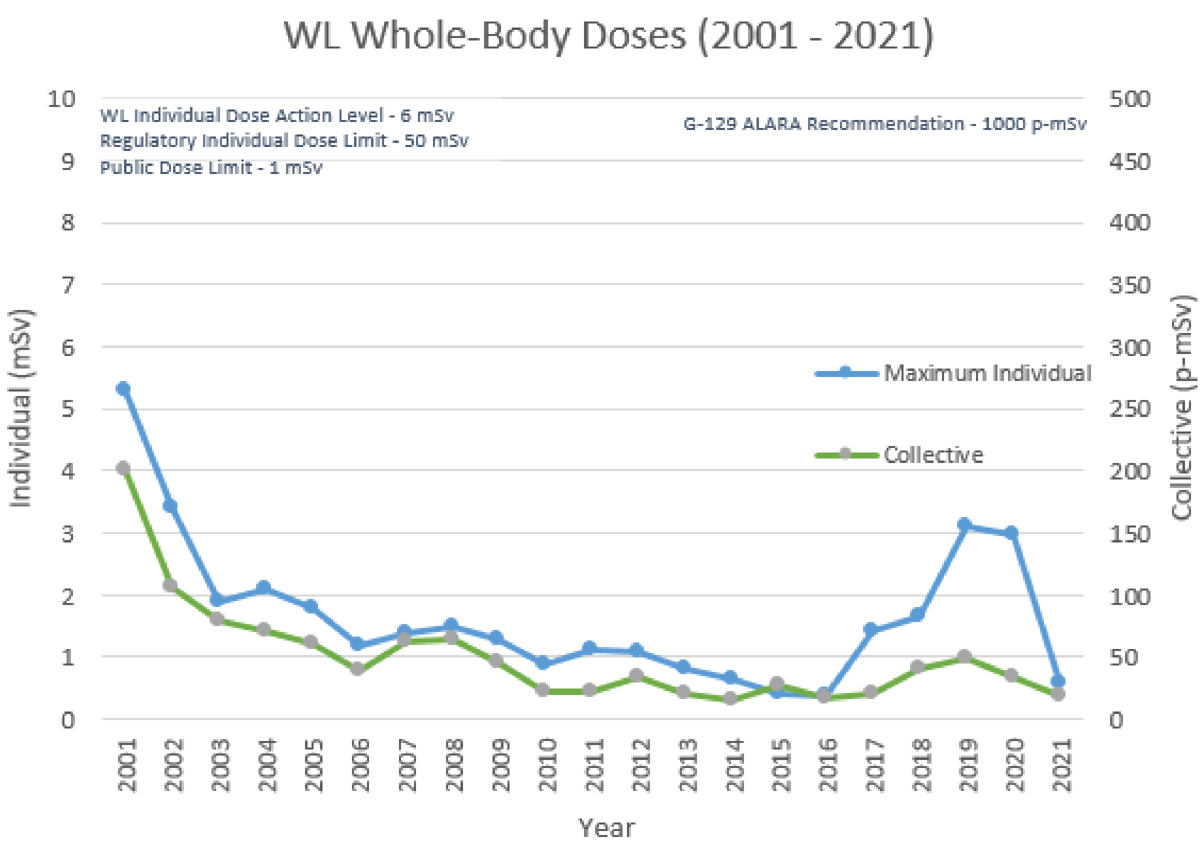


Figure 1: Whole-Body Effective Doses (2001 – 2021)

8 Conventional Health and Safety

8.1 Conventional Health and Safety Program

Whiteshell Laboratories adheres to the Corporate Conventional Health and Safety Functional Support Area. See Section 8 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives are continuing or began in 2021:

- To support project work, WL OSH purchased noise dosimeters, a sound calibrator, Jerome Mercury detector and Colorimetric Badges for chemical detection.
- OSH presence in the field continued at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to WL's internal safety success.
- Contractors continued to be "pre-qualified" prior to bidding on WL contracts. The pre-qualification process involves reviewing safety statistics and the safety programs of the potential bidders.
- WL continued to participate in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- There were 11 internal Safety Advisories and 2 Learning Advisories sent to WL site employees. The bulletins are intended to inform WL employees about imminent issues that could impact their safety. WL continued to be proactive in the approach to safety.
- Near Miss reporting (a known industry best practice) continued with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 16).
- Near Miss reporting at WL always includes an investigation/fact finding session. The majority of Near Miss reports also generate an ImpAct. Whether an ImpAct is generated or not, the possibility of a human error trap being involved in the Near Miss incident is always considered, evaluated and followed up as appropriate.
- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.
- Promoted the Stop/Pause protocol.

Table 16: Summary of WL Near Miss Reporting

Year	2017	2018	2019	2020	2021
Near Miss Reported	60	53	46	10	26

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis.

In 2021, the WL Site Safety and Health Committee received 93 inquiries out of which 6 remained open and in progress. There was one inquiry carried over from 2020. The Site Safety and Health Committee acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 61 site health and safety inspections completed in 2021.

8.1.3 HOIRs and Lost-Time Injuries

There was one hazardous occurrences at Whiteshell Laboratories that was reported to Employment and Social Development Canada in 2021. CNSC staff received a copy of this notification, as per the requirements of the CNSC REGDOC-3.1.2 [3].

The following is a summary of injury rate data for the last 5 years.

Table 17: Summary of Whiteshell Laboratories Injury Rate Data

	2017	2018	2019	2020	2021
Whiteshell Laboratories					
Person Hours Worked	706,000	688,000	642,000	584,030	684000
Lost-Time Injuries	3	1	0	1	0
Working Days Lost	27	5	0	2	0
Frequency[a]	0.85	0.25	0	0.34	0
Severity[b]	7.76	1.45	0	0.68	0
Whiteshell Laboratories Contractors[c]					
Lost Time Injuries	1	0	0	0	0
Working Days Lost	0[d]	0	0	0	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

c The Number of Person Hours worked are not divulged by Contractors. As such, Frequency and Severity rates cannot be calculated.

d Number of days lost is unknown as the contractor terminated the employee.

The Recordable Lost Time Injury rate over the last five years at WL in Manitoba is significantly lower than local lost-time injury rates for construction (3.7) and manufacturing (2.4), as per the data from the Workers Compensation Board of Manitoba found in *The Manitoba Workplace Injury and Illness Statistics Report 2010-2019* (safemanitoba.com).

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2021.

9 Environmental Protection

9.1 Environmental Protection Program

WL adheres to the Corporate Environmental Protection (EnvP) Functional Support Area. See Section 9 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

WL has an integrated Environmental Protection Program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program, and the Groundwater Monitoring Program. The WL Environmental Protection Program is designed to implement the requirements of:

- CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [19],
- CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [20],
- CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [21],
- CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [22],
- CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [23], and
- ISO 14001:2015, *Environmental Management Systems* [24].

The integrated Environmental Protection Program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

This report will focus and discuss the implementation of the WL Effluent Verification Monitoring Plan [25]. This plan defines the methodologies and protocols followed in performing the effluent verification monitoring required in CSA N288.5-11 [20].

The WL site has maintained its ISO 14001 [24] registration in 2021 with initial registration in 2010.

The CNSC has previously been notified of revisions to *Environmental Protection documents* [26], as per the *Licence Conditions Handbook.*

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control programs as required by CSA N288.5 [20]. General quality assurance objectives for CNL's

Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [27] for analytical laboratories.

Whiteshell Laboratories' Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 3247 quality verification tests during 2021 on WL's radiochemical counting equipment. Of these tests, 99.6% fully complied with acceptance criteria. The results of these tests are shown Table 18.

Table 18: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	1188	4	99.7
Total Beta (Instrumentation)	1188	5	99.6
Gamma (Instrumentation)	647	0	100.00
Tritium	224	4	98.2
2021 Total	**3247**	**13**	**99.6**

In 2021, the WL Effluent verification program continued performing regular field Quality Verification testing on the Outfall, Lagoon, and Ditch effluent sampling (Table 19). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

Table 19: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	N/A	N/A	4	100%
Conductivity	4	<LDML	4	100%
Total Organic Carbon	4	< LMDL	4	100%
Phenols	4	< LMDL	4	100%
TSS	4	<LMDL	4	50%
Phosphorus	4	<LMDL	4	75%
Oil and Grease	4	< LMDL	4	100%
Mercury	4	<LDML	4	75%
Chromium	4	< LMDL	4	25%
Copper	4	0.222 mg/L	4	25%
Magnesium	4	< LMDL	4	100%
Iron	4	< LMDL	4	50%
Lead	4	0.0033 mg/L	4	25%
Nickel	4	< LMDL	4	50%
Potassium	4	< LMDL	4	75%
Sodium	4	< LMDL	4	100%
Strontium	4	< LMDL	4	100%
Uranium	4	< LMDL	4	75%
Zinc	4	0.010	4	50%
Bromodichloromethane	4	0.002 mg/L	4	100%
Chloroform	4	0.096 mg/L	4	100%
Toluene	4	0.044 mg/L	4	100%
Radiological Parameters:				
Gross Alpha	N/A	N/A	1*	100%*
Gross Beta	N/A	N/A	1*	0%*
Cesium-137	N/A	N/A	1*	100%*
Americium-241	N/A	N/A	1*	100%*

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Potassium-40	N/A	N/A	1*	100%*
Lead-214	N/A	N/A	1*	100%*
Beryllium-7	N/A	N/A	1*	100%*
Strontium-90	N/A	N/A	1*	100%*
Plutonium-238	N/A	N/A	1*	100%*
Plutonium-239/240	N/A	N/A	1*	100%*
Sewage Lagoon				
No Samples collected in 2021				
Ditches				
Non-Radiological Parameters:				
pH	N/A	N/A	2	100%
Conductivity	1	2.1 uS/cm	2	100%
Phenols	1	<LDML	2	100%
TSS	1	<LDML	2	50%
Phosphorus	1	< LMDL	2	100%
Oil and Grease	1	< LMDL	2	100%
Mercury	1	< LMDL	2	50%
Chromium	1	< LMDL	2	100%
Copper	1	0.434 mg/L	2	100%
Iron	1	< LMDL	2	100%
Lead	1	0.007 mg/L	2	100%
Nickel	1	0.0006 mg/L	2	100%
Zinc	1	0.043 mg/L	2	100%
Radiological Parameters:				
Gross Alpha	1	< LMDL	2	50%
Gross Beta	1	< LMDL	2	50%
Tritium	1	< LMDL	2	100%
Cesium-137	1	< LMDL	2	100%
Americium-241	1	< LMDL	2	100%
Cobalt-60	1	< LMDL	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Radium-228	1	< LMDL	2	100%
Europium-154	1	< LMDL	2	100%
Lead-210	1	< LMDL	2	100%
Thorium-228	1	< LMDL	2	100%
Thorium-230	1	< LMDL	2	100%
Thorium-234	1	< LMDL	2	100%
Uranium-235	1	< LMDL	2	100%
Radium-226	1	< LMDL	2	100%
Actinium-228	1	< LMDL	2	100%
Potassium -40	1	< LMDL	2	100%
2021 Total	**224**	**--**	**146***	**89%***

*: Not all 2021 data has been received from the contract laboratory.
LMDL = Laboratory Method Detection Limit

It is important to note that not all of the radiological results for 2021 have been received from the contract laboratories carrying out the analysis of samples (see also Section 9.4.1.3.2). At the time of writing this report, results received to date indicate that out of the 146 duplicate quality verification tests, 130 of these tests meet the acceptance criteria (+/- 20% of the actual result) of the program, to yield an 89% pass rate. A larger number of duplicates failed this year, with the majority of the failures being related to the metal concentrations being observed at the Outfall monitoring station. CNL is attributing this increase in failures to the fact that the metal concentrations being observed in the effluent are near the detection limit. This leads to results with low concentrations and high variability being produced, which will increase the likelihood of a failure in the duplicates being observed. This is supported by the large number of results classified as not being detected, and the low concentrations of metals being observed at the Outfall as seen in Table 32. No further action by CNL is needed to address the failures.

Reviewing the travelling blank data, and comparing it to the field results, the environmental program has concluded that the water source being used for the travel blank is slightly contaminated with Copper, Lead, Zinc, Chloroform, and Bromodichloromethane. The traveling blank results for these parameters are not reflective of contamination being picked up while sampling in regards to these parameters.

In 2021, the WL Environmental Management group took part in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses, were offered through the Canadian Association for Laboratory

Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 20 and Table 21. There were four unacceptable test results out of thirty for the Environmental Research Associates inter-laboratory comparison studies, resulting in an 87% pass rate. The four unacceptable test results related to the gross alpha and gross beta analysis of water samples. The WL radiochemical counting laboratory is working on determining the cause of the problem, and until the cause has been identified, all quantitative analyses of this nature are being contracted out to a third party laboratory. The laboratory is in the process of ruling out possible factors. The areas the laboratory are currently reviewing includes the process for evaporation and ashing samples being utilized to prepare samples. The previously used method was required to change due to equipment limitations in the new environmental laboratories. The standard stock solutions that are used for the creation of the calibration curves used in this analysis may have also been compromised.

For the Proficiency Testing Canada inter-laboratory comparison studies, a 100% pass rate was achieved.

Table 20: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2021

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Air Filter Radionuclides	Americium-241	(pCi/Filter)	60.2	64.20	43.0 – 80.3	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	1030	898.76	668 - 1260	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	163	173.30	134- 214	Acceptable
MRAD-34	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	1220	1310.15	1040- 1550	Acceptable
MRAD-34	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	771	926.67	632- 1180	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	96.1	105.09	50.2-158	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	62.6	58.64	38.0-94.6	Acceptable
MRAD-34	Water Radionuclides	Americium-241	pCi/L	157	154.80	108-201	Acceptable
MRAD-34	Water Radionuclides	Cesium-134	pCi/L	1610	1369.04	1220-1770	Acceptable
MRAD-34	Water Radionuclides	Cesium-137	pCi/L	578	558.65	495-657	Acceptable
MRAD-34	Water Radionuclides	Cobalt-60	pCi/L	2180	2089.33	1880-2500	Acceptable
MRAD-34	Water Radionuclides	Zinc-65	pCi/L	1720	1765.19	1530 - 2170	Acceptable
MRAD-34	Water Gross Alpha/Beta	Gross Alpha	pCi/L	62.2	12.09	22.7 – 85.8	Not Acceptable

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Water Gross Alpha/Beta	Gross Beta	pCi/L	103	169.83	51.5 - 142	Not Acceptable
MRAD-34	Water Tritium	Tritium	pCi/L	22800	21216	17200-27800	Acceptable
MRAD-35	Air Filter Radionuclides	Americium-241	(pCi/Filter)	27.7	27.75	19.8-36.9	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	241	196.60	156-296	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	187	184.8	154-245	Acceptable
MRAD-35	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	310	310.75	264-394	Acceptable
MRAD-35	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	366	401.32	559	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	77.6	91.00	40.5-128	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	80.6	74.22	48.9-122	Acceptable
MRAD-35	Water Radionuclides	Americium-241	pCi/L	63.7	62.63	43.7-81.5	Acceptable
MRAD-35	Water Radionuclides	Cesium-134	pCi/L	649	558.51	490-714	Acceptable
MRAD-35	Water Radionuclides	Cesium-137	pCi/L	2170	2026.11	1860-2470	Acceptable
MRAD-35	Water Radionuclides	Cobalt-60	pCi/L	964	936.39	831-1110	Acceptable
MRAD-35	Water Radionuclides	Zinc-65	pCi/L	394	408.92	351-497	Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Alpha	pCi/L	93.9	27.66	34.3-129	Not Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Beta	pCi/L	97.0	142.66	48.5-133	Not Acceptable
MRAD-35	Water Tritium	Tritium	pCi/L	12800	12528.93	9650-15600	Acceptable

* MRAD: Multi-Media Radiochemistry

Table 21: Proficiency Testing Canada Accreditation Inter-Laboratory Comparison Program CNL WL - 2021

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2021	CO1A-1	Conductivity	(µS/cm)	741	740	99	Acceptable
	CO1A-2	Conductivity	(µS/cm)	1160	1153		
	CO1A-3	Conductivity	(µS/cm)	374	376		
	CO1A-4	Conductivity	(µS/cm)	523	522		
March -2021	CO4A-1	TSS	(mg/L)	15	16	97	Acceptable
	CO4A-2	TSS	(mg/L)	64	66		
	CO4A-3	TSS	(mg/L)	128	130		
	CO4A-4	TSS	(mg/L)	203	203		
March -2021	C15-1	pH	(pH units)	4.89	4.87	95	Acceptable
	C15-2	pH	(pH units)	6.58	6.54		
	C15-3	pH	(pH units)	3.34	3.32		
	C15-4	pH	(pH units)	9	8.95		
October-2021	CO1A-1	Conductivity	(µS/cm)	676	695	91	Acceptable
	CO1A-2	Conductivity	(µS/cm)	454	469		
	CO1A-3	Conductivity	(µS/cm)	412	428		
	CO1A-4	Conductivity	(µS/cm)	707	719		
October-2021	CO4A-1	TSS	(mg/L)	22	16	86	Acceptable
	CO4A-2	TSS	(mg/L)	136	134		
	CO4A-3	TSS	(mg/L)	185	178		
	CO4A-4	TSS	(mg/L)	53	52		
October-2021	C15-1	pH	(pH units)	4.9	4.89	96	Acceptable
	C15-2	pH	(pH units)	7.72	7.77		
	C15-3	pH	(pH units)	2.82	2.80		
	C15-4	pH	(pH units)	8.52	8.55		

9.3 Supplementary Studies

In 2020, the WL site began to do temporary enhanced monitoring on the effluent verification ditches for the year. The enhanced monitoring is being done to confirm the absence of a number of radiological and non-radiological parameters. The enhanced monitoring involved doing an open scan for Volatile Organic Carbons, semi-volatile organic carbons, and an expansion of the metals and gamma isotopes list currently being used to monitor the ditches.

Whiteshell is reviewing the data, and is deciding whether there is a need to add any of these parameters to the effluent verification monitoring program going forward. This study was on going in 2021, and will be continued into 2022 due to the limited number of ditch sampling events that occurred in 2021.

9.4 Effluent Monitoring - Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [28] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, *Environmental Monitoring in 2021 at Whiteshell Laboratories* [29] and *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

9.4.1 Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

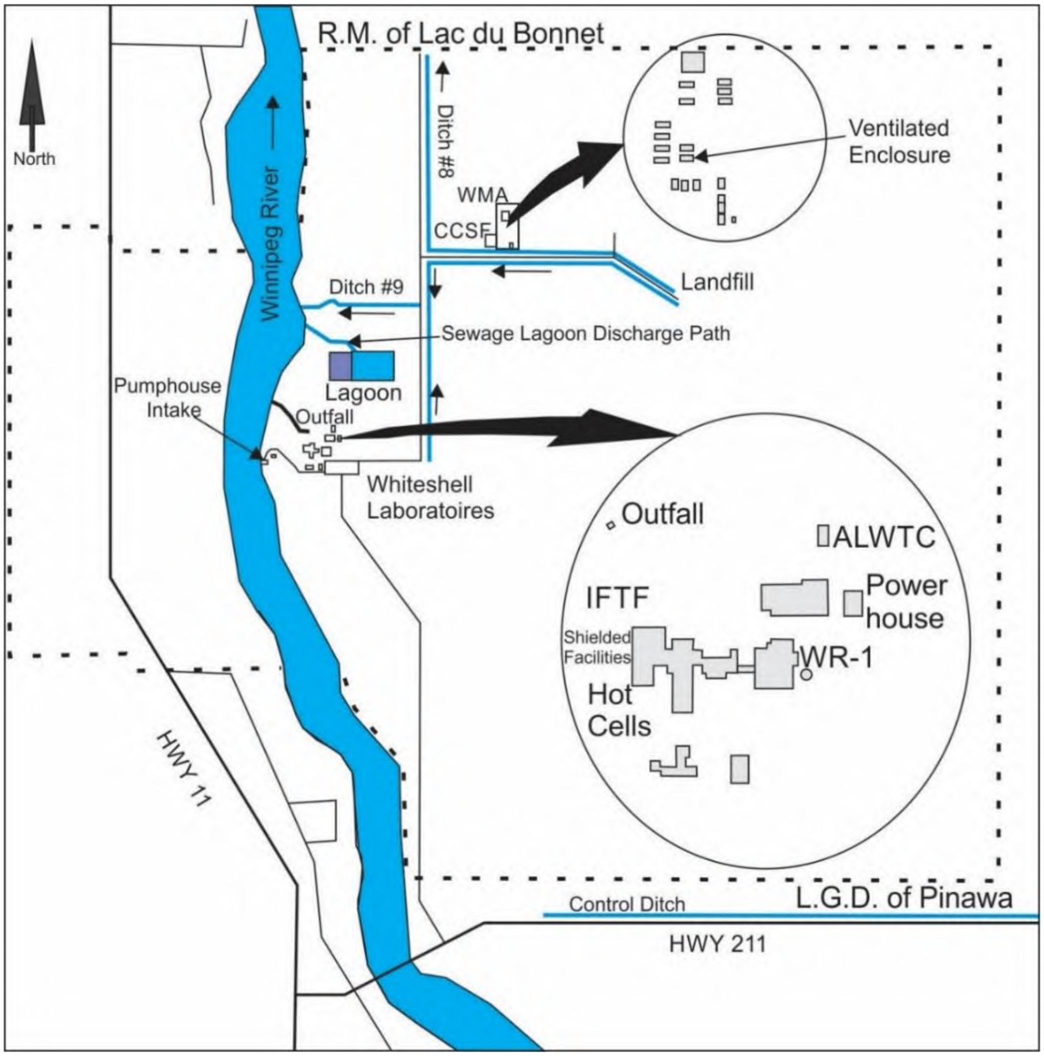


Figure 2: Effluent Monitoring Locations

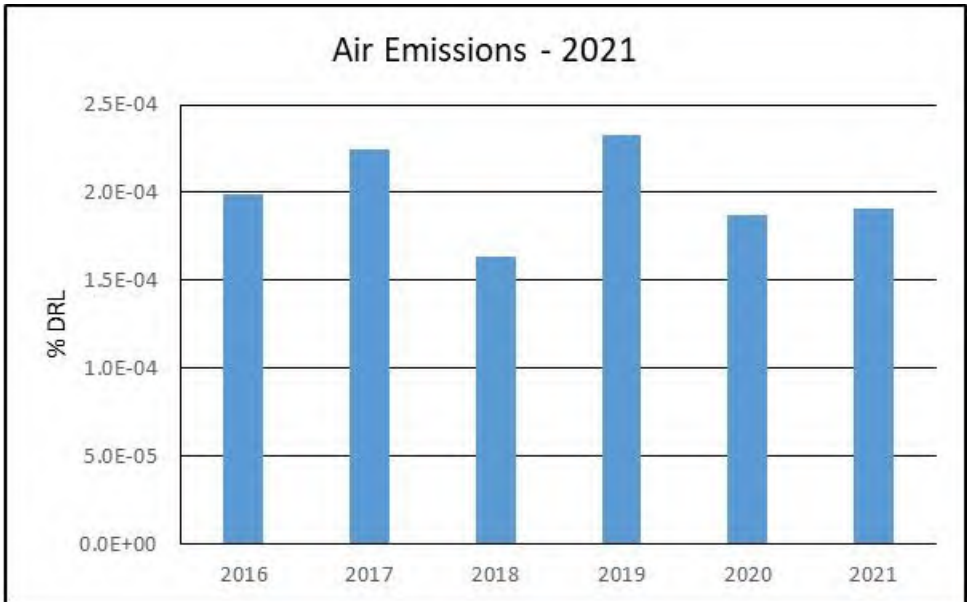
Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable DRLs [30]. The DRLs in use at WL came into effect on 2021 January 31. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction

and analysis of individual beta emitting radionuclides, such as Strontium (Sr)-90, complemented by examination of historical data.

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in CSA N288.1-08 [31]. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [32]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[5] that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3.2, the increase in 2019 to 2021 liquid effluents is due to an increase in detection limit values for Am-241 and Plutonium (Pu)-239/240. When the activities of radionuclide contaminants are not detected it is standard practice to report detection limit values as if they were observed concentrations. For example, Pu isotope activities were always detection level values and Am-241 and Cs-137 activities are very close to detection levels.

[5] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).



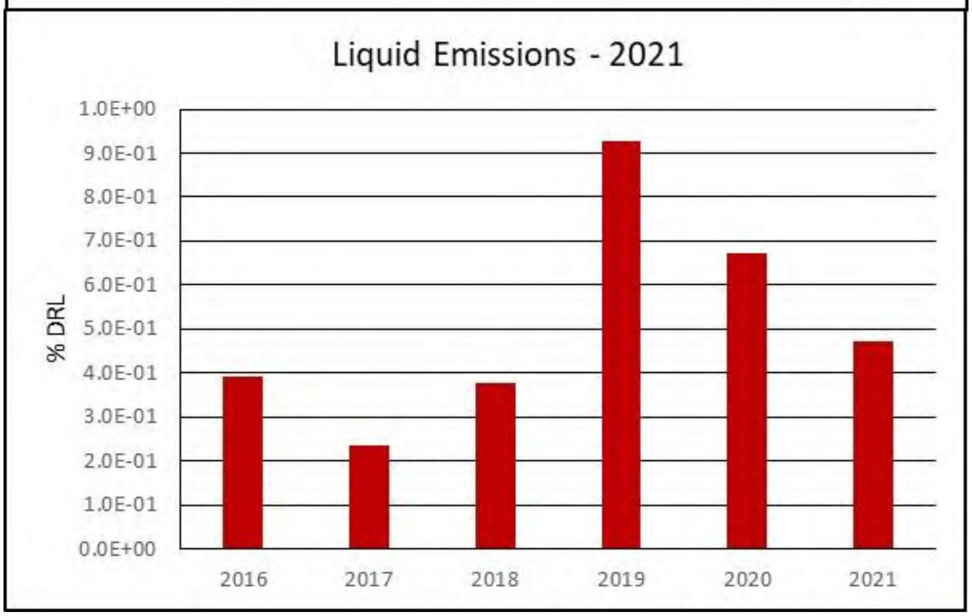


Figure 3: Trends for Airborne and Liquid Emissions form WL for 2016 to 2021

(Note: The Liquid Emissions for 2021 need to be corrected to include October to December data. This will be revised upon receipt of the data.)

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Administrative and Action Levels[6] as specified in Reference [33]. The Action Levels were calculated based on current CNSC guidance to meet CSA N288.8 [23] and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

9.4.1.2 Airborne Effluents Monitoring

9.4.1.2.1 Monitoring Points, Schedules and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. These activities include waste compaction in the Waste Handling Area, located in the Immobilized Fuel Testing Facility (IFTF), and decommissioning activities in the ALWTC. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)
- ALWTC (Building 200)

Air effluents from Buildings 100 and 300 were sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 22. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. Any proposals on modifications to the monitoring program will be communicated to CNSC staff. In 2020, Building 200 (ALWTC) was prepared for demolition and the ventilation system was shut down in 2020 October. Monitoring of stack effluents for Building 200 ceased after 2020 October 13, and the building was demolished in 2021. Therefore the reported air emissions in 2021 do not include emissions from Building 200, which is no longer included in the monitoring schedule (Table 22).

[6] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

Table 22: Radiological Air Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
Building 100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
Building 300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
Building 300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured but passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water Bubbler for tritium.

W Weekly

N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The WL maintenance planning team performs the measurements for the stack flows and the RP team measures the Sampler flow. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [30]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (Sr-90 for gross beta and Pu-239 and Pu-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 23 and Figure 3 for the years 2016 to 2021. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also includes tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. The reader should be aware that the values for 2021 in Table 23 represent averages that include detection limit values where nothing has actually been detected. The releases from the Reactor Building include gross beta and tritium values that are always above detection, and gross alpha numbers that are often detection limits. The gross alpha releases from the HCF are normally detection levels and the gross beta are often, but not always detection levels. The gross alpha values from the IFTF are always detection limits and the gross beta are a mixture of detects and non-detects.

Airborne emissions remain a small fraction of the release limit. The result for 2021 (0.00019% of the DRL) is similar to 2020, and slightly lower than the average for the last five years. Total site gross alpha in 2021 is lower than in 2020 and the last five years average. It remains near detection limit values. The gross beta emissions are slightly more than in 2020 and similar to the last five-year average. In 2021, the air emissions from all facilities were below Administrative Levels and regulatory Action Levels. In 2021, Building 200 no longer contributed to air emissions. The average values of the previous five years shows that Building 200 had contributed 16 percent of the total alpha air emissions and 8 percent of the total beta air emissions.

Tritium emissions from the WR-1 stack were higher than in 2020 and slightly less than the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative level (1.52E+10 Bq/week) for the facility and well below the Action Level (7.62E+10 Bq/week) and DRL (1.65E+15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence.

Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Building 100, and work in the Shielded Facilities and Concrete Canister Storage Facility. Outdoor Workplace Air Sampler monitoring was performed for Building 200 demolition. Environmental airborne dust monitoring was performed close to the east, north,

west and south boundaries of the WL campus during building demolitions. The results of the 2021 dust monitoring are described in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

Table 23: Radionuclides in Air Effluents from WL Facilities – 2016 to 2021

Location/Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2016 (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	2019 (Bq/wk)	2020 (Bq/wk)	Five-Year Average		2021		2021 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building													
Gross Alpha[b]	1.73E+09	1.71E+04	4.16E+02	3.82E+02	2.65E+02	2.89E+02	3.07E+02	3.32E+02	1.92E-05	4.16E+02	2.40E-05	1.29E+03	7.45E-05
Gross Beta[b]	6.79E+09	1.68E+05	1.91E+03	1.83E+03	1.07E+03	1.95E+03	1.62E+03	1.67E+03	2.47E-05	2.34E+03	3.45E-05	7.36E+03	1.08E-04
Tritium	1.65E+15	7.62E+10	6.24E+08	9.68E+08	2.51E+08	6.43E+08	2.51E+08	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
ALWTC													
Gross Alpha	1.73E+09	1.00E+04	2.25E+02	2.37E+02	3.13E+02	3.12E+02	3.80E+02	2.93E+02	1.70E-05	N/A	N/A	N/A	N/A
Gross Beta	6.79E+09	2.02E+04	2.33E+02	2.92E+02	3.24E+02	4.54E+02	4.59E+02	3.52E+02	5.19E-06	N/A	N/A	N/A	N/A
HCF													
Gross Alpha	1.73E+09	1.58E+04	6.00E+02	6.00E+02	6.00E+02	6.10E+02	6.00E+02	6.02E+02	3.48E-05	6.19E+02	3.58E-05	1.59E+03	9.18E-05
Gross Beta	6.79E+09	6.82E+04	1.05E+03	1.15E+03	1.04E+03	2.05E+03	8.43E+02	1.23E+03	1.81E-05	1.07E+03	1.58E-05	1.29E+04	1.91E-04
IFTF													
Gross Alpha	1.73E+09	1.48E+04	5.78E+02	5.78E+02	5.78E+02	5.78E+02	6.37E+02	5.90E+02	3.41E-05	5.78E+02	3.34E-05	5.78E+02	3.34E-05
Gross Beta	6.79E+09	3.76E+05	8.92E+02	1.04E+03	8.41E+02	1.84E+03	1.18E+03	1.16E+03	1.70E-05	1.08E+03	1.58E-05	2.22E+03	3.26E-05
Total Tritium (as %DRL)			3.78E-05	5.87E-05	1.52E-05	3.90E-05	1.52E-05	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
Total Alpha (as %DRL)			1.05E-04	1.04E-04	1.02E-04	1.03E-04	1.11E-04	1.82E+03	1.05E-04	1.61E+03	9.32E-05	3.46E+03	2.00E-04
Total Beta (as %DRL)			5.90E-05	6.23E-05	4.73E-05	9.21E-05	6.04E-05	4.41E+03	6.50E-05	4.49E+03	6.61E-05	2.25E+04	3.32E-04
Total (%DRL)			**2.02E-04**	**2.25E-04**	**1.64E-04**	**2.33E-04**	**1.87E-04**	**2.03E-04**		**1.91E-04**		**5.99E-04**	

a The DRL's shown are for members of the public at the WL boundary as described in reference [30].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A – Not applicable

9.4.1.3 Liquid Effluent Monitoring

9.4.1.3.1 Monitoring Points, Schedules and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the Outfall, the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the process water outflow (Outfall), which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways, around buildings through the weeping tile system, cooling water used in process and experimental facilities, and discharges from the Low Level Liquid Waste treatment systems tanks based in Building 100 and Building 300. The ALWTC was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 24.

Table 24: Radiological Liquid Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	**Frequency**	**Method**	**Beta Screen**	**Gross Beta**	**Gross Alpha**	**Tritium**	**Gamma Spec (liquid)**	**Gamma Spec (ash)**	**Sr-90 (ash)**	**U-238 Pu-239/240 Pu-238**	**C-14**
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wc	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, up to twice a year for the Lagoon.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2021 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2021 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers in 2018, which reduced the contribution from the washing of footwear. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is now directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4 L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 32 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (Am-241, Cs-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for Pu-239/240, Pu-238 and Pu-241 isotopic analyses. Monitoring for Carbon (C-14) and tritium in Outfall samples was initiated in 2020 because they are known to exist in WR-1, and decommissioning activities have a potential for releasing these isotopes. The activities of tritium and C-14 at the Outfall continued to be below the lower limits of detection.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. The minimum residence time for the lagoon is equal to the amount of time the secondary cell is isolated from the primary cell, to allow for biodegradation and settling. This is typically around 45 days. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail later). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon’s north side. In 2021, the lagoon was not discharged at all because there was enough freeboard that a discharge was not necessary.

Whenever there is a discharge, the outflow of the Lagoon is continuously sampled during the discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium, and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at the Ditch 7 and Ditch 8 sampling locations, are also released to the Winnipeg River from the two ditches indicated in Figure 2. Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (395 mm) in 2021 was less than in 2020 (441 mm), and in 2019 (646 mm). The winter of 2021 was very dry. The spring precipitation was normal, but the early summer was unusually dry. Normal amounts of precipitation were observed for August, October and November. Due to the low

precipitation, ditches were only sampled six times during March, April, May and June. The August and October precipitation was captured by the dry ground and there was no moving water in the ditches to be sampled any time after June.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[7]. The samples are analyzed for gross alpha, gross beta, gamma spec and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are submitted for radio strontium analysis. Uranium activities are calculated from uranium concentrations obtained from total metals analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [30]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cs-137 for beta activity and Pu-239 and Pu-240 for alpha activity. With the introduction of total uranium (U) and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

9.4.1.3.2 Monitoring Results

The liquid emission results[8] are summarized in Table 26 and Figure 3 for the years 2016 to 2021. Average monthly emissions, in Becquerels, are shown for gross alpha, gross beta, total U (including U-234, U-235, and U-238), Am-241, Sr-90 and Cs-137 for the releases from the Outfall and the Lagoon. The monitoring of tritium from the Outfall began in 2019. In addition, quarterly activities of Pu-239/240 and Pu-238 were reported for Outfall effluents. A plot of the monthly Cs-137 and Sr 90 releases as Bq from the Outfall in 2021 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of Sr-90 and Cs-137 from the tanks in 2021 were 1.13E+06 Bq and 4.01E+06 Bq, respectively. These releases were only a fraction of the total Sr-90 (2.6E+07 Bq) and Cs-137 (1.3E+07 Bq) releases from the Outfall. There was little correlation between the patterns of

7 The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

8 As mentioned in Section 9.2, not all of the radiological results for 2021 have been received from the contract laboratories due to a number of issues, solely impacting the Outfall results for 2021 October through December. Once received, this document will be revised and reissued. The red font text in this section indicates text that will or may need to be updated.

releases from the tanks with the pattern of releases from the Outfall because the tank releases were only a small fraction of the total releases. The additional Sr-90 and Cs-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical site contamination events and historical radioactivity disposition in the storm drain line from Building 200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970's, although more likely from the Building 200 drain line. The high Sr-90 and Cs-137 releases from the Outfall during April, May and August correlate with higher rainfall during these months. The periods of high precipitation are believed to flush contamination into the Outfall from storm drains and previously contaminated process piping.

Note, all monthly releases from the Outfall were well below the administrative release level[9]. Releases of gross alpha were less than the 2020 releases and the five year average. Gross beta releases in 2021 were also less than the 2020 releases and the five year average. Sr-90 releases in 2021 were lower than in 2020 and the five year average. The Cs-137 releases were similar to 2020 releases and below the five year averages. Am-241 releases were greater than 2020 releases. The total uranium releases were slightly lower than in 2020. The relatively constant emissions of gross alpha, gross beta, Sr-90 and Cs-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Pu-239/240 and Pu-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.27). In 2021, Outfall water was also analyzed for the presence of C-14, which could be introduced by the discharge tanks from Building 100. C-14 was below detection levels (varying from 0.99 to 1.26 Bq/L) in Outfall samples. Given that the DRL for C-14 is 1.06E+08 Bq/month, the detection limit of 1.26 Bq/L would correspond to a %DRL value of 0.18. Measurements of C-14 in site intake water from Building 902 were also below detection values.

[9] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the ALARA process.

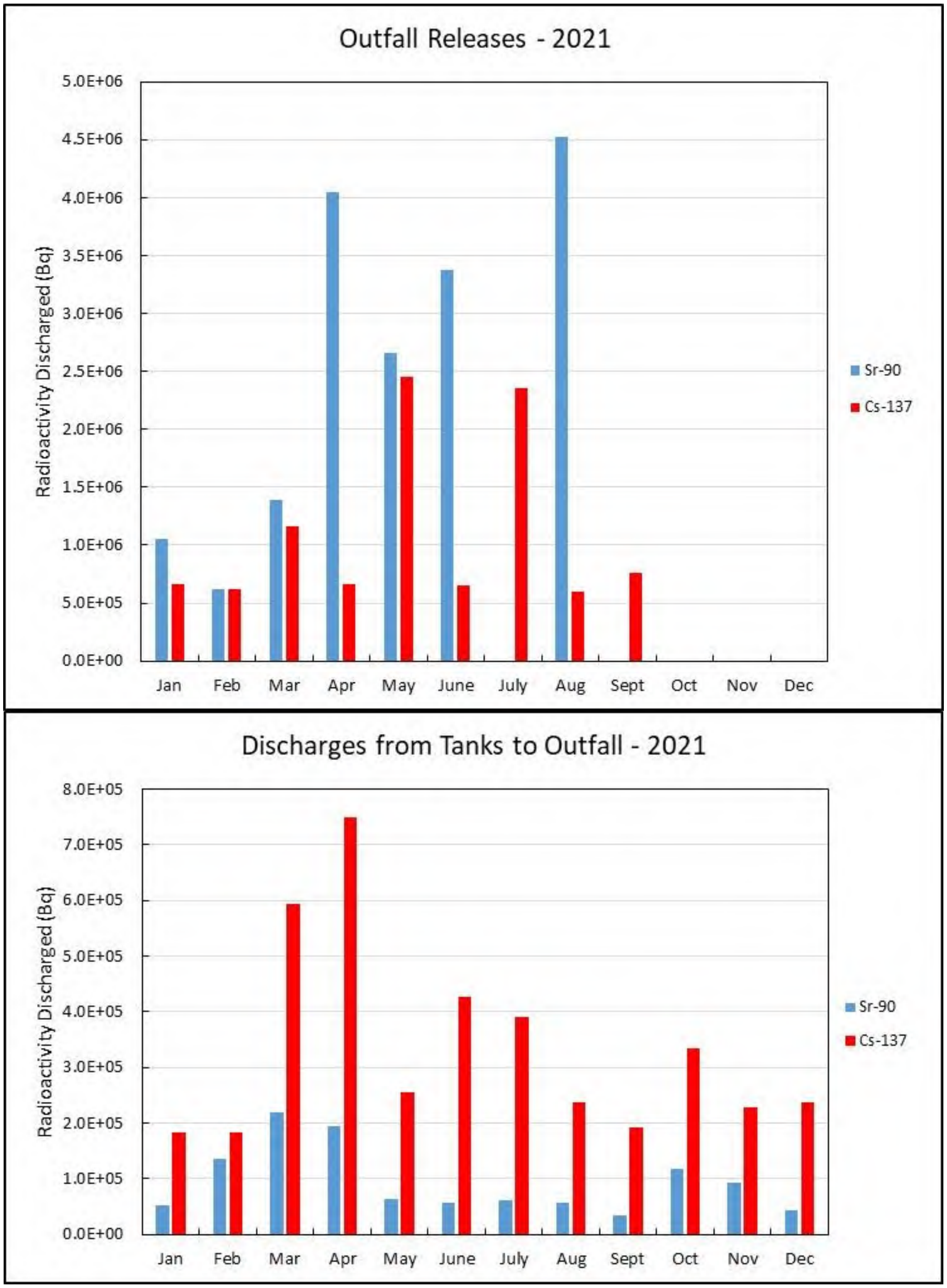


Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2021

As stated above there were no Lagoon discharges in 2021 and so there are no results to report. In 2021 the lagoons did not contribute to the total liquid discharges from the site.

The averaged results for the two drainage ditches and control sample are shown in Table 25. The reported errors are the standard deviations of parameter values indicating their variability between different sampling events.

Table 25: Annual mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2016 to 2021

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Five-Year Average**	**2021[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.12	0.14	0.52	0.19	0.12	0.22	0.13 ± 0.04
Gross Alpha	0.50	0.07	0.17	0.11	0.18	0.15	0.10	0.14	0.05 ± 0.02
Tritium	7 000	3	4.4	4.8	5.3	5.5	4.3	4.9	4.6 ± 0.5
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.09	0.13	0.32	0.20	0.11	0.17	0.24 ± 0.34
Gross Alpha	0.50	0.07	0.09	0.09	0.16	0.20	0.06	0.12	0.07 ± 0.03
Tritium	7 000	3.00	17.4	21.1	9	10	6.5	13	4.7 ± 0.4
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.10	0.15	0.14	0.19	0.11	0.14	0.17 ± 0.13
Gross Alpha	0.50	0.07	0.11	0.10	0.22	0.114	0.07	0.12	0.05 ± 0.01
Tritium	7 000	4	4.8	4.67	<4	<4	4.7	4.4	4.4 ± 0.4

a Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. LLD is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.
b LLD = Lower Limit of Detection.
c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2021, the gross beta activities in Ditches 8 and 9 were higher than in 2020. The 2021 gross alpha activities were lower in Ditch 8 and slightly higher in Ditch 9 compared to 2020. The average gross beta values were similar to the control sample collected off of Highway 211, given the variability in their values. The gross alpha values were similar to the control ditch. The control sample is unaffected by CNL's operations. Compliance with the *Guidelines for Canadian Drinking Water Quality* [34] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [35] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring

uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amount measured in drainage Ditch 8 (4.6±0.5 Bq/L) and Ditch 9 (4.7±0.4 Bq/L) were not significantly different from that noted at the control location (4.4±0.9 Bq/L). A number of ditches close to WMA are known to contain tritium. In 2021, the amount of tritium reaching the Ditch 8 and 9 locations was not significant. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [34].

Table 26 summarizes the data for releases of liquid effluents[10] for the years 2016 to 2021. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2021 was 0.49% of the DRL, which is lower than 2020 and the five-year average (0.51%). The main reason for the higher 2019, 2020 and 2021 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release from the Outfall in 2021 was Pu-239/240 at 0.29% of the DRL. There were no lagoon discharges in 2021.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

[10] The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [34] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 26: Radionuclides in Liquid Effluents from WL – 2016 to 2021

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2016 (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	2019 (Bq/mo)	2020 (Bq/mo)	Five-Year Average		2021		2021 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.43E+08	2.43E+06	2.20E+06	2.86E+06	4.23E+06	3.99E+06	3.14E+06	2.71E-01	2.77E+06	-	5.31E+06	-
Uranium-total	1.25E+10	N/A	N/A	1.24E+06	9.13E+05	1.05E+06	9.65E+05	N/A		9.28E+05	7.42E-03	1.26E+06	1.01E-02
Plutonium-239/240	1.11E+09	N/A	N/A	5.76E+05	1.89E+06	3.19E+06	2.32E+06	N/A		1.86E+06	1.67E-01	2.98E+06	2.68E-01
Plutonium-238	1.16E+09	N/A	N/A	7.24E+05	1.53E+06	4.05E+06	1.99E+06	N/A		1.86E+06	1.61E-01	2.54E+06	2.19E-01
Americium-241	1.04E+09	N/A	N/A	1.49E+05	1.07E+05	1.06E+06	9.76E+05	N/A		1.16E+06	1.12E-01	3.66E+06	3.52E-01
Gross Beta[b]	-	5.00E+08	1.43E+07	2.06E+07	1.36E+07	2.06E+07	1.98E+07	1.78E+07	-	1.48E+07	-	2.44E+07	-
Strontium-90	1.30E+10	N/A	2.50E+06	4.83E+06	2.39E+06	3.11E+06	2.41E+06	3.05E+06	2.35E-02	1.96E+06	1.51E-02	4.53E+06	3.48E-02
Cesium-137	1.16E+10	N/A	1.31E+06	1.51E+06	1.26E+06	1.14E+06	1.03E+06	1.25E+06	1.08E-02	1.09E+06	9.36E-03	2.45E+06	2.11E-02
Tritium	6.80E+13					3.76E+08	4.09E+08	N/A		3.48E+08	5.64E-04	7.05E+08	1.04E-03
LAGOON													
Gross Alpha[a]	1.11E+09	5.84E+07	7.22E+05	1.03E+06	3.92E+05	6.17E+05	1.57E+06	8.65E+05	7.46E-02	N/A		N/A	
Uranium-total	1.25E+10	N/A	N/A	1.66E+05	5.49E+04	1.92E+05	1.19E+05	NA		N/A		N/A	
Americium-241	1.04E+09	N/A	N/A	2.76E+05	2.44E+05	6.17E+05	5.22E+05	NA		N/A		N/A	
Pu-239/240[a]	1.11E+09	N/A	N/A	4.22E+05	4.52E+04	7.28E+05	9.67E+05	NA		N/A		N/A	
Gross Beta	-	1.50E+08	5.76E+06	4.14E+06	2.53E+06	8.00E+06	1.04E+07	6.17E+06	-	N/A		N/A	
Strontium-90	1.30E+10	N/A	1.16E+06	7.26E+05	2.82E+05	1.85E+06	2.35E+06	1.27E+06	9.79E-03	N/A		N/A	
Cesium-137	1.16E+10	N/A	5.05E+04	6.43E+04	2.44E+02	6.17E+05	5.22E+05	2.51E+05	2.16E-03	N/A		N/A	
TOTAL as %DRL	**-**	**-**	**3.24E-01**	**2.61E-01**	**3.79E-01**	**9.27E-01**	**6.71E-01**		**5.10E-01**		**4.72E-01**		**9.06E-01**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 and Cs-137 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 27: Effluents Monitoring Equipment Unavailability – 2021

	Unavailability Criteria[a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. In Building 100 there was one instance when the stack pump went down for a long weekend, resulting in 112.5 hours of unplanned loss of air monitoring. In the Shielded Facilities there were three instances of planned loss of monitoring because class III power was shut down for electrical equipment inspections. The total planned loss of monitoring, affecting the Hot Cells and IFTF was 6.5 hours. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities, this amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. There was one instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability was calculated as per procedure. In each instance, an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 23 and Table 26 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2016 to 2021. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2021 were below CNL's Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [30]. All air emissions were below CNL's Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2021 continue to be very low, averaging 0.00019% of the DRL, which is similar to 2020 and lower than in 2019.

Radioactivity in the WL liquid releases for 2021 was 0.47% of the DRL which is lower than in 2020 (0.67%) and the last five-year average (0.51%). The main reason for the higher 2019 to 2020 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Pu-239/240, at detection limit values, was the primary contributor to the Outfall, averaging 0.17% of the DRL. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2021 release results, as well as the previous years' trends, indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement on hazardous substances monitoring of liquid and airborne effluents for the WL site for 2021. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [28].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedule, and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Sewage Lagoon (referred to as the Lagoon) at point of discharge to the Lagoon drainage ditch, the Process Outfall (referred to as the Outfall), the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low-Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are used as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial Highway 211. More details for each monitoring area are provided in the sections that follow.

Referring to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 28 lists the non-radiological parameters monitored at the inlet and effluent streams sampled, and the sampling schedule that is followed. The WL monitoring program follows the

protocols from the Ontario Ministry of Environment [36] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups. These are described in Table 29, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment (SRI). The LMDL and SRI were decided following protocol. The WL monitoring program also meets the requirements set out in the Federal Wastewater Systems Effluent Regulations [37], and the standards from CSA N288.5-11, *Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [20].

Table 28: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS Tanks	
						Building 300-LLLWTS	Building 100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	Quarterly [c]	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
5b	Total Organic Carbon	Monthly	-	Discharge	-	-	-
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9a	Magnesium	Monthly	-	Discharge	-	-	-
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
-	Potassium	Monthly	-	Discharge	-	-	-
9	Strontium	Monthly	-	Discharge	-	-	-
9a	Uranium	Monthly	-	Discharge	-	-	-
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
16	Bromodichloromethane	Monthly	-	Discharge	-	-	-
16	Chloroform	Monthly	-	Discharge	-	-	-
17	Toluene	Monthly	-	Discharge	-	-	-
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.

b The Monthly = grab sample taken once within each month.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

In 2021, there was no discharging of the Lagoon.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were six events in 2021.

Whenever a tank was discharged at either of the Low Level Liquid Waste Treatment System's (LLLWTS), the effluent was sampled.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [36]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system supplies a justifiable set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into Analytical Test Groups, listed in Table 29. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses, and result reporting.

Table 29: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.001
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.050
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
5b	Total Organic Carbon	High Temperature Combustion	mg/L	-	-	-	0.5
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9a	Magnesium	ICP	mg/L	--	--	--	0.05
9	Nickel	ICP	mg/L	0.02	--	--	0.001
-	Potassium	ICP	mg/L	--	--	--	0.05
9	Strontium	ICP	mg/L	--	--	--	0.001
9a	Uranium	ICP	mg/L	--	--	--	0.0001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0019
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
16	Bromodichloromethane	GC-MS	mg/L	--	--	--	0.0005
16	Chloroform	GC-MS	mg/L	--	--	--	0.0005
17	Toluene	GC-MS	mg/L	--	--	--	0.0004
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.

b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a common estimate of bacterial counts, especially for sewage effluent.

c RMDL = Regulation Method Detection Limit

d The LMDL = Laboratory Method Detection Limit (“MDL” also used).

e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is found for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results because of equipment failure, maintenance/calibration outages or operator action requiring “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. There were no instances of non-radiological air monitoring unavailability. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities. This amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. One instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2021. These include an averages summary table and a comparison against the CNL’s Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2021 are presented in Table 30 through Table 34. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [36]. The next three give the CNL monthly guideline concentration, LMDL (Table 29) and units for each measurement. The next six columns provide comparison of the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven

columns have a summary of the results for the 2021 monitoring period (explained further below).

WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 29.

Within the 2021 results section, the number of samples included in the average ("# Spl.") is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled "ND's") gives the number of samples in which the analyte was not detected and was therefore deemed a "zero" result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables found at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number allows some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 31 through Table 34, yearly average values for parameters marked with an asterisk show that a monthly guideline was exceeded for at least one month during the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected in Table 36, and compared to the previous five years).

Table 30: Averages Summary for Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2021							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)
3	pH	6 to 9	N/A	pH	7.03	7.42	7.41	7.43	7.17	7.29	12	0	6.73	8.11	7.66	5.84	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	9.0	9.0	12	0	6.9	9.7	8.4	10.1	25000
6	Phosphorus	1.0	0.003	mg/L	0.040	0.026	0.020	0.017	0.014	0.023	12	0	0.010	0.019	0.014	21.4	46
7	Conductivity	N/A	2.0	µS/cm	104	93.0	107	107	98	102	12	0	97	110	101	4.26	N/A
8	TSS	25	1.0	mg/L	2.63	3.03	2.05	3.15	3.80	2.93	12	4	0	6.1	2.23	94.7	6205
9	Chromium	0.5	0.001	mg/L	0.0002	0	0.0001	0.0005	0.0006	0.0003	12	11	0	0.0062	0.0005	346	0.53
9	Copper	0.5	0.0005	mg/L	0.007	0.004	0.005	0.007	0.007	0.006	12	0	0.004	0.013	0.007	39.9	19
9a	Iron	1.0	0.01	mg/L	0.32	0.310	0.233	0.331	0.242	0.287	12	0	0.159	0.354	0.247	27.0	805
9	Lead	0.1	0.0002	mg/L	0.001	0.0002	0.0001	0.0001	0.0001	0.0003	12	5	0	0.0003	0.0001	89.2	0.65
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	3.62	3.62	12	0	3.34	4.13	3.70	47.7	11840
9	Nickel	0.5	0.001	mg/L	0.0008	0	0	0.0001	0.0002	0.0002	12	10	0	0.0272	0.0025	318	2.72
9	Potassium [f]	-	0.05	mg/L	-	-	-	-	0.823	0.823	12	0	0.735	0.859	0.810	5.27	2564
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	2.23	2.23	12	0	2.00	3.68	2.38	18.52	8190
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.023	0.023	12	0	0.022	0.025	0.024	3.81	75
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0000	0	12	8	0	0.0001	0.0000	148	0.10
9	Zinc	0.5	0.005	mg/L	0.0023	0	0	0	0.0022	0.0009	12	11	0	0.0072	0.0006	318	1.26
12	Mercury	1.0	0.002	µg/L	0.0016	0	0.0002	0	0.0016	0.0007	12	12	0	0	0	N/A	0
14	Phenolics	0.02	0.001	mg/L	0.0014	0.0017	0.0002	0.0007	0	0.0008	12	12	0	0	0	N/A	0
16	Bromodichloromethane [f]	-	0.0005	mg/L	-	-	-	-	0.0015	0.0015	12	3	0	0.0028	0.0017	68.79	4.33
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.068	0.068	12	0	0.001	0.120	0.053	75.71	139
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	12	12	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	0.4	0.1	0.1	0	0	0.1	12	12	0	0	0	N/A	0

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						**Results for Year 2021**							
ATG	**Parameter**	**Monthly Guide[b]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.[a]**	**RSTD (%)[e]**	**Load (kg)**
--	Estimated Flow (total volume for year)			m^3	1.30E+06	1.21E+06	1.18E+06	1.01E+06	1.12E+06	1.16E+06	3.14E+06						

a Averages were calculated by setting to zero results reported as “< DL”.

b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A not applicable

Table 31: Averages Summary for Lagoon

					Monitoring Point: Lagoon													
					Averages from Previous Five Years						Results for Year 2021							
ATG	Parameter	Monthly Guide[a]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[b]	NDs[c]	Min.	Max.	Vol. Wt. Avg.	RSTD[d] (%)	Load (kg)
-	CBOD	25	2.0	mg/L	0	2.5	17.7	0	0	4.0	0	0	0	0	0	0	N/A
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.0099	0.0100	0.0097	0.0011	0.0010	0.0063	0	0	0	0	0	0	N/A
-	Total residual Chlorine	0.02	0.05	mg/L	0.035*	0.017	0.018	0.022	0.057	0.030	0	0	0	0	0	0	N/A
--	Total Coliform	N/A	3	MPNUe/100 mL	35	534	330	200	763	372	0	0	0	0	0	0	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	5	40	5	13.5	88	30	0	0	0	0	0	0	N/A
3	pH	6 to 9	N/A	pH	7.01	8.59	8.68	6.66	7.00	7.59	0	0	0	0	0	0	N/A
6	Phosphorus	1.0	0.003	mg/L	0.083	0.069	0.131	0.049	0.075	0.081	0	0	0	0	0	0	N/A
7	Conductivity	N/A	2.0	µS/cm	279	223	229	348	446	305	0	0	0	0	0	0	N/A
8	TSS	25	1.0	mg/L	1.92	4.807	3.8	1.2	3.9	3.1	0	0	0	0	0	0	N/A
9	Chromium	0.5	0.001	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0016	0.0021	0.0015	0.0007	0	0.0012	0	0	0	0	0	0	N/A
9a	Iron	1.0	0.01	mg/L	0.245	0.283	0.370	0.119	0.116	0.227	0	0	0	0	0	0	N/A
9	Lead	0.1	0.0002	mg/L	0	0.0001	0	0	0	0	0	0	0	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.0005	0.0015	0.0015	0.0011	0	0.0009	0	0	0	0	0	0	N/A
9	Zinc	0.5	0.005	mg/L	0.0003	0	0	0	0	0	0	0	0	0	0	0	N/A
12	Mercury	1.0	0.002	µg/L	0.0006	0	0	0	0	0.0001	0	0	0	0	0	0	N/A
4	Phenolics	0.02	0.001	mg/L	0.0015	0.0017	0.0033	0	0	0.0013	0	0	0	0	0	0	N/A
25	Oil & Grease	15	1.0	mg/L	0.45	0.78	0.856	0	0	0.4172	0	0	0	0	0	0	N/A
--	Estimated Flow (total volume for year)[f]			m^3	7.46E+04	4.72E+04	1.22E+04	3.83E+04	3.08E+04	4.06E+04	0						
--	Number of Batches Discharged			--	2	2	2	1	1	2	0						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

d RSTD = Relative Standard Deviation

e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.

f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: There were no discharges in 2021 of the Lagoon.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A = not applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 32: Averages Summary for Outfall

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.50	7.81	7.76	7.67	7.50	7.65	52	0	6.79	8.30	7.66	4.67	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	13.4	13.4	51	0	7.4	21.0	10.2	31.5	12230
6	Phosphorus	1.0	0.003	mg/L	0.040	0.035	0.030	0.022	0.021	0.030	52	1	0	0.074	0.022	57.5	25.9
7	Conductivity	N/A	2.0	µS/cm	130	139	131	164	134	140	52	0	110	790	149	63.0	N/A
8	TSS	25	1.0	mg/L	2.35	2.97	1.5	4.2	5.4	3.3	52	3	0	18	5.3	74.6	6630
9	Chromium	0.5	0.001	mg/L	0.0001	0	0.0001	0.0006	0.0005	0.0003	52	43	0	0.0062	0.0003	307	0.035
9	Copper	0.5	0.0005	mg/L	0.006	0.006	0.005	0.005	0.010	0.006	52	0	0.002	0.016	0.007	67.6	8.44
9a	Iron	1.0	0.01	mg/L	0.316	0.262	0.186	0.218	0.302	0.257	52	0	0.107	1.300	0.271	65.7	322
9	Lead	0.1	0.0002	mg/L	0.0004	0.0003	0.0002	0.0002	0.0004	0.0003	52	17	0	0.0015	0.0003	102	0.303
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	5.46	5.46	52	0	3.82	8.05	5.18	16.4	6118
9	Nickel	0.5	0.001	mg/L	0.0009	0.0020	0.0006	0.0005	0.0007	0.0009	52	25	0	0.0273	0.0017	322	1.49
-	Potassium [f]	-	0.05	mg/L	-	-	-	-	1.111	1.11	52	0	0.85	2.25	1.10	25.7	1302
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	4.40	4.40	52	0	2.68	21.3	4.34	71.9	5086
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.033	0.033	52	0	0.026	0.044	0.034	10.5	39.3
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0004	0.0004	52	0	0.0002	0.0007	0.0004	27.0	0.461
9	Zinc	0.5	0.005	mg/L	0.003	0.001	0.001	0.004	0.006	0.003	52	15	0	0.026	0.006	84.3	7.88
12	Mercury	1.0	0.002	µg/L	0.001	0	0.0006	0.0009	0.0002	0.0005	52	47	0	0.0033	0.0003	314	0.0003
14	Phenolics	0.02	0.001	mg/L	0.0017	0.004	0.0001	0.0003	0.0000	0.0012	52	52	0	0	0	N/A	0
16	Bromodichloro methane [f]	-	0.0005	mg/L	-	-	-	-	0.0005	0.0005	52	52	0	0	0	N/A	0
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.0259	0.0259	52	9	0	0.019	0.0072	78.3	8.82
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	52	52	0	0	0	N/A	0

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	Parameter	Monthly Guide [b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.	RSTD[e] (%)	Load (kg)
25	Oil & Grease	15	1.0	mg/L	0.82	0.19	0.10	0.02	0	0.226	52	50	0	6.80	0.15	627	188
--	Estimated Flow (total volume for year)			m^3	1.41E+06	1.13E+06	1.16E+06	1.25E+06	1.21E+06	1.23E+06	1.15E+06						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A = Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Note: There were no monthly guideline exceeds for any monitored parameter.

Table 33: Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.50	7.88	7.81	7.73	7.64	7.71	5	0	7.5	8.00	7.81	2.39
6	Phosphorus	1.0	0.003	mg/L	0.049	0.071	0.045	0.043	0.135	0.069	5	0	0.031	0.059	0.041	27.2
7	Conductivity	N/A	2.0	µS/cm	571	445	690	586	451	549	5	0	330	700	454	33.4
8	TSS	25	1.0	mg/L	2.3	1.4	1.65	1.92	3.4	2.1	5	2	0	3.0	1.26	103
9	Chromium	0.5	0.001	mg/L	0.0004	0	0	0.0005	0.0002	0.0002	5	5	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.002	0.0015	0.0015	0.0013	0.0010	0.0015	5	0	0.0008	0.0019	0.0014	29.1
9a	Iron	1.0	0.01	mg/L	0.208	0.192	0.083	0.147	0.205	0.167	5	0	0.089	0.274	0.141	54.5
9	Lead	0.1	0.0002	mg/L	0.0002	0	0	0	0	0	5	5	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.005	0.004	0.003	0.003	0.003	0.004	5	0	0.002	0.004	0.003	25.8
9	Zinc	0.5	0.005	mg/L	0.004	0.002	0.001	0.001	0.001	0.002	5	1	0	0.006	0.004	58.4
12	Mercury	1.0	0.002	µg/L	0.0055	0	0.0020	0.0009	0.0014	0.0020	5	0	0.0029	0.0044	0.0037	18.0
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0070	0.0002	0.0006	0.0008	0.0022	5	4	0	0.0011	0.0002	223
25	Oil & Grease	15	1.0	mg/L	0.85	0.4	0.13	0.17	0.08	0.33	5	5	0	0	0	N/A

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					Monitoring Point: DITCH 9 (Westbound)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**#Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.05	7.67	7.69	7.58	7.32	7.46	6	0	7.23	8.08	7.57	22.0
6	Phosphorus	1.0	0.003	mg/L	0.053	0.045	0.042	0.004	0.039	0.037	6	1	0	0.440	0.097	174
7	Conductivity	N/A	2.0	µS/cm	193	214	538	400	224	314	6	0	200	600	300	50.3
8	TSS	25	1.0	mg/L	2.4	2.1	2.1	2.7	3.3	2.5	6	1	0	4.9	2.3	73.98
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0005	0.0004	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0008	0.0013	0.0021	0.0018	0.0018	0.0016	6	0	0.0014	0.0029	0.0019	29.8
9a	Iron	1.0	0.01	mg/L	0.575	0.326	0.315	0.250	0.558	0.405	6	0	0.251	0.710	0.382	44.1
9	Lead	0.1	0.0002	mg/L	0	0	0	0	0.0000	0.0000	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.003	0.003	0.004	0.003	6	0	0.002	0.006	0.003	95.8
9	Zinc	0.5	0.005	mg/L	0.006	0.002	0.004	0.003	0.006	0.004	6	0	0.004	0.061	0.015	153
12	Mercury	1.0	0.002	µg/L	0.0087	0	0.0021	0.0016	0.005	0.0035	6	0	0.0029	0.0410	0.0109	136
14	Phenolics	0.02	0.001	mg/L	0.0021	0.0086	0	0.0005	0.0002	0.0023	6	5	0	0.0011	0.0002	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0	0	0.1	0.24	6	5	0	1	0.2	245

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					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.22	7.76	7.83	7.72	7.54	7.61	6	0	7.27	8.07	7.76	4.02
6	Phosphorus	1.0	0.003	mg/L	0.148	0.083	0.065	0.104	0.071	0.094	6	0	0.03	0.14	0.06	65.8
7	Conductivity	N/A	2.0	µS/cm	347	380	939	579	385	526	6	0	280	550	415	26.0
8	TSS	25	1.0	mg/L	3.28	6.2	2.9	7.0	3.1	4.5	6	0	1.4	20	5.63	128
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0008	0.0001	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0005	0.0010	0.0015	0.0018	0.0009	0.0011	6	0	0.0009	0.0017	0.0013	21.3
9a	Iron	1.0	0.01	mg/L	0.714	0.594	0.674	0.762	0.464	0.642	6	0	0.357	0.769	0.509	37.9
9	Lead	0.1	0.0002	mg/L	0.0005	0.0002	0	0.0002	0.0000	0.0002	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.005	0.003	0.002	0.003	6	0	0.002	0.003	0.002	19.5
9	Zinc	0.5	0.005	mg/L	0.003	0	0.013	0.011	0.001	0.006	6	2	0	0.014	0.004	117
12	Mercury	1.0	0.002	µg/L	0.0127	0	0.0004	0.0007	0.0008	0.0029	6	0	0.0022	0.0040	0.0031	25.11
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0074	0.0001	0.0007	0.0006	0.0022	6	5	0	0.0022	0.0004	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0.3	0	0.01	0.28	6	6	0	0	0	N/A

a All results below the LMDL, originally flagged as “< DL” when reported, are only estimates.

b Averages were calculated by setting to zero results reported as “< W.”

c Monthly Guide is from CNL’s limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = “< W,” result = 0).

f RSTD = Relative Standard Deviation

N/A = not applicable

Table 34: Averages Summary for the Low-Level Liquid Waste Treatment Systems

					Monitoring Point: Building 100 & 300 LLLW Treatment Systems [a]												
					Averages from Previous Five Years[b]						**Results for Year 2021**						
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.50	7.52	7.39	7.54	7.69	7.53	33	0	2.58	8.01	7.55	12.5	N/A
6	Phosphorus	1.0	0.003	mg/L	0.145	0.370	0.327	0.554	0.503	0.380	33	0	0.011	2.00	0.810*	64.9	0.0719
7	Conductivity	N/A	2.0	µS/cm	326	267	348.84	352	473	353	33	0	240	1800	527	57.4	N/A
8	TSS	25	1.0	mg/L	4.38	14.67*	16.28*	8.25	15.0*	11.7	33	0	1.50	24.0	10.2	65.7	0.8968
9	Chromium	0.5	0.001	mg/L	0.0016	0.0007	0.0006	0.0009	0.0011	0.0010	33	25	0	0.0250	0.0021	255	0.0001
9	Copper	0.5	0.0005	mg/L	0.128	0.509*	0.516*	0.512	0.423*	0.418	33	0	0.011	1.660	0.333*	102	0.0296
9a	Iron	1.0	0.01	mg/L	9.37*	3.39*	1.660*	0.465	1.77*	3.33	33	0	0.42	6.05	1.57*	81.7	0.1379
9	Lead	0.1	0.0002	mg/L	0.006	0.014	0.0112	0.0057	0.0047	0.0083	33	0	0.0008	0.2020	0.0143	253	0.0013
9	Nickel	0.5	0.001	mg/L	0.0180	0.0066	0.0055	0.003	0.0040	0.0074	33	0	0.0037	0.0420	0.0117	85.1	0.0010
9	Zinc	0.5	0.005	mg/L	0.096	0.180	0.272	0.152	0.124	0.165	33	0	0.027	1.210	0.175*	151	0.0156
12	Mercury	1.0	0.002	µg/L	0.161	0.130	0.060	0.030	0.010	0.078	33	1	0	0.071	0.023	88.3	0.0000
14	Phenolics	0.02	0.001	mg/L	0.007	0.007	0.01*	0.005	0.005	0.007	33	7	0	0.010	0.004	82.8	0.0003
25	Oil & Grease	15	1.0	mg/L	0.60	0.73	0.88	0.59	0.70	0.70	33	30	0	2.50	0.18	326	0.0164
--	Estimated Flow (total volume for year)			m³	2.30E+02	1.72E+02	1.32E+02	1.89E+02	1.07E+02	1.66E+02	8.82E+01						
--	Number of batches discharged			--	14	24	50	68	40	39	33						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< DL."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).
f RSTD = Relative Standard Deviation
N/A = not applicable
Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

Discharges of effluent coming from the new low level liquid waste treatment systems are being combined, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. They are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 35 supplies a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2021 or at any time during the previous five years.

As with the average summary table provided, for each monitoring point, the first two columns in the table identify the Ministry of Environment ATG and parameter names. The next three columns give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns show the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

To assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 35: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2021		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	100	83	100	96.6	12	4	67
	8	TSS	25	1.0	mg/L	100	78	92	100	92	92.4	12	0	100
	9	Copper	0.5	0.0005	mg/L	100	67	33	42	58	60.0	12	2	83
	9a	Iron	1.0	0.010	mg/L	67	44	50	83	42	57.2	12	8	33
	9	Zinc	0.5	0.005	mg/L	100	100	100	100	100	100	12	1	92
	14	Phenolics	0.02	0.0010	mg/L	100	100	92	100	100	98.4	12	0	100

Notes:

- Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table.
- Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that parameter at the monitoring point. This year there were 9 months when one of four parameters (Iron, Copper, Phosphorous and Zinc from the LLLWTS had monthly values higher than CNL monthly guidelines. Figure 5 shows the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, Figure 8 and Figure 9 for each parameter, and the explanations for the observed high values can be found in Section 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is shown by a broken red line in the corresponding figures.

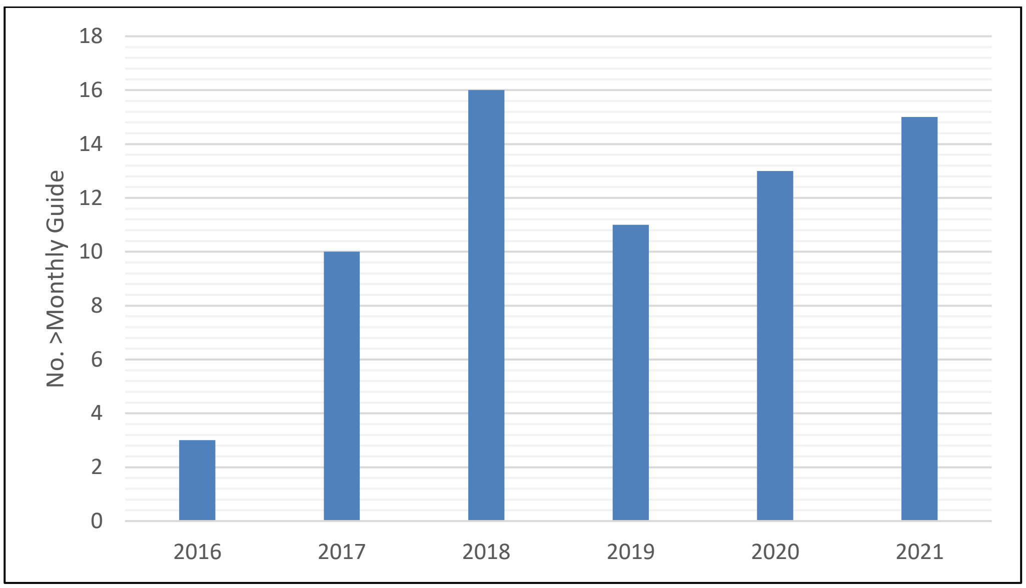

Figure 5: Non-Radiological Monitored Effluent Parameters Above Monthly Guidelines

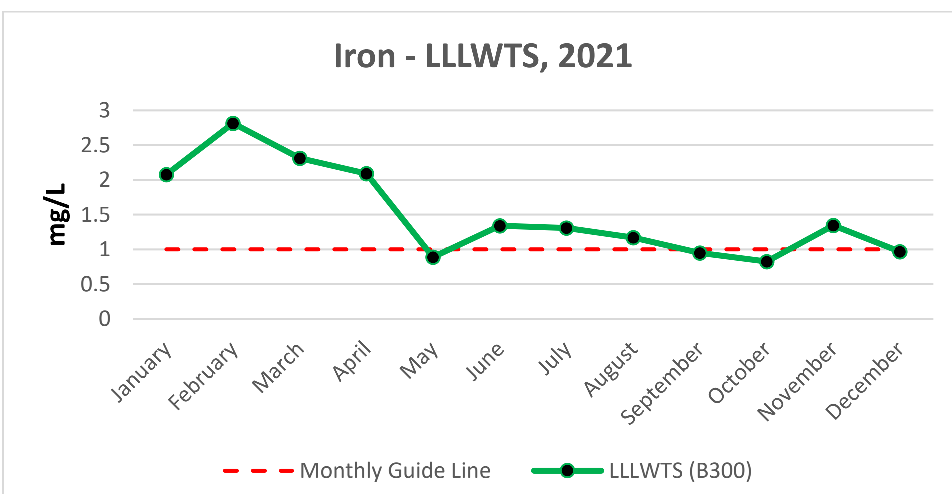

Figure 6: Monthly Average Iron Concentrations of Effluents from the Low-Level Liquid Waste

Treatment System for 2021

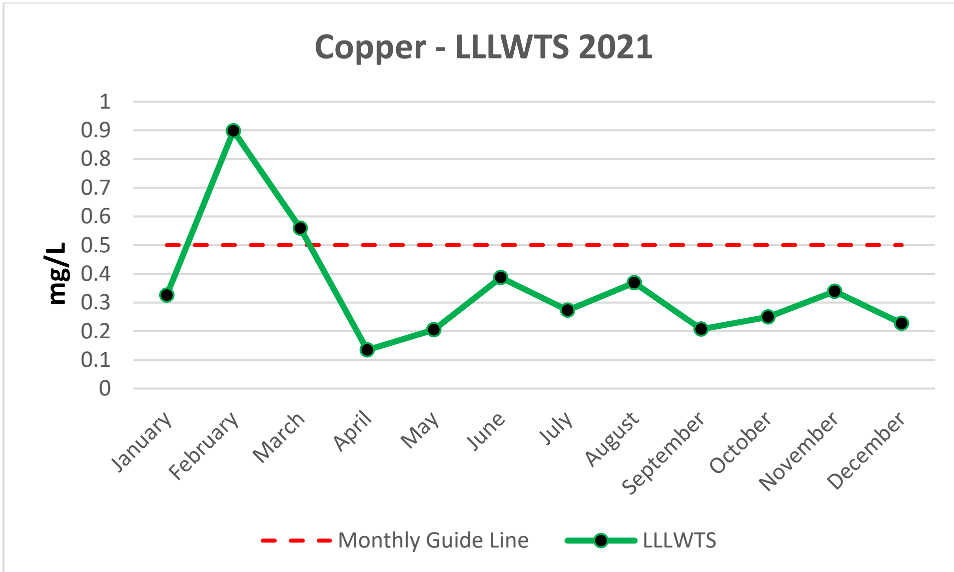

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

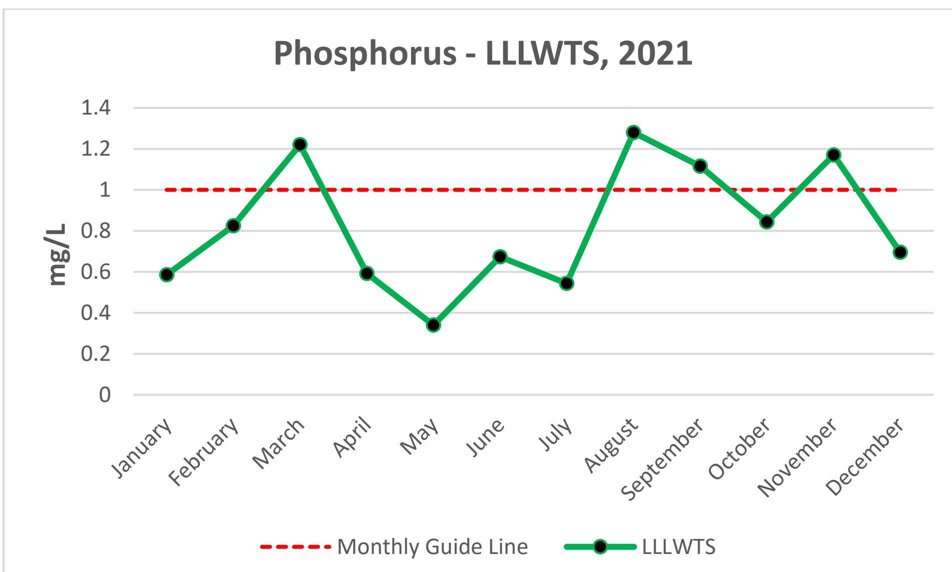

Figure 8: Monthly Average Phosphorus Concentration of Effluents from the Low-Level Liquid Waste Treatment Systems for 2021

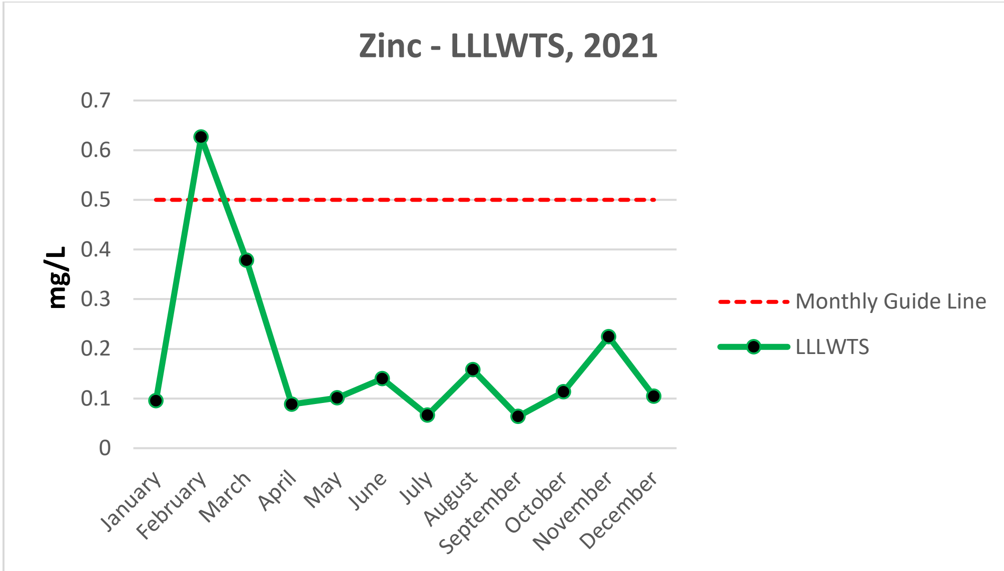

Figure 9: Monthly Average Zinc Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

9.5.1.4.4 Monitoring of Intake Water from the Winnipeg River

Except for bottled drinking water, all the water needed to run the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 30, where they are compared to available data for the previous five years. Figure 10 shows the estimated amount of water used monthly for 2021.

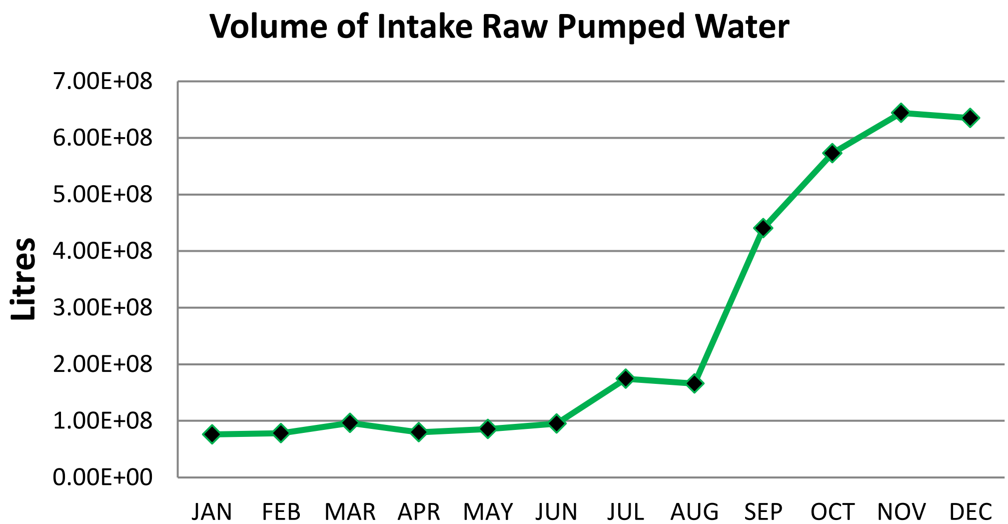

Figure 10: Monthly 2021 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2021 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 3.14E+06 m^3 of water was pumped from the river over the year.
- Compared to the five-year average, increased concentrations (> 10%) were seen for Chromium, Copper, Nickel, and Bromodichloromethane.
- Parameters that had their concentrations improve (> 10% decrease) this year compared to the average seen for the last five years are Phosphorus, TSS, Iron, Lead, Mercury, Phenolics, chloroform, and Oil & Grease.
- Water consumption for the site drastically increases during misting operations that are employed during building demolition. As these operation progress into sub-zero temperatures, a further increase is also observed, as a high flow of water is utilized to ensure the water lines do not freeze.

Intake water results can have a significant impact on the environmental performance of the WL site and they will continue to be monitored closely.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell was not discharged during 2021. With reduced personnel on site due to the COVID-19 pandemic, the occupancy of Building 540 (modular office complex) which

has its bio-waste diverted offsite, and the low level of precipitation observed in 2021, the lagoon had enough freeboard to allow the site to operate into 2022 without discharging.

The total amount of effluent discharged from the Lagoon in 2021 was 0 m^3.

If the lagoon was discharged, the Lagoon would be tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the cell occurs. During discharge, grab-samples would be collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters would be collected on a weekly basis during the discharge.

The vertical scale from which surface height is found was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

Volume (in L) = Height x [Width_Bottom x Length_Bottom
+ 0.5(Width-Width_Bottom) Length_Bottom
+ 0.5(Length-Length_Bottom) Width_Bottom
+ (1/3) (Width-Width_Bottom) (Length-Length_Bottom)]

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

$$\text{Volume (in L)} = 636\,655 * d + 206.886 * d^2 + 0.02133 * d^3 \text{ for depth "d" (in cm)}$$

The position of the Lagoon's water surface would be recorded once or twice daily while emptying. The daily flow would then be calculated from changes in the contained volume. This permits the calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in deciding meaningful average concentrations.

Discharging of the secondary cell is only allowed to proceed after initial testing. Once discharging begins, the pH is checked daily throughout the discharge period.

Table 31 summarizes the results of the fall discharge. Some notable points are:

- There was no effluent discharged from the lagoon in 2021.

9.5.1.4.5.2 Process Outfall

The Outfall monitoring station functioned as expected during 2021. The total discharge volume was 1.15 GL. This volume is lower than the previous five-year average of 1.23 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 52 samples of each parameter for the year.

Table 32 summarizes the results obtained, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were no instances of CNL's monthly guidelines being exceeded at the Outfall monitoring station.
- The only parameters that had a significant increase (> 10%) compared to the 5-year average were TSS, Copper, Nickel, and Zinc. The increased TSS loads are a reflection of the demolition activities occurring on site, while sediment controls are put in place to mitigate the impact, an increased load of sediments are entering the storm drain system. The increase in nickel and copper concentrations being observed are related to the elevated levels being observed at the intake this year. Zinc is being detected close to the detection limit, a slight increase seen in the concentrations is having a significant percentage increase being measured in the Outfall, especially since the 5-year average concentration is below the method detection limit.
- Compared to the five-year average, Phosphorus, bromodichlormethane, chloroform, Phenolics, and Oil and Grease concentration levels significantly decreased (>10%).
- Quarterly Acute Lethality Testing on the Outfall effluent was not successful in 2021, as CNL missed collecting samples for the second and third quarter of the calendar year. A corrective action plan has been developed to prevent reoccurrence.
- Acute Lethality Testing for the outfall effluent in first and fourth quarter showed no mortality on the rainbow trout tested.

Overall, there were no concerns about the effluent discharged from Outfall during 2021.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were six events from 2021 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the

flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparison is made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines this year. The measurement data are summarized in Table 33. The following are notable points for the 2021 ditches results:

- There were only six sampling events for the ditches. The sample events were also predominately influenced by the spring melt as four of the six events were related to water flows experienced during this period, in other years rain fall events made up the majority of the sampling events.
- Zinc and Mercury were the parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 8. The parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 9 were Phosphorus, Copper, Zinc, and Mercury. The control ditch had TSS and Copper being observed at significantly higher concentrations (>10%) than the previous five-year average.
- Metal concentrations detected are very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase being observed in Ditch 8 and Ditch 9.
- The five year average for phosphorus in ditch #9 was higher this year due to the reduced sampling. It is not uncommon for the spring melt to observe elevated phosphorus concentrations due to the decaying vegetation from the fall, but the phosphorus concentrations throughout the summer during rainfall events are typically lower and would drive the average down.
- All concentrations remain well below the CNL’s monthly guideline limit and pose no concern.
- All parameters measured in Ditch 8 and Ditch 9 are comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.

It should be noted that sediment control measures were put in place for projects in the WMA in 2021, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria do not include all parameters listed in CNL's non radiological guideline limit values; however, the post-discharge analysis includes all these parameters. CNL staff have

determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the earlier system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging requires a day or less to complete, and can be more gradual if needed.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to measure pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the Research and Development (R&D) Complex in Building 300 and Building 100 should still be similar enough that a comparison is worthwhile.

In 2021, 0.09 ML was discharged from the LLLWTS.

The weighted averages of the joint releases from the LLLWTS are presented in Table 34 and monthly plots for the parameters that exceed the monthly guidelines are in Figure 6, Figure 7, Figure 8, and Figure 9.

The following are notable results for 2021:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being observed at the Outfall monitoring location downstream in the process.
- There were increases (> 10%) in the annual average concentrations of Phosphorus, Chromium, Lead, Nickel, and Oil and Grease, compared to the previous five-year average results.
- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines eight times (January, February, March, April, June, July, August, and November). The overall Iron concentration seen for the year is lower than the previous 5-years. The introduction of the environmental laboratories in Building 300 at the end of 2019 increased the amount of Iron being introduced into the system (through the lab processing soil samples), as a number of the drain lines in the environmental laboratories are being directed to the LLLWTS in the facility. The majority of the effluent being generated by the environmental laboratories does not require the treatment

operations offered by this system, but it is possible it is affecting the effluent stream non-radiological characteristics.

- Early in 2021 (January-March), it was identified that the environmental laboratories and sample management office practises were having a negative impact on the effluent, as acid wash water and the clean out of expired acid-preserved sampling bottles was not properly being neutralized prior to disposal down the drainage system. In Figure 6, the drop in iron concentrations in the LLLWTS effluent can be observed when cleaning practises were improved. The improper disposal of the acidified wash water is being identified as the major cause of the increased metal concentrations being observed in the first four months of the calendar year.
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines two times in 2021 (February and March). Frequent exceedances are being seen in relation to the new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon as the new tanks were commissioned and used, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration seen at the Outfall is still well below the monthly guideline limits.
- The Zinc concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in February.
- The phosphorus concentration in the Building 300 effluent has effectively doubled, and exceeded the CNL monthly guideline limit four times throughout the calendar year (March, August, September, and November). As this trend did not exceed a monthly administrative level it was not identified until all the data was compiled for the year, and the cause of this increase is currently unknown. The plot of the monthly concentrations for phosphorous appears to be correlated with the increased cleaning frequency (due to muddy work boots) that would be associated with the spring and the fall periods. CNL will begin with reviewing the current selection of cleaning products being utilized in Building 300.

9.5.1.5 Loading Calculations

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 36 shows the results from the calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- The Lagoon did not contribute to the observed loads in 2021 as it was not discharged.
- TSS, Nickel and Zinc are the parameters that had a load increase greater than 10% when compared to the five-year average.
- Unlike 2020, this increase in overall load for TSS is not tied to a similar increase being observed at the intake and is directly tied to demolition work occurring on site for 2021.
- The increase in the Nickel load is related to the increase in Nickel concentrations being observed in the Intake water being utilized by the site.
- The increase in Zinc is being attributed to the results at the Outfall over the years being detected very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase.
- Phosphorus, Chromium, Mercury, Lead, and Oil and Grease had a significant decrease of 10% or more in their loads when compared to the 5-year average.

Table 36: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	0	132	216	0	0	69.6	0	0	0
		Site Total	**0**	**132**	**216**	**0**	**0**	**69.6**	**0**	**0**	**0**
-	Un-ionized Ammonia	Lagoon	0.74	0.46	0.118	0.042	0.043	0.281	0	0	0
		Site Total	**0.74**	**0.46**	**0.118**	**0.042**	**0.043**	**0.281**	**0**	**0**	**0**
-	Total residual Chlorine	Lagoon	2.6	0.808	0.220	0.831	1.743	1.24	0	0	0
		Site Total	**2.6**	**0.808**	**0.220**	**0.831**	**1.743**	**1.24**	**0**	**0**	**0**
5b	Total Organic Carbon	Outfall	-	-	-	-	16814	16814	51	0	12230
		Site Total	-	-	-	-	**16814**	16814	**51**	**0**	**12230**
6	Phosphorus	Lagoon	6.2	3.29	1.59	1.90	2.30	3.06	0	0	0
		Outfall	55.4	38.0	42.6	27.7	25.2	37.8	52	1	25.9
		Site Total	**61.6**	**41.3**	**44.2**	**28.6**	**27.5**	**40.6**	**52**	**1**	**25.9**
8	TSS	Lagoon	143	227	46.4	44.7	120	116	0	0	0
		Outfall	3504	3142	2031	5764	6657	4220	52	3	6630
		Site Total	**3647**	**3369**	**2077**	**5809**	**6777**	**4336**	**52**	**3**	**6630**
9	Chromium	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.35	0	0.06	0.818	0.651	0.376	52	43	0.035
		Site Total	**0.35**	**0**	**0.06**	**0.818**	**0.651**	**0.376**	**52**	**43**	**0.035**
9	Copper	Lagoon	0.12	0.10	0.018	0.027	0	0.053	0	0	0
		Outfall	9.5	6.61	7.63	7.03	13.5	8.85	52	0	8.44
		Site Total	**9.6**	**6.71**	**7.65**	**7.06**	**13.5**	**8.90**	**52**	**0**	**8.44**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9a	Iron	Lagoon	18.3	13.34	4.52	4.56	3.57	8.86	0	0	0
		Outfall	417	291.1	258	296	381	329	52	0	322
		Site Total	**435**	**304**	**263**	**301**	**385**	**338**	**52**	**0**	**322**
9	Lead	Lagoon	0	0.003	0	0	0	0	0	0	0
		Outfall	0.55	0.312	0.23	0.220	0.481	0.359	52	17	0.303
		Site Total	**0.55**	**0.32**	**0.23**	**0.220**	**0.481**	**0.360**	**52**	**17**	**0.303**
9	Nickel	Lagoon	0.035	0.069	0.019	0.042	0	0.033	0	0	0
		Outfall	1.4	1.349	0.836	0.742	0.972	1.06	52	25	1.49
		Site Total	**1.4**	**1.42**	**0.855**	**0.784**	**0.972**	**1.09**	**52**	**25**	**1.49**
9	Potassium	Outfall	-	-	-	-	1348	1348	52	0	1302
		Site Total	-	-	-	-	**1348**	1348	**52**	**0**	**1302**
9	Sodium	Outfall	-	-	-	-	5223	5223	52	0	5086
		Site Total	-	-	-	-	**5223**	5223	**52**	**0**	**5086**
9	Strontium	Outfall	-	-	-	-	39.9	39.9	52	0	39.3
		Site Total	-	-	-	-	**39.9**	39.9	**52**	**0**	**39.3**
9a	Uranium	Outfall	-	-	-	-	0.485	0.485	52	0	0.461
		Site Total	-	-	-	-	**0.485**	0.485	**52**	**0**	**0.461**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0.024	0	0	0	0	0.005	0	0	0
		Outfall	6.3	1.167	1.77	6.13	0.306	3.13	52	15	7.88
		Site Total	**6.4**	**1.17**	**1.77**	**6.13**	**0.306**	**3.15**	**52**	**15**	**7.88**
12	Mercury	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.005	0	0.001	0.001	0.0003	0.0015	52	47	0.0003
		Site Total	**0.005**	**0**	**0.001**	**0.001**	**0.0003**	**0.0015**	**52**	**47**	**0.0003**
14	Phenolics	Lagoon	0.13	0.155	0	0	0	0.057	0	0	0
		Outfall	2.1	4.024	0.0001	0.0003	0	1.22	52	52	0
		Site Total	**2.2**	**4.18**	**0.0001**	**0.0003**	**0**	**1.28**	**52**	**52**	**0**
16	Bromodichloro methane	Outfall	-	-	-	-	0.547	0.547	52	52	0
		Site Total	-	-	-	-	**0.547**	0.547	**52**	**52**	**0**
16	Chloroform	Outfall	-	-	-	-	31.4	31.4	52	9	8.82
		Site Total	-	-	-	-	**31.4**	31.4	**52**	**9**	**8.82**
17	Toluene	Outfall	-	-	-	-	0	0	52	52	0
		Site Total	**-**	**-**	**-**	**-**	**0**	**0**	**52**	**52**	**0**
25	Oil & Grease	Lagoon	59	40.40	0	0	0	19.9	0	0	0
		Outfall	1147	163.5	124	19.1	0	291	52	50	188
		Site Total	**1206**	**204**	**124**	**19.1**	**0**	**311**	**52**	**50**	**188**

a Averages were calculated by setting to zero results reported as “< DL.”
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

9.5.2 Airborne Effluent Monitoring

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen for cleaner burning propane used on site. Table 37 presents WL heating fuel consumption from 2016 to 2021. Fuel consumption continues to trend downward (see Section 9.7.2 and Figure 11).

Table 37: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2021
Parameter	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	361,110	287,982	209,158	243,268	190,372	258,378	160,159
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	9.815	7.827	5.685	6.612	5.1743	7.0227	4.3531
Total	**TJ**	**9.815**	7.827	**5.685**	**6.612**	**5.1743**	**7.0227**	**4.3531**
Heating Demand								
Heating Degree Days	HDD	5573	5403	5855	6079	5615	5705	5233

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.

b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

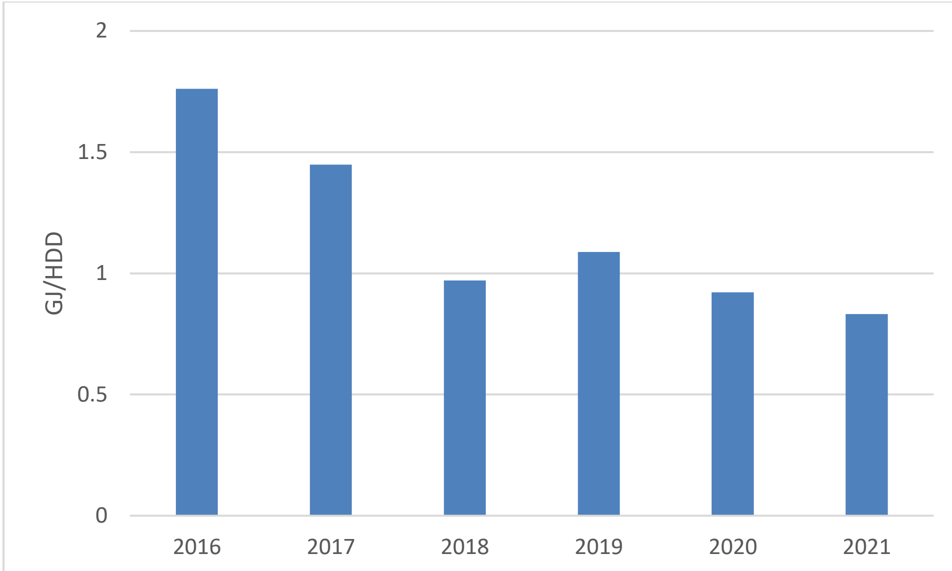

Figure 11: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [39]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2021 will be captured in the *2021 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories* [28].

Table 38 outlines the annual CACs generated from site activities, and shows a small decrease in emissions seen in 2021 compared to the 5-year average for the values for total particulate matter, PM_{10}, and $PM_{2.5}$. The PM_{10} value met the NPRI reporting threshold this year, and is reported to Environment and Climate Change Canada. Road dust emissions were the major contributor to meeting these reporting thresholds.

Table 38: Stationary Combustion Data and Emissions from WL

Parameter	Unit	Data for Previous Five Years						Data for 2021	NPRI Reporting Threshold
		2016	2017	2018	2019	2020	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	0.908	0.753	0.536	0.621	0.602	0.684	0.331	20
SO_2	Mg	0.023	0.020	0.014	0.016	0.017	0.018	0.005	20
CO	Mg	0.399	0.348	0.233	0.271	0.256	0.301	0.162	20
TPM	Mg	15.022	13.651	14.562	10.574	8.883	12.538	8.174	20
PM_{10}	Mg	3.853	3.499	3.726	2.712	2.281	3.214	2.091	0.5
$PM_{2.5}$	Mg	0.415	0.376	0.391	0.292	0.249	0.345	0.218	0.3
Volatile Organic Compounds	Mg	0.071	0.059	0.042	0.049	0.048	0.0538	0.026	10

9.5.2.3 Greenhouse Gas Emissions

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38] WL must calculate releases under the GHGs emissions notice [40] providing the facility emits over 10,000 tonnes of carbon dioxide equivalent or more within the calendar-year.

Greenhouse Gas emissions from WL include carbon dioxide, methane, and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill, and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

Table 39 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have decreased significantly from 2020. This decrease can be attributed to the decrease in propane needed to heat the site in 2021 as shown in Table 37. There was a decrease in the number of heating degree days (i.e., decreased demand for building heat based on temperature) in 2021, this combined with the fact Building 200 did not require any building heating during the calendar year, and Buildings 402 and 305 no longer had to be heated starting in the fall of 2021 due to demolition activities. Overall, greenhouse gases in 2021 are 29% less than the average for the last 5 years.

Table 39: Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2021 Releases
	2016	2017	2018	2019	2020	5-yr. Avg.	
GHG CO_2e tonnes	1883	1873	1678	1756	1692	1776	1177

Note: GHG CO2e tonnes - A unit of measure used to compare between gases that have different GWP. For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, following the Federal Halocarbon Regulations [41]. All releases greater than 10 kg are considered reportable.

As seen in Table 40, there were two reportable releases of halocarbons in 2021. Both releases were related to the Building 100 chiller system. The first release occurred in 2021 April. During maintenance activities it was discovered that 15.5 kgs of R-134a refrigerant escaped from the chiller system through a leak of one of the shut off values on the equipment. Upon replacement of the shut off valve it was observed that the threads of the valve were compromised. The second leak occurred in 2021 October. During maintenance activities to take the equipment offline for the season, it was discovered that 16.3 kgs of R-134a refrigerant escaped from the chiller system through a faulty solenoid valve.

Table 40: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2021	
Type	**Global Warming Potential[b]**	**Ozone Depleting Potential[c]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Number of Losses**	**Annual Loss (kg)**
Refrigerants[a]									
CFC (R-11)	4 600	1	0	0	0	0	0	0	0
CFC (R-12)	10 600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1 700	0	0	0	0	0	0	0	0
HFC (R-134a)	1 300	0	0	12.47	0	0	0	2	31.8
Fire Suppressants									
Halon (R-1301)	6 900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b GWP per unit mass, compared to CO2 = 1.00
c Ozone Depleting Potential per unit mass, compared to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [41]

9.5.3 Overall Performance

The non-radiological effluent monitoring program set up by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were no discharges from the Outfall and Lagoon which exceeded the current monthly guideline limits placed on CNL in 2021.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances or reportable events in 2021.

9.7 Discussion of Improvement Initiatives

The following sections describe some of the ongoing efforts the WL site is undertaking to enhance the effluent verification monitoring program.

9.7.1 Monitoring Site Intake Water and Outfall Effluent

In 2020, the WL site expanded the monitoring program to encompass additional parameters at the site's Intake and Outfall monitoring station. This expansion resulted from the enhanced monitoring that was performed on the Intake and the Outfall in 2019 to address the gaps in baseline data when assessed against the monitoring criteria in Table 19-1 of the *WL Effluent Verification Monitoring Plan* [25]. It was decided that when there was a 20% change in concentration when comparing the results for a given parameter at the Intake and Outfall, that these parameters would be incorporated in the effluent verification monitoring program.

Under this criteria, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene have been added to the list of parameters being measured at these stations. Currently, CNL can show that the source of the Potassium and Sodium being introduced to the Outfall is a result of the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products resulting from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL is planning to do temporary upstream process monitoring (monitoring at LLLWTS in Buildings 100 and 300) to try to be able to explain the operational source of the increase.

In order to be compliant with REGDOC-2.9.1 [42] it was determined that the effluent verification monitoring program needed to include acute lethality testing at the Outfall monitoring station.

Although the need to monitor for these parameters is currently captured in *WL Effluent Verification Monitoring Plan* [25], WL laboratories acknowledges that the plan needs to be updated to reflect that these parameters are actively being monitored, and plans to revise Reference [25] in 2022.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, to heat the site buildings. Starting in 2013, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 11 shows the annual fossil energy consumption since 2016, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 11, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply. Beginning in 2020 October, Building 200 no longer had to be heated as demolition activities on the building began at this time. In 2021 September, Buildings 305 and 402 no longer required to be heated as demolition activities began on these buildings.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28] (to be issued to the CNSC by 2022 June 30).

10 Emergency Management and Fire Protection

10.1 Emergency Preparedness Program

Whiteshell Laboratories adheres to the Corporate Emergency Preparedness Functional Support Area. See Section 10.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL program continues to adapt to the changes on site, including the demolition of buildings/assets, the construction of temporary structures, the number and composition of staffing levels, and the organisational structure. Vacated buildings are transitioned from building emergency procedures to construction/demolition oriented emergency placards.

Planning for and responding to COVID-19 continued as a primary focus for the Emergency Preparedness Functional Support Area at WL in 2021, providing procedures and guidance to enable work to continue safely in this dynamic situation. This was safely managed, without an outbreak at WL, despite the pandemic impact on Manitoba.

10.1.1 Drills and Exercises

The ongoing COVID-19 Pandemic continues to make running in-person emergency scenarios a challenge, especially with our external partners. For 2021, drill and exercise development focused on scenarios that allow for adequate physical spacing and still yield quality learning and evaluation potential.

In 2021, a total of 143 exercises and drills were delivered at WL. This is a significant step up from the 94 drills/exercises delivered in 2020. While not quite back to pre-pandemic levels, this increase signifies an adjustment in the program to the new normal of the current environment. Table 41 provides details on the number and type of the exercises and drills conducted in 2021.

Table 41: WL Emergency Preparedness Exercises – 2021

Type of Drill or Exercise	Number Completed in 2021
Fire Drills	2
Site-wide Specialty Drills	106
Table Top Exercises [a]	5
Targeted Communication Exercise	17
Site-wide Communication Exercise	12
Field Exercises (Functional)	1

a Table Tops include specific EOC Skill workshops as well. Each workshop focuses on a unique aspect of the EOC and includes a small practice scenario.

10.1.2 Training

There was no change to the Emergency Operations Centre (EOC) staff structure in 2021. Building emergency teams are being maintained for all occupied structures on site. Fewer occupied structures has resulted in a decrease in the number of team members required.

10.1.3 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains a physical EOC, and conducts monthly tests of the technical equipment stored for use in that location. Repairs, improvements and updates are requested as required and when identified. All checks were completed in 2021. A cache of emergency food rations is also maintained at WL, which have a five year shelf life. The rations were replaced in 2019. The cache is stored in a secure location and the condition of the cases is checked annually.

10.1.3.1 Emergency Operation Center

As part of WL's EOC framework, there are two teams of EOC staff, and an alternate person for each of the team positions that can be engaged to cover for members of either of the two teams. These two teams operate on a two week on-call rotation. One EOC member retired in 2021 and his trained alternate was able to step straight into this position.

There were no emergency events requiring activation of the EOC in 2021.

10.1.3.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories continues to maintain the Mobile Nuclear Laboratory (MNL) for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the MNL in 2021.

10.1.3.3 Equipment Checks

Respirators make up the majority of the equipment in the strategically placed emergency cabinets that remain on site. These cabinets are opened and inspected monthly by Radiation Protection staff. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2021.

There were no emergency events requiring the use of this equipment in 2021.

10.1.3.4 Public Address System

The Public Address (PA) system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2021.

10.1.3.5 Secondary Emergency Signals

The WL site still employs an exterior siren as a redundant form of emergency alerting. The system is no longer required and was replaced by the PA system as the primary alerting system. This system will continue to be used as a redundant alerting system until either the equipment fails completely (there have previously been some issues with the equipment) or the building it is mounted to is decommissioned and demolished.

10.1.3.6 EOC Notification System

WL continued to use the Everbridge Mass Notification system in 2021. The system continues to perform well, with a 100% response rate to all monthly communication tests (see Table 42) for the third year in a row.

Table 42: WL EOC Communication Tests: 2021

Y= Yes N= No	January	February	March	April	May	June	July	August	September	October	November	December
EOC Commander	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liaison Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Env. Protection Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safety Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Planning Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Logistics Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Operations Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nuclear Facilities Representative	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

In addition to these regularly scheduled monthly drills, a random quarterly drill is conducted. These drills are scheduled for random times and dates, including weekends, evenings and work hours. These random drills include the expanded EOC teams, including all alternates and non-routine staff. Table 43 identifies the response rates of the 2021 WL EOC Staff to the Quarterly Random EOC call out drills, with an average of 94% response. Only responses received within an hour of the notification being sent out are considered a positive response, the rest are considered ‘no response’.

Table 43: WL EOC Random Quarterly Communication Tests: 2021

	Q1	Q2	Q3	Q4
Response Percentage	96%	100%	88%	92%

10.1.4 External Collaborations

In 2021 contact was maintained with a variety of external emergency response/management organizations and interested public groups. Due to COVID-19 many of these were once again virtual meetings or connections. WL EmP:

- Engaged with the LGD of Pinawa Emergency Operations Centre staff for local response planning purposes.
- Participated in the Manitoba Provincial Flood and Forest Fire forecasting sessions.
- Continued to participate on the Manitoba Municipal Relations Governance COVID-19 teleconference meetings throughout 2021, though with decreasing frequency as the year progressed.
- Maintained working relationships with Manitoba Emergency Measures Organization staff through less formal interactions this year, including regional response officers and the Critical Infrastructure protection program staff.
- Attended the Provincial emergency management conference, which brought many Local, Provincial and Federal stakeholders together to share best practices and lessons learned on a variety of relevant topics.
- Maintained membership with the Prairie Region (Manitoba and Saskatchewan) of the Federal Coordination Working Group. The Federal Coordination Working Group helps WL maintain ties with representatives from multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police (RCMP), Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada, in order to support organizational planning and response.

10.1.5 Unplanned Emergency Events

There were no incidents requiring initiation of the WL Site Emergency Plan occurred during 2021.

10.2 Fire Protection Program

Whiteshell Laboratories adheres to the Corporate Fire Protection Functional Support Area. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

There were no reportable fire events at WL in 2021.

10.2.1 Fire Response Drills

In 2021, WL was unable to conduct all the fire drills that it identifies as an annual requirement in accordance with the National Fire Code of Canada [43] and CSA standard N393-13 Fire Protection for Facilities that Process Handle, or Store Nuclear Substances [44]. This deviation has been captured as part of an internal self-assessment and a corrective action plan is being developed to ensure these are adequately planned and executed.

10.2.2 External Collaborations

Whiteshell Laboratories and the Town of Pinawa signed a Fire Protection Service Agreement in 2019 to improve Mutual Aid support capabilities. The agreement is still in effect. Interdepartmental training has been interrupted by the COVID-19 pandemic, but will be resumed as soon as it is safe to do so.

10.2.3 Third Party Audits & Inspections

As per the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [44], a third party Fire Protection Audit was conducted in 2021. The findings are being collated and their resolution will be tracked through the corrective action program (see also Section 1.2.1.1).

10.2.4 Fire Hazard Analysis

All fire hazard analysis documentation for buildings requiring a fire hazard analysis have been reviewed and are being evaluated against the decommissioning schedule. A corrective action plan was developed and submitted to the CNSC outlining the timeline for Fire Hazard Analysis documentation review and revisions.

11 Waste Management

11.1 Waste Management Program

Whiteshell Laboratories adheres to the Corporate Waste Management Functional Support Area. See Section 11.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program include:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL Programs to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Closure Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for three of the waste receiving facilities on-site (including the Waste Handling Area and the WMA storage facilities) remained unchanged for 2021.

11.1.1 Waste Management Operations

Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for interim storage.

Demolition of Buildings 402 and 305 began in 2021 and is on target to be complete early 2022. A total of 2,246 m³ clean waste was generated in 2021; 1,290 m³ of concrete material was dispositioned to an off-site receiver for future re-use, 450 m³ of metal was recycled, while 483 m³ of asbestos-containing material and 17 m³ of polychlorinated biphenyl (PCB) contaminated materials were dispositioned to appropriate off-site waste receivers.

Decommissioning on the south area of the WL main campus continued, which involved asbestos abatement and remediation of high temperature water lines, generating approximately 188 m³ of clean concrete waste; 28.5 m³ of this volume contained asbestos-containing materials which was sent to an approved off-site licensed facility.

Building 200 Active Liquid Waste Treatment Centre demolition was completed. A total of 1,077 m³ of Low-Level Waste (LLW) and 77.5 m³ of Intermediate - Level Waste[11] (ILW) waste

[11] In this context, ILW refers to any waste that does not meet the proposed Near Surface Disposal Facility (NSDF) Waste Acceptance Criteria (WAC) and requires storage in ILW facilities at CRL.

was generated; of this LLW total, 876 m³ has been safely dispositioned to CRL, with the remaining 201 m³ and 77.5 m³ of ILW waste safely stored in certified transportation packages awaiting shipment to CRL in 2022.

De-inventorying efforts of legacy waste stored in LLW Bunker 5 began. Wastes are undergoing additional qualification and inspection to ensure transportation and waste criteria compliance are met. This activity has generated 360 m³ of LLW to date, which are safely stored in certified transportation packages awaiting shipment to CRL in 2022.

Table 44 summarizes the quantities of radioactive waste generated in 2021 that was sent to each storage location. Table 45 summarizes the volumes of solid low-level radioactive waste originating from each facility in 2021. Table 46 summarizes the volumes of solid intermediate-level radioactive waste originating from facilities in 2021. Table 47 summarizes the volumes of solid low-level and intermediate-level radioactive waste transported to CRL for disposition.

Table 44: Radioactive Waste by Storage Location

Storage Facility	Volume (m³)	
	2020	2021
Low-Level Quonsets	32.3	0
Intermediate-Level Waste Bunkers	0	2.5
SMAGS[a]	4.1	0
Soil Storage Compound	0	0
Total	36.4	2.5

a Shield Modular Above Ground Storage (note: SMAGS is no longer used for waste storage)

Table 45: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2020		2021	
	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)
Building 100	0.8	9.2	1.5	0.0
Building 200	7.2	198.9	0.0	875.6
Building 300	0.3	0.0	0.0	0.0
Building 303	0.0	0.0	0.0	0.0
Building 304	0.0	0.0	0.0	0.0
Building 402	0.2	0.0	0.8	0.0
Building 421	0.0	0.0	0.0	0.0
Concrete Canister Storage Facility	0.0	0.0	0.0	0.0

Shielded Facilities (HCF & IFTF)	10.8	0.1	45.6	0.0
Waste Handling Area	0.0	0.0	0.0	0.0
Waste Management Area	2.5	0.0	14.2	0.0
LLW Bunker 6	0.8	0.0	0.0	9.0
LLW Bunker 5	0.0	0.0	0.0	360.0
Affected Lands	0.2	0.0	0.0	0.0
SSC	0.0	0.0	0.0	0.0
Total	**22.7 (5.0)[a]**	**208.2**	**62.1 (5.0)[b]**	**1244.6**
Total after Compaction	**213.2**		**1249.6**	

a This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

b This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

Table 46: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m^3)	
	2020	2021
Affected Lands	0.0	0.0
Building 200	5.8	77.5
Total	5.8	77.5

Table 47: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2020		2021	
	LLW Volume (m^3)	ILW Volume (m^3)	LLW Volume (m^3)	ILW Volume (m^3)
Building 402	0.0	0.0	0.0	0.2
WMA (Legacy Sources)	112.5	0.0	39.0	0.0
Soil Storage Compound	0.0	0.0	0.0	0.0
SMAGS[a]	14.0	7.7	0.0	0.0
LLW Bunker 6	182.0	0.0	6	3
LLW Bunker 5	0.0	0.0	0.0	0.0
Building 200	198.8	5.8	876	0
LLW Quonsets (B431, B432, B433)	20.4	12.8	0	0

Total	527.7	26.3	921	3.2

a Shielded Modular Above Ground Storage – legacy waste generated from various decommissioning projects.

Clearable waste from Controlled Areas was monitored in-situ. Clean bagged waste was monitored using the bag monitor located in Building 300 where WL's laundry facility is now stationed; all bagged waste met the screening criteria and was deemed to be suitable for unrestricted release in 2021.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable; this includes both recyclable materials sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

Table 48 summarizes the disposition pathway of non-active wastes, while Table 49 summarizes the amount, by material type, of recyclable waste shipped off-site.

Table 48: Non-Active Waste Disposition Pathways

Disposition Location	Volume (m^3)	
	2020	**2021**
WL Asbestos Disposal Site [a]	0	0
WL Burn Pit	247	189
WL Inactive Landfill	0	0
Recycling[b] **Sent Off-Site**	513	271
Off-Site Landfill [c]	1,256	1,352
Total	2,016	1,812

a The WL Asbestos Disposal Site stopped receiving waste in 2019 to support the environmental risk assessment. Non-active asbestos is directed to off-site licensed landfills.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted at municipal recycling facilities.

c WL Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

Table 49: Recycled Waste Shipped Off-Site

Material[a]	Weight (kg)	
	2020	**2021**
Aluminum	0	0
Batteries Shipped	0	0
Batteries Recycled	227	0
Cardboard[b]	0	0

Copper and Brass	0	0
E-Waste Shipped	347	3,464
E-Waste Sold	0	0
Ferrous Metals	108,457	26,231
Glass	0	0
Lumber	0	0
Plastic Shipped	0	0
Plastic Sold	0	0
Stainless Steel	0	0
Lead	0	7,450
Total	109,031	37,145

a This recycling waste pertains to material that is sold or charged to be taken to a material specific recycling facility.

b Cardboard is sent to a municipal recycling facility and inclusive in Table 48.

Improvements were made in preventing waste accumulation inside of buildings and transferring the waste to appropriate waste facilities immediately after generation. Improvements continue to be addressed in reference to the lack of processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes radioactive wastes generated from decommissioning activities. Mitigation measures put in place in 2021 included finalizing a Nuclear Safety Note for the interim storage of cargo containers containing radioactive wastes in the WMA. This area is referred to as the Recoverable Surface Storage and Staging Area (RSSSA), and consists of an outdoor, above ground storage pad to enable the storage and loading of solid low-level waste in sea land containers and storage of oversize LLW items which are awaiting further processing, characterization and/or packaging to be considered compliant for off-site disposition. Additionally, satellite transshipment areas were established north of the WMA and one by the B200 demolition to reduce additional handling and improve efficiencies with off-site disposition of waste.

11.1.1.1 Liquid Waste Generation

During 2021, 78.9 m^3 of low-level liquid was processed in the Building 300 LLLWTS and 9.9 m^3 in the Building 100 LLLWTS, for a total of 88.8 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Whiteshell Laboratories adheres to the Corporate Cleanup Functional Support Area. See Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

11.2.1 Program Overview, Achievements and Accomplishments

As per the Licence Conditions Handbook for WL [2], CNSC have been notified of revisions to the Detailed Decommissioning Plan (DDP) for WL [45].

11.2.2 Land Use Program

Table 50 provides a summary of the status of the WL Site's Overview DDP.

Table 50: Overview Decommissioning and Cleanup Plan Updates for WL in 2021

Document Reference	Key Activity Status in Year	Effective Date (if applicable)
WLDP-02000-DDP-001	Approved by Regulator	December, 2021

The Overview DDP was revised, submitted to the CNSC, and approved for use in 2021.

11.2.3 Decommissioning and Demolition Program

Table 51 lists the WL DDPs and their status as of 2021.

Table 51: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned.
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility has been decommissioned. End-state report in development.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach)	Facility has been shut down and currently under monitoring and surveillance. Complete Dismantlement and Removal approach has been

Facility	DDP Document Title	Document #	Status
		WLDP-26400-DDP-001, Revision 5, 2021 (In Situ Decommissioning Approach)	approved by the CNSC (Revision 3). EA process for ISD is in progress, Revision 4 to be revised with final EA submission (note: copy of Revision 5 submitted for review of comment disposition to CNSC prior to final EA submission). DDP Volume (Revision 3) is available for use.
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC and comments received (to be dispositioned).
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001	Facility is operational DDP under development.
	Volume 8 - WMA Part 2: Intermediate - Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 5, 2021	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
R&D Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use.
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001	Decommissioning activities ongoing. DDP Volume is available for use.
DP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.

Facility	DDP Document Title	Document #	Status
	Area Buildings and Facilities		
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

11.2.3.1 Detailed Decommissioning Planning and Execution

Table 52 provides a summary of WL facility DDPs that were revised in 2021.

Table 52: Summary of WL Detailed Decommissioning Plans in 2021

Facility	Document Status	Document Name and Reference	Effective Date	Document Highlights
WMA	Current Published	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 8 - WMA: Part 3 - Low Level Waste Liabilities, WLDP-24400-DDP-001, Revision 5	April, 2021	DDP was submitted to and accepted by CNSC staff.

Table 53 provides a summary of decommissioning and demolition statuses for WL in 2021.

Table 53: Summary of WL Decommissioning and Demolition Status by Facility in 2021

Facility	Decommissioning and Demolition Status
B402	Active Decommissioning
B200	Building Demolished
B413	Active Decommissioning
B420	Active Decommissioning
B426	Active Decommissioning
B429	Active Decommissioning
WMA	Active Decommissioning
Site Affected Lands and Contaminated Structures	Active Decommissioning

Several buildings and structures were decommissioned in 2021, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition where feasible.

Demolition of Buildings 402 and 305 began, and is expected to be completed early 2022. The demolition of the buildings included remediation and abatement of asbestos-containing materials, specifically the mastic tar adhered between the masonry and exterior wall, and PCB's found within window glazing and exterior caulking and general demolition of construction and demolition materials.

Remediation of the south-side of the main campus continued. Phase one field work was completed, which consisted of remediating the high temperature water lines. Phase two field work to excavate and remove underground electrical bus ducts, isolate fire water, domestic water, storm drains and sanitary drain systems will commence in 2022. The exterior of Buildings 413, 420, 426 and 429 were radiologically surveyed for clearance, with interior portions to be completed in 2022.

Building 200 was successfully demolished, which involved the above and below grade structure, while the building footprint was backfilled. Remediation of this footprint was strategically adjusted to align with future remediation of the surrounding lands known to be contaminated from historical spills associated with the building. This will ensure remediation of the known contamination is completed in one phase, avoiding the potential of creating additional volumes of waste that may be generated from migration of contaminants within the soil.

Legacy wastes stored in the LLW Quonsets (Building 431, 432 and 433) and LLW Bunker 5 began to be retrieved in 2021. Wastes are undergoing visual examination, destructive and non-destructive characterization, and packaging to ensure transportation and waste criteria compliance are met, before waste can be dispositioned to CRL. This work is scheduled to be complete in 2022.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

11.2.3.2 End State Reporting

Table 54 provides a summary of end-state reports completed for WL in 2021.

Table 54: Summary of WL Decommissioning and Demolition End-State Reports in 2021

Facility	Document Type	Document Status	Document Name and Reference	Submission Date (if applicable)
Building 514 (WMA)	End State Report	Submitted to CNSC	Decommissioning and Demolition of Organic Coolant Incinerator Complex (B514), WLDP-24400-ESDR-001, Revision 1	July, 2021

12 Security

12.1 Security Program

Whiteshell Laboratories adheres to the Corporate Security Functional Support Area. See Section 12 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Whiteshell Site Security Report [46] outlines the security arrangements that are in place at the WL site. The Security Functional Support Area consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Functional Support Area and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in REGDOC-2.2.4, *Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness* [47].

Hours of Work Exceedances

As per REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* [47] Sections 4.2 and 4.3, CNL has recorded all exceedances of hours of work for Security's safety-sensitive positions. See Table 55 below for a list of exceedances for 2021. NOTE: COVID pandemic had a direct contribution to Table 55 in order to ensure minimum shift complement.

Table 55: Hours of Work Exceedances for Nuclear Security Officers and Tiered Response Force Personnel at WL in 2021.

Limits:			2021			
			Q1	Q2	Q3	Q4
4.2	1.	>16 hrs in a 24-hour period	3	4	7	4
4.2	2.	> 28 hrs in a 48-hour period	15	21	28	11
4.2	3.	> 120 hrs in a 14-day period	6	4	1	1
4.3	2. d.	Min recovery 48 hrs after 2 consecutive nights	19	11	5	15
4.3	2. d.	Min recovery 72 hrs after 3 consecutive nights	2	5	3	2
		Total	45	45	44	33

A CNSC Type II Security Compliance Inspection was carried out - see Section 1.2.2. A corrective action plan was submitted to the CNSC to address findings.

CNL-WL received notification from the CNSC on the closure of one (1) enforcement item, Directive WL-SEC-19-T2-001-D01 – Training. The Directive closure was granted as CNL-WL completed all actions required to address the enforcement items listed in the Directive.

12.1.1 Security Events

In 2021, there were no security events that affected the Whiteshell Laboratories.

13 Safeguards and Non-Proliferation

13.1 Safeguards Program

Whiteshell Laboratories adheres to the Corporate Nuclear Materials and Safeguards Management (NM&SM) Functional Support Area. See Section 13 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

13.1.1 IAEA Activities

The IAEA conducted various types of activities as part of the safeguards approach for CNL, including, but not limited to, IAEA safeguards seals changes, human surveillance, implementation and/or maintenance of IAEA safeguards monitoring equipment, and technical visits. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2, Management System of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In 2021 May-June, 14 of 16 WL concrete canisters were re-welded, during which the IAEA provided oversight. The IAEA also verified and changed the IAEA seals attached to the canisters to maintain continuity of knowledge. Minor difficulty was encountered during resealing of one canister and the IAEA inspector decided to employ an alternate sealing arrangement. In 2021 September, the other two canisters were re-welded, during which IAEA provided oversight, including resealing the one canister into the original configuration as it was operationally preferable.

A Physical Inventory Verification (PIV) inspection was completed by an attending IAEA inspector on 2021 May 25. This inspection was a sampling of accessible items containing Special Fissionable Material.

The IAEA also completed a Design Information Verification (DIV) inspection on 2021 May 25 - 27. The activities associated with the DIV included:

- Verification of the Design Information Questionnaire:
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

14 Packaging and Transport

14.1 Packaging and Transport Program

Whiteshell Laboratories adheres to the Corporate Transportation of Dangerous Goods (TDG) Functional Support Area, which includes the requirements of the Packaging and Transport SCA. See Section 14 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances and radiation devices. The TDG Functional Support Area applies to any activities involving the transportation of dangerous goods to or from CNL sites. The TDG Functional Support Area provides an operational framework for the safe off-site transport of dangerous goods by conforming to all applicable laws and regulations, as well as company policies and procedures.

The Waste Certification & Transportation branch is a centralized organizational department responsible for planning, coordinating and executing radioactive waste shipments from the WL site to the off-site disposal or storage facilities in a safe and compliant manner, including having fully trained Radioactive Material Shippers as authorized under the CNL TDG Functional Support Area.

Significant activities in 2021 included:

- Transportation of 921 m^3 of low-level waste and 3.2 m^3 intermediate-level waste sent off-site and safely delivered to CRL;
- Throughout 2021, additional technical assessments and studies on the WL used fuel inventory were completed in support of the licensing application of the Used Fuel Transportation Package (UFTP). These assessments were focused on the WL mixed fuel types (i.e., enriched and experimental fuel types, including Uranium Carbide and Uranium Metal fuel types) and the physical operation of the UFTP. The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations starting in 2022 (due to the COVID-19 Pandemic, these transportation operations were delayed and subsequently pushed out from 2020). There is a two-step licensing strategy for the UFTP, with the first phase focusing on licensing the UFTP for non-enriched CANDU fuels and the second phase focusing on WL's inventory of mixed fuel types. The phase UFTP Safety Analysis Report (SAR) Addendum was submitted to the CNSC in 2019 May, with updates provided throughout 2020, and acceptance is anticipated in early 2022. The UFTP SAR for Mixed Fuel Types (representing phase two) will be submitted in 2022, following the CNSC's acceptance of the phase 1 SAR addendum. Additional accomplishments throughout 2021 include the revision and acceptance of the revised UFTP pre-shipment leak tests, the progression of detailed planning and operational readiness deliverables, and the completion of field trials with the UFTP, Shielded Interface Module (SIM) and Fuel Transfer Flask.

- Award of the subcontract to Nuclear Assurance Corporation (NAC) to design and fabricate Type B casks, cask handling equipment and on-site services needed to support ILW transport to CRL was completed. Two versions of the OPTImal Modular Universal Shipping (OPTIMUS) casks, the OPTIMUS-H and OPTIMUS-L were accepted for use after their licence review and received. Personnel from WL and CRL participated in a week long training session, qualifying them on the use, loading and transport of the casks.
- Extensive training was conducted to site personnel responsible for the handling and packaging of radioactive waste materials, which included Class 7 RAM Material – Handler Training, as well as Waste Management and Packaging Fundamental Training, which was developed to capture the requirements to compliantly process, load, and handle waste materials into certified transport packages, as well as the various waste receivers' waste acceptance criteria.

14.1.1 Shipments

At WL, 68 radioactive transport packages making up 53 loads were safely and successfully sent off-site in 2021. One reportable event occurred in 2021 (see ImpAct ERM-21-1036 in Table 5) where a consignment of waste material was misclassified in accordance with the Packaging and Transport of Nuclear Substances Regulations [48] and IAEA Safe Transport of Radioactive Material [49], due to an incomplete inventory of the package's contents. Several corrective and remedial actions were completed to address the event.

15 Other Matters of Regulatory Interest

15.1 Public Information and Disclosure Program

Whiteshell Laboratories adheres to the Corporate Public Information Program. See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Public Information Program document [50] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure* [51].

15.1.1 Outreach and Stakeholder Engagement

WL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events. As employees are CNL's greatest ambassadors, they are kept informed of developments so that they can also share information with their relatives, friends, and neighbours.

CNL engaged with the public on WL using a number of tactics. During the COVID-19 pandemic, engagement followed public health and corporate guidelines and was primarily virtual. Table 56 presents public engagements from 2021.

Table 56: Public Engagements for Whiteshell Laboratories

Date	Location	Activity
March 2, 2021	Pinawa, MB	Presentation and meeting with Local Government District of Pinawa Council and Mayor
April 20, 2021	Webinar	WL Closure Project: Environmental Protection
May 18, 2021	Webinar	WR-1 Reactor Decommissioning Fact or Fiction Webinar
September 21, 2021	Webinar	WL Closure Project: Project update
November 16, 2021	Webinar	WL Closure Project: Environmental Protection
November 24, 2021	Winnipeg, MB	Emerging issues conference 2021: The net-zero future investing in sustainability

15.1.2 Public Consultation

CNL actively works to engage local stakeholders on matters related to WL activities. In 2021, a number of methods were deployed to gain feedback from and create discussion with interested parties including: breakfast sessions, social media, and feedback forms available online and at external events, and responses provided to inquiries. CNL strives to create open and transparent communication with all identified stakeholders, and to address concerns and respond to all inquiries.

Throughout 2021, CNL received 21 community inquiries related to WL (Table 57), largely through the WR-1 Breakfast Session/Webinar series.

Table 57: Whiteshell Laboratories Closure Project Public Inquiries

Nature of Enquiry	Number
Transportation	3
Environmental protection	7
Whiteshell Laboratories Closure Project	11

15.1.3 Traditional and Online Communications

15.1.3.1 Website

CNL's Whiteshell Decommissioning web page had 1,667 page views in 2021.

To support the Whiteshell projects and site, CNL has used social media to promote events, share and receive information, and generally engage with the public. As Table 58, Table 59 and Table 60 show that social media has been an effective tool to reach and engage stakeholders. Table 61 shows that CNL also shared information through a community information bulletin.

Definitions:

Engagements - Measures how much and how often others interact with you and your content in social media.

Shares or retweets - Measures how often the message was shared or forwarded on the twitter website.

Table 58: Facebook Metrics for WL-related Posts*

Date of Post	Engagement	Shares
February 16, 2021	3	0
March 29, 2021	3	1
April 14, 2021	20	11
May 5, 2021	34	19
September 14, 2021	38	4

Table 59: Twitter Metrics for WL-related Posts*

Date of Post	Engagement	Retweets	Clicks
April 14, 2021	1	0	0

Table 60: YouTube Videos

Date of Post	Engagement	Views
April 21, 2021	Webinar: WL Closure Project (April 2021)	163
April 21,2021	Webinar: Déclassement des Laboratoires de Whiteshell (2021 avril)	12
May 20, 2021	Déclassement du réacteur WR-1 Webinaire "Mythe ou Réalité" – 2021 mai	27
May 20, 2021	WR-1 Reactor Decommissioning Fact or Fiction Webinar – 2021 May	42
July 12, 2021	CNL Live Event: CNL's major projects and opportunities for supply chain engagement	224
October 1, 2021	Whiteshell Closure Project Webinar – 2021 September	56
October 1, 2021	Déclassement des Laboratoires de Whiteshell Webinaire - 2021 septembre	12
November 22, 2021	Overview of Environmental Protection at Whiteshell Laboratories	34
November 22, 2021	Un aperçu de la protection de l'environnement à les Laboratoires de Whiteshell	25

Table 61: Community Information Bulletins

Date	Bulletin
January 28, 2021	Whiteshell Monitoring

15.1.3.2 Newsletters

CONTACT is CNL's external, bilingual newsletter. It is distributed to community stakeholders, businesses and approximately 8,000 homes in the region surrounding WL, and is available on www.cnl.ca. This publication informs the reader on activities undertaken at CNL's Whiteshell Laboratories and profiles CNL's community activities. Two issues of *CONTACT* were distributed in 2021 and included the following topics:

- WL Closure Project and WR-1 updates
- Highlights of public and Indigenous engagement activities
- CNL initiatives in the community, demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- CNL's COVID-19 response
- Employee transition
- Environmental stewardship, including steps CNL has taken to reduce greenhouse gas emissions, protect wildlife and minimize waste.

15.1.3.3 Media Releases

During 2021, there were seven articles written by media on the Whiteshell Closure Project (see Table 62).

Table 62: Media Coverage for 2021

Date	Article	Title of Publication
January 2021	Canada's Radioactive Waste Policy Review	LGD of Pinawa Municipal Quarterly Newsletter
January 20, 2021	O'Regan All In On Unnatural Resources	Winnipeg Free Press
March 18, 2021	CNL contributes to Pinawa daycare upgrades	The Clipper
March 24, 2021	Who decides where nuclear waste goes	Winnipeg Free Press
March 26, 2021	Nuclear waste solution	Winnipeg Free Press
July 15, 2021	Pinawa erosion responsibility in question	The Clipper
September 2, 2021	CNEA continues funding North Forge East with three-year deal	The Clipper

15.1.4 Ongoing Projects

15.1.4.1 WR-1 In-Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning project (also referred to as in situ disposal) is a key part of CNL's overall integrated approach to safely manage and reduce Canada's legacy liabilities. The Environmental Assessment (EA) process for the project includes a requirement that WR-1 project information be made available to neighbouring communities, Indigenous communities and organizations, and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Engagement activities conducted in support of this requirement included social media and website content, presentations, meetings, site tours and fulfilling stakeholder requests for information.

Project-specific webpages and content were produced for the WR-1 Project and included: fact sheets, info-graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages at www.cnl.ca/wr-1.

15.2 Indigenous Engagement

CNL follows CNSC REGDOC-3.2.2 *Indigenous Engagement* [52] which sets out requirements and guidance for licensees on Indigenous engagement. CNL recognizes and values ongoing engagement with Indigenous communities and organizations in the spirit of truth and reconciliation.

15.2.1 Engagement Objectives

As part of its corporate, environmental, and social responsibility, CNL recognizes and encourages the ongoing engagement of the First Nations and the Red River Métis (represented by the Manitoba Métis Federation) through the course of the environmental assessment process for the WR-1 Project and engagement on the overall site closure project. Through information-sharing and engagement activities, CNL seeks to build awareness and learn about interests and concerns in an effort to strengthen mutual understanding and pursue

opportunities for collaboration and long-term relationships. CNL engages with First Nations and Red River Métis leadership, representatives and members on the potential effects of the WR-1 Project and the Whiteshell Laboratories Closure Project (WLCP) on the environment and on Indigenous and/or treaty rights including rights to trap, hunt, fish, gather and conduct cultural ceremonies.

CNL has five overarching Indigenous engagement goals:

- **Build awareness and mutual understanding** by supporting and facilitating opportunities for mutual learning on topics including current and traditional use, values and perspectives on nuclear decommissioning, environmental remediation and radioactive waste management, in order to demonstrate CNL's long-term commitment and approach to safe and responsible management of radioactive waste and decommissioning liabilities (e.g., through site monitoring activities).
- **Share information on the project**, including the potential effects on the environment. This includes developing meaningful, user-friendly information and communication products for the First Nations and the Red River Métis, and providing accessible and current information on project activities.
- **Seek input and feedback from the First Nations and the Red River Métis** on project-related activities, and traditional and current uses of the land surrounding the WR-1 project site. Initiate early and meaningful two-way communication between CNL and the First Nations and the Red River Métis to determine the best methods for sharing information and to provide opportunities for Indigenous Peoples to give input on project considerations including design, the EA process, and assessment of impacts.
- **Develop long-lasting relationships with the First Nations and the Red River Métis** to support their continued involvement in the project, community healing and reconciliation. This will extend beyond the scope of the EA process for WR-1.
- **Meet or where possible exceed all regulatory-based communication and engagement requirements** and facilitate engagement that reflects current memorandums of understanding and contribution agreements, and that takes into account the interests, needs and schedule of each Indigenous Nation.

15.2.2 Identified Indigenous Communities

CNL developed a list of the First Nations and the Red River Métis with a potential interest in the WR-1 Project and the WLCP. The identification of the First Nations and the Red River Métis was based on consultation with the CNSC, through CNL's previous Indigenous engagements, and through the use of publicly available sources of information including:

- First Nation and the Red River Métis and organization websites;
- The Aboriginal and Treaty Rights Information System (ATRIS; Government of Canada and INAC 2016); and
- Crown-Indigenous Relations and Northern Affairs Canada First Nation community profiles.

The list was based on the identified potential or established Indigenous or treaty rights of the First Nations and the Red River Métis and is provided in Table 63 with a brief rationale for inclusion. The inclusion of specific Nations considers the nature of the established and/or claimed rights and potential effects on those rights caused by the proposed project, based on a preliminary assessment of existing and available information. As such, the working list is subject to change based on information and dialogue with the identified First Nations, the Red River Métis, and Indigenous organizations.

Table 63: Identified Indigenous Communities

First Nations, the Red River Métis or Organizations	Identification Rationale
Sagkeeng First Nation (Treaty No. 1 and 3)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve located 52 kilometres (km) north of the WL site, and downstream along the Winnipeg River. Existing relationship and interest in the Whiteshell Laboratories site.
Brokenhead Ojibway Nation (Treaty No. 1)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy three reserves: 44 km northwest, 55 km northwest and 73 km southwest of the Whiteshell Laboratories site respectively. Interest expressed comments on Project Description.
Manitoba Métis Federation (MMF)	The MMF is the official democratic and self-governing political representative for the Métis Nation's Manitoba Métis Community. The MMF is considered the government of the Red River Métis. Potential asserted and/or established Métis harvesting rights in the vicinity of the Project. Interest expressed comments on Project Description.
Black River First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve 75 km north of the Whiteshell Laboratories site.
Hollow Water First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Occupy one reserve, 113 km north of the Whiteshell Laboratories site.
Shoal Lake No. 40 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 94 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Iskatewizaagegan No. 39 Independent First Nation (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.

First Nations, the Red River Métis or Organizations	Identification Rationale
	Occupy four reserves: 93 km southeast, 102 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Northwest Angle No. 33 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 111 km southeast, 140 km southeast and 176 km southeast of the Whiteshell Laboratories site, respectively.
Wabaseemoong Independent Nations (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy four reserves: 80 km east, 85 km east, 95 km east and 140 km southeast of the Whiteshell Laboratories site, respectively.
Grand Council of Treaty 3	Umbrella treaty organization which represents 28 First Nations and 5 with potential interest in the Project. Treaty 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.
Chiefs of Ontario	First Nations umbrella organization that represents 133 First Nations and 4 with potential interest in the Project

15.2.3 Summary of Engagement

Table 64 lists CNL's Indigenous engagement activities related to the WLCP from 2021. Further details on Indigenous engagements are available in the Indigenous Engagement Report [53].

Table 64: CNL Indigenous Engagement Activities for 2021

Date	Event	Location
Sagkeeng First Nation (SFN)		
January 5	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 18	Discussion on the application of Free Prior and Informed Consent on the WR-1 Project	Teleconference
March 9	Discussion with Chief and Council on engagement with Sagkeeng's members	Teleconference
April 6	Leadership discussion on Sagkeeng's Psychosocial Impact Assessment Report	Teleconference
April 15	Site Tour with Sagkeeng's Liaison Officer	On-Site Visit
June 16	CNL, AECL, and Sagkeeng participated in first Technical Working Group meeting	Teleconference
June 17	Sagkeeng's Liaison Officer visits the site to record video for National Indigenous Peoples Day	On-Site Visit
July 14	Sagkeeng's Liaison Officer participated in a bat survey on site	On-Site Visit
July 19	CNL, AECL, and Sagkeeng participated in second Technical Working Group meeting	Teleconference
August 11	Sagkeeng's Liaison Officer participated in a site tour	On-Site Visit
August 12	Sagkeeng's participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 17	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
August 24	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 7	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 14	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
September 22	Sagkeeng's Liaison Officer participated in Trauma-informed Engagement Training with CNL, AECL, and the CNSC	In-person, Winnipeg
September 28	Sagkeeng's participated in the second preliminary discussion of the Indigenous Advisory Committee	In-person, Winnipeg
November 10	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
November 15	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
December 15	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
Manitoba Metis Federation		
January 6	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 8	Technical Workshop on WR-1 Groundwater Monitoring	Teleconference
February 18	Environmental Monitoring and MMF Green Initiatives Discussion	Teleconference

Date	Event	Location
March 2	Technical Workshop on Alternative Means Assessment and VC Components	Teleconference
March 9	Discussion on developing a relationship agreement	Teleconference
March 17	Overview presentation on the site's Environmental Protection Program	Teleconference
May 11	Wrap-up Meeting for Technical Workshops	Teleconference
May 25	Discussion on participation in site field monitoring	Teleconference
June 2	Discussion on WR-1 draft commitments and relationship agreement	Teleconference
June 3	Update on Whiteshell Laboratories Closure Project	Teleconference
June 14	MMF participated in groundwater monitoring, a songbird survey, and a turtle search at the site	On-Site Visit
June 18	Discussion on developing a relationship agreement	Teleconference
June 22	MMF participated in a bat survey on site	On-Site Visit
June 23	MMF participated in the a second bat survey on site	On-Site Visit
July 14	MMF participated in the a third bat survey on site	On-Site Visit
August 12	MMF participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 13	MMF hosted a leadership discussion with CNL's President and AECL's	In-person, Winnipeg
August 16	MMF observed river sediment, soil, and vegetation sampling	On-site Visit
August 19	MMF, CNL, and the CNSC participated in a trilateral meeting	Teleconference
August 19	Discussion on collaborating on a green initiative	Teleconference
September 8	MMF participated in Mushroom collection at site	On-Site Visit
September 21	Discussion on developing a relationship agreement	Teleconference
September 28	MMF participated in a second preliminary discussion on developing the Indigenous Advisory Committee	In-person, Winnipeg
October 20	Alpha Targeted Therapy Discussion	Teleconference

Date	Event	Location
November 17	Alpha Targeted Therapy Discussion	Teleconference
November 22	Discussion on developing a relationship agreement	Teleconference
December 2	Discussion on developing a relationship agreement	Teleconference
Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation		
February 1	Discussion on developing a relationship agreement	Teleconference
April 1	CNL, Black River First Nation, and Hollow Water First Nation sign a relationship agreement	E-mail
May 18	Discussion on onboarding the newly appointed liaison officer	Teleconference
May 25	Liaison officer participated in a site tour	On-Site Visit
June 1	Liaison officer onboarding discussion	Teleconference
June 23	Participating in site monitoring discussion	Teleconference
July 6	Participating in site monitoring discussion	Teleconference
July 14	Liaison officer participates in bat survey	On-Site Visit
August 12	Communities participate in preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 16	Liaison officer participates in observation of river sediment, soil, and vegetation sampling	On-Site Visit
August 19	WR-1 Environmental Impact Statement Document review discussion	Teleconference
September 20	Update on Site Decommissioning Activities	Teleconference
September 28	Communities participate in second preliminary discussion of the Indigenous Advisory Committee	Teleconference
November 10	Six-month Relationship Agreement Discussion	Teleconference
December 13	Update meeting of community liaison committee development	Teleconference

15.2.4 CNL's Long-Term Relationship with Indigenous Peoples

CNL recognizes First Nations and the Red River Métis as stewards of the land and is working towards developing meaningful long-term relationships with each Nation that occupies and has traditional territories and/or modern-day interests near its site operations. CNL recognizes each Nation has its own unique set of interests and concerns associated with both the WR-1 decommissioning project and the WLCP is committed to taking a distinctions based approach to engagement to ensure each Nation's interests and concerns are addressed. CNL also takes a

holistic, relationship-based approach to engagement with each Nation, working closely with AECL, to help address interests and concerns regarding all aspects of the WLCP.

This shift in CNL's Indigenous engagement approach from project based engagement to a holistic, relationship and distinction-based approach will support meaningful actions to build foundations for trust, understanding, and mutually beneficial relationships, including addressing broader issues and concerns such as the historical siting of the Whiteshell Laboratories site.

CNL is currently working with each Nation to formalize these relationships through relationship-building and corresponding agreements. These agreements are intended to help enable greater integration of Traditional Knowledge, ceremony, and cultural and stewardship practices in the decommissioning, monitoring, and closure of the project. These agreements will also enable dialogue and participation through the development of monitoring programs, culturally appropriate communications, and trauma-informed engagement. In addition, the agreements help to enhance community engagement, build trust and strengthen relationship-building, and provide mechanisms that facilitate Indigenous participation and input into CNL's environmental monitoring program, economic development and procurement opportunities, future land use, and other areas of collaboration.

CNL has signed a relationship agreement with Black River First Nation and Hollow Water First Nation. Relationship agreements with Sagkeeng First Nation and the Red River Métis are contemplated, and steps are being taken to negotiate such agreements. CNL is committed to ongoing engagement and finalizing these agreements.

CNL continues to build relationships with local First Nations and the Red River Métis to support overall decommissioning of the Whiteshell Laboratories site, including the WR-1 Project. CNL is committed to learning about Indigenous values through ceremony and ongoing dialogue, and discussing, incorporating, and addressing concerns to the extent possible.

16 Acronyms

α	Alpha
ACMR	Annual Compliance Monitoring Report (formerly Annual Safety Review (ASR) or Annual Compliance Report (ACR))
AECL	Atomic Energy of Canada Limited
ALWTC	Active Liquid Waste Treatment Center
β/γ	Beta-Gamma
CCSF	Concrete Canister Storage Facility
CNEA	Canadian National Energy Alliance Limited
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COVID-19	Novel Coronavirus Disease 2019
CRL	Chalk River Laboratories
DRL	Derived Release Limits
EM	Environmental Monitoring
EmP	Emergency Preparedness
EnvP	Environmental Protection
GHG	Green House Gases
HCF	Hot Cells Facility
ImpAct	Improvement Action
LCH	Licence Conditions Handbook
LLD	Lower Limit of Detection
LLW	Low-Level Waste
LLLW	Low-Level Liquid Waste
LLLWTS	Low-Level Liquid Waste Treatment System
LMDL	Laboratory Method Detection Limit
NEW	Nuclear Energy Worker
OPEX	Operating Experience
OSH	Occupational Safety & Health
REGDOC	Regulatory Document

R&D	Research & Development
RP	Radiation Protection
SAR	Safety Analysis/ Assessment Report
SCA	Safety and Control Area
SF	Shielded Facilities
TLD	Thermoluminescent Dosimeters
WL	Whiteshell Laboratories
WLCP	Whiteshell Closure Project
WMA	Waste Management Area

17 References

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Appendix A Concrete Canister Storage Facility

A.1 Operations

The Concrete Canister Storage Facility (CCSF) is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [54]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2021, staff of the Site and Nuclear Operations Branch monitored the operation of the CCSF.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2021.

Routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

With the recognition of increased work in the CSSF and WMA, three operator trainees were hired, with two of the trainees starting in late 2021. A senior operator was appointed as Facility Supervisor.

In 2021, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [54]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the CCSF in 2021. Procedures for the Facility began their updates as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

A.2 Compliance Monitoring

A.2.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in October. Despite multiple attempts flow could not be established in the Canister 8 air lines, these air lines have had issues in previous years obtaining flow. The normal approach to establishing air flow through lines was unsuccessful. Attempts will be made in 2022 to clear the line again.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters that were measured.

There was no visible moisture detected from the internal canister space during 2021 monitoring, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.2.2 Monitoring of Ground and Surface Water

Figure 12 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, and compliance results for the CCSF are described below.

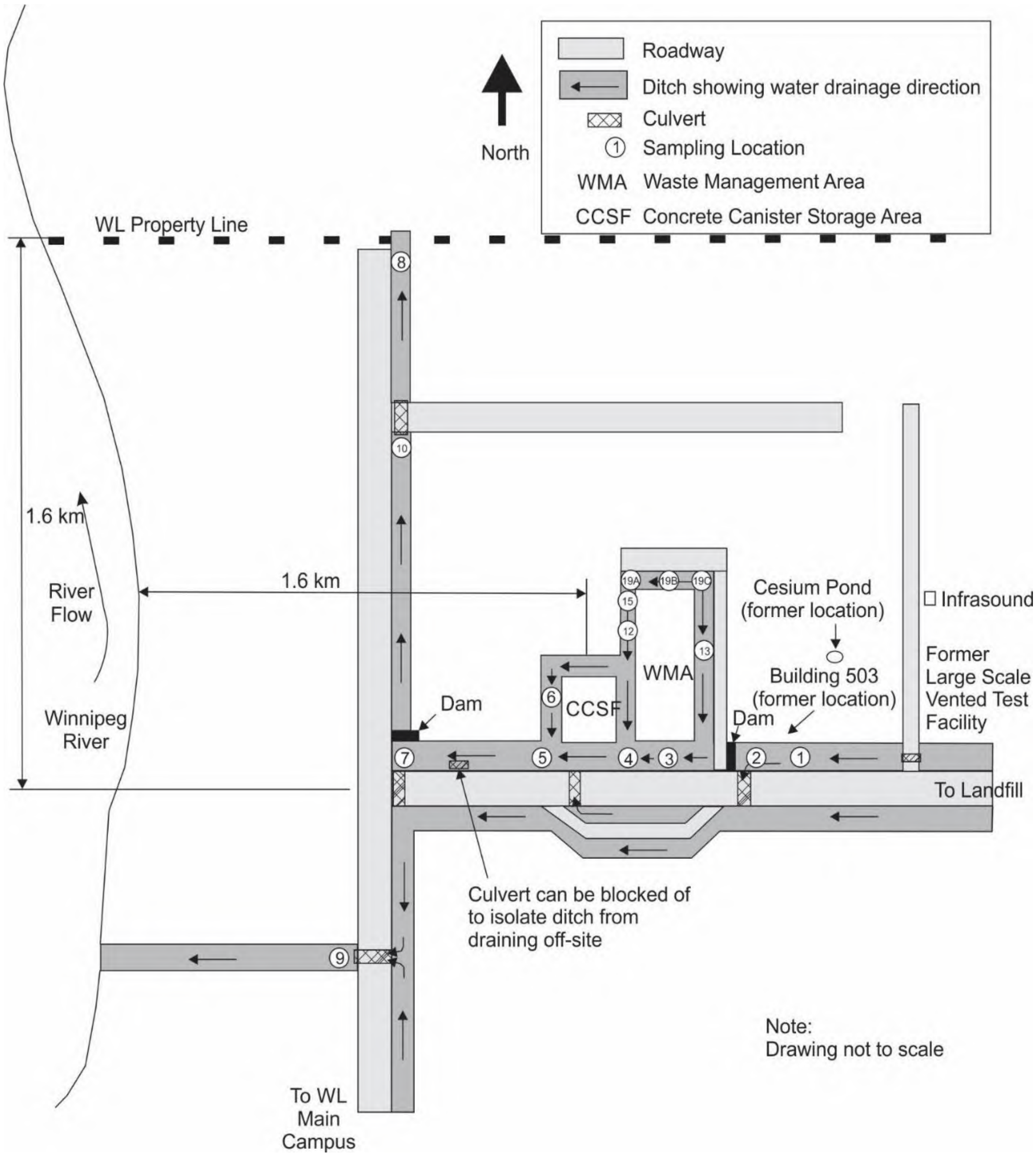

Figure 12: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Appendix D of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Strontium (Sr)-90. Gamma spectrometry analysis provides individual results for Cobalt (Co)-60, Niobium (Nb)-94, Antimony (Sb)-125, Cesium (Cs)-134, Cs-137 (Barium (Ba)-137m), Promethium (Pm)-147 and Americium (Am)-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [34]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Ditch Location 5 and Ditch Location 6 samples (see Figure 12 for sampling locations) could contain surface drainage from the CCSF, however, due to drought conditions and limited snow fall over the 2020/2021 winter, there was only one day with sufficient ditch water movement. This did not include Locations 5 and 6.

The alpha activities were below the trigger level of 0.5 Bq/L.

Table 65, Table 66, Table 67 and Table 68 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2021. Operational control-monitoring data from previous years has been included for completeness.

The ditch sample collected immediately downstream from the WMA (Location 7) contained elevated levels of tritium[12] (see Table 67), which did not exceed the associated Maximum Acceptable Drinking Water concentration of 7,000 Bq/L [34]. The activity seen is from the WMA as discussed in Appendix D.

[12] Tritium analysis of samples from Ditch Locations 5 and 6 was previously discontinued due to the higher levels of tritium (~4000 Bq/L) noted at upstream locations associated with the WMA.

Table 65: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.56	1.02	2.37	0.69	0.61	IF

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 66: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.25	0.24	0.29	0.27	0.36	IF

a The reference nuclide for total alpha is total Uranium.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry
ND Sample not available for analysis

Table 67: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	**Sampling Data (Total Tritium Bq/L) in 2021**
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	706	699	111	117	67	IF

a Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 68: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data[a] (Uranium ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	NR	NR	24.70[b]	13.8	11.3	IF

a Arithmetic average of samples collected.
b Single Value
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

A.3 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13]. There were no major facility changes made in 2021.

A.4 Equipment Performance, Planned Maintenance Testing and Inspections

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2021. None of the canisters had a deviation greater than 1°. In 2021, Canister C5 had a deviation of 0.8° to the east. This deviation and those observed on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2021.

As required by Section 8 of the Facility Authorization [54], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2021. The general appearance and fencing were found to be satisfactory on each inspection. Minor infilling was done along the base of the fence to meet security requirements.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes and it has been noted that edges of many pour pockets are more brittle as was noted in 2020. Selective patching is done of these pour pockets, only minor patching was conducted in 2021. No increased radiation field was noted from the canisters.

A.4.1 Canister Site Monitoring and Surveillance

GAMMA FIELD SURVEYS

Gamma exposure rates from the canisters were measured quarterly in 2021. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No gamma field anomalies were found during 2021.

Table 69 shows the averaged gamma near contact exposure rates measured during 2021, and for the previous four years.

Table 69: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.08	0.08	0.07	0.08	2021	C13	0.16	0.18	0.12	0.14	2021
	0.07	0.08	0.06	0.09	2020		0.16	0.25	0.15	0.14	2020
	0.11	0.08	0.10	0.12	2019		0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
	0.08	0.08	0.09	0.08	2017		0.18	0.25	0.15	0.18	2017
C6	0.08	0.08	0.08	0.08	2021	C14	0.11	0.09	0.09	0.07	2021
	0.08	0.09	0.07	0.09	2020		0.11	0.17	0.15	0.13	2020
	0.09	0.11	0.10	0.08	2019		0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
	0.08	0.10	0.08	0.06	2017		0.11	0.18	0.17	0.13	2017
C7	0.11	0.14	0.09	0.14	2021	C15	0.20	0.32	0.23	0.21	2021
	0.15	0.12	0.13	0.14	2020		0.29	0.37	0.27	0.29	2020
	0.18	0.16	0.14	0.16	2019		0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
	0.20	0.16	0.14	0.14	2017		0.33	0.39	0.31	0.30	2017
C8	0.11	0.12	0.10	0.10	2021	C16	0.17	0.21	0.15	0.15	2021
	0.11	0.12	0.10	0.09	2020		0.16	0.21	0.15	0.17	2020
	0.11	0.13	0.11	0.11	2019		0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
	0.10	0.10	0.10	0.09	2017		0.18	0.29	0.13	0.17	2017
C9	0.23	0.18	0.16	0.18	2021	C17	0.12	0.12	0.20	0.20	2021
	0.23	0.21	0.14	0.22	2020		0.15	0.13	0.23	0.22	2020
	0.26	0.23	0.17	0.21	2019		0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
	0.25	0.19	0.20	0.22	2017		0.20	0.15	0.23	0.24	2017
C10	0.16	0.20	0.17	0.13	2021	C18	0.52	0.70	0.94	0.55	2021
	0.23	0.20	0.19	0.42	2020		0.67	0.49	1.05	0.55	2020
	0.24	0.28	0.22	0.21	2019		0.69	0.76	1.25	0.62	2019
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
	0.24	0.30	0.21	0.22	2017		0.70	0.70	1.22	0.70	2017
C11	0.25	0.17	0.21	0.27	2021	C19	0.16	0.18	0.16	0.17	2021
	0.19	0.21	0.23	0.28	2020		0.16	0.17	0.20	0.17	2020
	0.25	0.24	0.29	0.29	2019		0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
	0.26	0.26	0.30	0.30	2017		0.18	0.18	0.25	0.22	2017
C12	0.16	0.15	0.12	0.08	2021	C20	0.11	0.09	0.13	0.13	2021
	0.16	0.19	0.10	0.13	2020		0.14	0.12	0.14	0.16	2020
	0.19	0.21	0.13	0.13	2019		0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018
	0.22	0.25	0.15	0.13	2017		0.16	0.11	0.18	0.18	2017

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h =1 mrem/h

AIR MONITORING

Air monitoring was conducted on each of the canisters in the CCSF in 2021. This involved an air pump that circulates air from an outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero. As 2021 was a drier, warmer year, 7 months of sampling were done. As discussed above in Section A.2.1, flow could not be established in the Canister 8 air lines.

One anomalous but still low reading was found in Canister 20 leading to an average of 1.8 Bq/filter for the year. As the other readings were zero, this reading was retained but it is not indicative of a trend. Canister 13 and 16 had single readings slightly greater at 1 Bq/filter. The values may also relate to some disturbances of contamination on the baskets by the previous year's visual observations and the air flow from sampling.

Table 70 shows the averaged beta readings on each filter measured during 2021, and for the previous four years.

Table 70: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	7	<0.02	2021	C13	7	0.25	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	0.02	2017
C6	7	0.02	2021	C14	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	<0.02	2017
C7	7	<0.02	2021	C15	7	0.12	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C8	7	No Flow	2021	C16	7	0.16	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C9	7	0.02	2021	C17	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C10	7	<0.02	2021	C18	7	0.03	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
	6	<0.02	2017		6	<0.02	2017
C11	7	0.03	2021	C19	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
	6	<0.02	2017		6	0.03	2017
C12	7	<0.02	2021	C20	7	1.81	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.03	2017

A.5 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

See Section 11.1 Waste Management Program for summaries of any volume of radioactive solid and/or liquid waste generated in the CCSF in 2021.

A.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the CCSF as part of routine operations.

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix B Active Liquid Waste Treatment Center

B.1 Operations

The Active Liquid Waste Treatment Center (ALWTC) in Building 200 did not operate in 2021.

Previously, in 2020 October, CNL notified the CNSC that the ALWTC, Building 200 was being demolished and had requested that the Facility Authorization [55] and the Safety Analysis Report [56] associated with the ALWTC be removed from the Whiteshell Laboratories LCH [14]. CNSC granted this request in 2020 December [57].

In 2017, new LLLWTS began operation in Buildings 100 and 300. All of the Building 100 low level liquid waste is now being tested, treated and controlled release to the river in the Building 100 LLLWTS and likewise in Building 300.

In 2020 October, the last of the operating systems in Building 200 were shut down and isolated (ventilation and compressed air systems). The building was rendered cold and dark and demolition of the building started later in 2020 October. Demolition of Building 200 above grade and 1.5m below grade were completed in 2021 October. The demolition footprint is still fenced and protected. The fence will remain until the potentially contaminated ground can be remediated.

B.2 Facility Changes

The demolition of the building was completed in 2021 October.

B.3 Wastes Generated

No solid radioactive or hazardous waste was generated in the ALWTC as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the ALWTC during demolition activities in 2021.

B.4 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the ALWTC as part of routine operations.

Appendix C Shielded Facilities

C.1 Operations

The WL Shielded Facilities (SF) operates under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [58]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shut down and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of HEPA filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

There were no organizational changes in 2021. Although there was a reduction in the staffing for the operating staff responsible for the SF in 2021, the minimum staffing requirements outlined in the SF Facility Authorization [58] was maintained at levels to provide the needed operational and safety support.

No program changes were made for the SF in 2021. Procedures are being updated as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

C.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

C.3 Equipment Performance, Planned Maintenance Testing and Inspections

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Equipment tests and inspections were completed with the exception of a secondary Intermediate-Level Liquid Waste containment tank leak detector due to a defective probe. Compensatory measures were put in place until the detector was repaired. Monthly housekeeping and fire prevention inspections were completed.

VENTILATION SYSTEM

Maintenance activities requiring part of the ventilation system to be taken down occurred without incident.

The annual routine Poly-Alpha-Olefin testing of the HCF HEPA filters were successfully conducted.

C.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of the volume of radioactive solid and liquid wastes generated in the SF in 2021.

LOW-LEVEL SOLID WASTE

In 2021, the SF generated 45.6 m^3 of compactable low-level radioactive solid waste and no non-compactable waste.

The Waste Handling Area processed 62.1 m^3 of low-level radioactive solid waste which was reduced to 5 m^3. A portion of this waste was generated in the SF, and the remainder came from all of the nuclear facilities and decommissioning projects at WL where waste is being generated.

Table 71 lists the annual low-level solid waste generated in the SF for 2021 and the previous four years.

Table 71: Solid Wastes Generated

Total Volume	2017	2018	2019	2020	2021
Low-Level Solid Waste (m^3)	0.4	73.3	64.3	10.9	45.6
Medium-Level Solid Waste (m^3)	0	0	0	0	0

MEDIUM-LEVEL SOLID WASTE

In 2021 the SF generated no medium-level (intermediate-level) radioactive solid waste. Table 71 lists the annual medium-level solid waste generated for 2021 and the previous four years.

LOW-LEVEL LIQUID WASTE SYSTEM

In 2021, 99 m^3 of low-level liquid waste was processed through the Building 300 low-level liquid waste system (see Appendix E).

MEDIUM-LEVEL LIQUID WASTE SYSTEM

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2021, there was one transfer of 0.1 m^3 medium-level liquid waste to transportable totes that is being stored for future disposition.

Table 88 lists the annual aqueous waste generated for 2021 and for the previous four years.

C.5 Effluents Released

Liquid radioactive and hazardous effluents were discharged from the SF as part of routine operations are provided and discussed in Section 9, Environmental Protection.

Appendix D Waste Management Area

D.1 Operations

The Waste Management Area (WMA) operated under the WL Site Licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [59]. During 2021, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2021, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, Facility Supervisor, WMA Operators and two WMA based utility workers, with support from other Site and Nuclear Operations personnel and Environmental Monitoring personnel as required.

In 2021, the staffing of the WMA was increased. A Facility Supervisor (Senior Operations Technician) was appointed and three additional Operations Technologist trainees were hired.

In 2021, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the WMA in 2021. Procedures are being updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

D.1.1 Inventory Additions And Deletions

Changes in inventory are reported in Table 72 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.2 Low-Level Solid Waste

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. Some of the inventory of stored waste in WMA was sent to CRL for storage pending future disposal. The stored volume of waste is listed in Table 72.

D.1.3 Industrial Waste

There were no additions of industrial chemical waste during 2021.

Table 72: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2020 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433.	18,798.84	1,967.38	330.58
Additions for 2021	Building 431 to 433	0	0	0
Removals for 2021	LLW Bunker 6 Buildings 431 to 433	9 0	13 0	0 0
Total Accumulation as of 2021 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433	18,789.84	1,954.38	330.58

D.2 Compliance Monitoring

D.2.1 Monitoring And Surface Water

SURFACE WATER

Figure 12 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period. In 2021, there was only one day where the ditch flow met the required flow conditions in some sample locations due to the light snow pack leading to limited snow melt, limited rainfall and dry soil conditions.

A recorded amount of precipitation of 395 mm occurred in 2021, which was less than the 441 mm recorded in 2020, and is a ten year low for recorded precipitation. The low precipitation is reflective of an ongoing drought in the area.

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

- If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.

- If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, as was the case last year, all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration (MAC) established by Health Canada [34]. If uranium is detected, the result is evaluated against the MAC for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity at ditch sample Locations 1 to 7 (Table 73) all remained well below 10 Bq/L. Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. Most beta activity levels in the ditch water remained below the drinking water screening level of 1 Bq/L, and below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137 [60]. Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. There were no exceedances of the Canadian Drinking Water [34] standard of 1.0 Bq/L (Table 73) in 2021.

The alpha activity levels in the surface water are presented in Table 74, and were below the trigger level of 0.5 Bq/L. Uranium results are presented in Table 75.

There was no flow at Locations 19 A, B and C in 2021. In past years, the uranium values recorded at these locations are believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation. This rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018. The Lac du Bonnet Batholith granite is noted to have naturally occurring uranium.

As shown in Table 76, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [34] at all locations with only one result above near-detection limits of 124 Bq/L at Location 7 in 2021. Other locations had no flow or near non-detection of tritium. Locations 19 A, B and C were originally chosen for sampling for the potential migration of cesium-137 due to the presence of the Cesium Pond soil pile. Although the Cesium Pond soil has been removed, CNL will continue to monitor locations 19 A, B and C due to the elevated levels of tritium.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [61], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is slightly elevated immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 4.7 Bq/L in 2021). With the low flow volumes, tritium was only detected in one location. Although the amount measured in Locations 1 to 7 are above that noted at the Control location, the levels are much lower than the Maximum Acceptable Concentration in drinking water for tritium (7000 Bq/L).

Table 73, Table 74, and Table 75 present the WMA surface-water sampling data. The data represents continuing documentation of a spill incident that occurred in 1979 near ILW Bunker 3, from the reference sample point (Location 3) in the southeast section of the WMA, as shown

in Figure 12 and Figure 13. In 2017, sampling Location 3 was reconfigured to allow preparations for future bunker and standpipe remediation, but the location was dry this year due to the dry summer. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater are below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of 1.27×10^7 Bq/L [62]. These tables, and Table 76, have been expanded to include the historical monitoring at Ditch Locations 19 A, B and C, water flow permitting.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. There was no flow recorded in the north WMA ditch in 2021 (Locations 19 A, B and C) (Figure 13). Table 77 reflects this circumstance and shows that previous years indicated no migration of Cs-137 to these ditches.

As Trench 16 has a known quantity of Technetium-99 (Tc-99), Tc-99 measurements were performed as part of ditch water monitoring in 2021. Only one value near the limit of detection was measured (Table 78) The Tc-99 limit for drinking water is 200 Bq/L [60] and the measurement is well below this level.

Table 73: Gross Beta Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	1.23	1.62	1.24	IF	1.96	IF
19 A	0.40	0.69	0.36	0.44[c]	IF	IF
19 B	0.52	0.72	0.24	0.43[c]	IF	IF
19 C	0.39	0.58	0.38	IF	IF	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 74: Gross Alpha Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	0.64	0.28	0.31	IF	0.06	IF
19 A	0.34	0.53	0.92	0.26[c]	IF	IF
19 B	0.36	0.74	0.24	0.51[c]	IF	IF
19 C	0.40	1.05	0.39	IF	IF	IF

a The reference nuclide for total alpha is total Uranium
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 75: Uranium of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data (Average[a] ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	ND	NR	21	IF	10.06	IF
19 A	NR	24	52 [a]	13[b]	IF	IF
19 B	NR	39	NR	16[b]	IF	IF
19 C	NR	67	47 [a]	IF	IF	IF

a Arithmetic average of samples collected
b Based on single sample analyses
ND- Not Detected/Below Detection Limit
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
NR Analysis not required

Table 76: Tritium Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2021
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	228	1335[b]	178	IF	348	IF
19 A	2324	5535	459	543[b]	IF	IF
19 B	4001	8123	325[b]	777[b]	IF	IF
19 C	4203	9610	405	IF	IF	IF

a Arithmetic average of samples collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 77: Cesium-137 Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample	Sampling Data (Total Cesium-137 Bq/L) in 2021
Locations	**25 May**
19 A	IF
19 B	IF
19 C	IF
Background	<1

Historical Cs-137 Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
19 A	ND	ND	ND	<1[b]	IF	IF
19 B	ND	ND	ND	<1[b]	IF	IF
19 C	ND	ND	ND	IF	IF	IF

a Arithmetic average of sample collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 78: Technetium-99 Results from Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Technetium-99 Bq/L) in 2021
Locations	**25 May**
1	1.17
2	ND
3	IF
4	IF
5	IF
6	IF
7	ND
10	ND
13	IF

IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

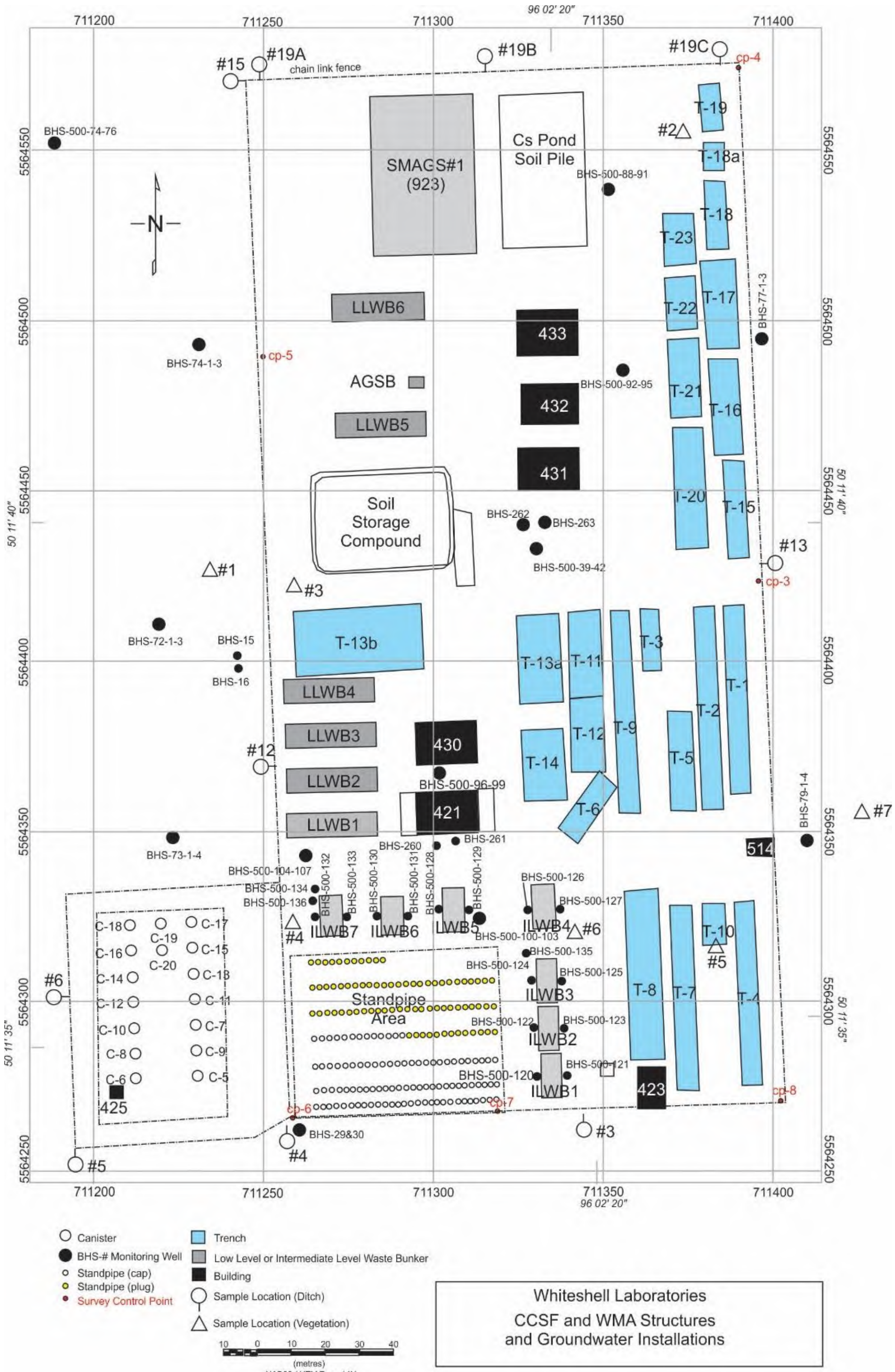

Figure 13: Ground Water Sample Points

INTERMEDIATE - LEVEL WASTE BUNKERS NEAR FIELD WELLS

A series of shallow near field wells were installed adjacent to the ILW bunkers in the WMA in 2015 (Figure 12). Groundwater samples were taken from the wells and from water in the ILW Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile but will bond with sand, and tritium is the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2021, Sr-90 was noted to be a maximum of 34 Bq/L adjacent to ILW Bunker 1, and 20 Bq/L adjacent to ILW Bunker 3. For all other locations, the Sr-90 and Cs-137 levels were minor or negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 79) from the ILW Bunkers, and Sr-90 (Table 80) and tritium levels (Table 81) that are orders of magnitude below the levels observed in the water in the adjacent ILW Bunkers. At ILW Bunker 3, the tritium results remain high (126,326 Bq/L) and moderately high at ILW Bunker 5 (11,051 Bq/L).

A series of water measurements were made as a confirmatory check in 2020 for the presence of base neutral chemicals (e.g., benzenes, ethylenes) and PCBs. These measurements indicated these chemicals were not present in the water around the bunkers. The measurement was not repeated in 2021.

Table 79: Cesium 137 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	31762					
BHS 500-120	-	<1	<1	<1	<1	<1
BHS 500-121	-	<1	<1	<1	<1	<1
ILW Bunker 2	1170					
BHS 500-122	-	<1	<1	<1	<1	<1
BHS 500-123	-	<1	<1	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	<1	<1	<1	<1	<1
BHS 500-125	-	<1	<1	<1	<1	<1
BHS 500-135	-	<1	<1	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	<1	<1	<1	<1	<1
BHS 500-127	-	<1	<1	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	<1	<1	<1	<1	<1
BHS 500-129	-	<1	<1	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	<1	<1	<1	<1	<1
BHS 500-131	-	<1	<1	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	<1	<1	<1	<1	<1
BHS 500-133	-	<1	<1	<1	<1	<1
BHS 500-136	-	<1	<1	<1	<1	<1

a Bunker values from 2015 samples
ND Not detected

Table 80: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate - level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	98300					
BHS 500-120	-	32	15.30	22.10	24.9	33.9
BHS 500-121	-	1.31	4.44	2.92	5.19	4.15
ILW Bunker 2	865					
BHS 500-122	-	0.25	0.21	0.14	0.5	0.68
BHS 500-123	-	1.27	2.55	1.59	1.84	1.08
ILW Bunker 3	26950					
BHS 500-124	-	5.70	11.3	6.58	12.6	19.8
BHS 500-125	-	<0.20	<0.10	<0.10	<0.10	0.69
BHS 500-135	-	0.72	0.74	1.32	0.84	0.75
ILW Bunker 4	2485					
BHS 500-126	-	0.33	0.24	0.30	0.21	0.7
BHS 500-127	-	<0.20	0.28	0.35	0.24	0.56
ILW Bunker 5	3850					
BHS 500-128	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-129	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 6	157500					
BHS 500-130	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-131	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 7	3335					
BHS 500-132	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-133	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-136	-	<0.20	<0.10	<0.10	<0.10	<0.10

a Bunker values from 2015 samples
ND Not detected

Table 81: Tritium Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	42000					
BHS 500-120	-	70	279	258	410	700
BHS 500-121	-	765	2788	2355	1509	1230
ILW Bunker 2	6100					
BHS 500-122	-	1877	475	4274	3587	966
BHS 500-123	-	1876	2554	2834	1640	2942
ILW Bunker 3	4600000					
BHS 500-124	-	158564	83604	128534	179094	126326
BHS 500-125	-	2956	2512	39	2484	2349
BHS 500-135	-	2404	3536	47	2737	3372
ILW Bunker 4	41000					
BHS 500-126	-	69	24	39	225	20
BHS 500-127	-	76	< 4	47	37	45
ILW Bunker 5	5500000					
BHS 500-128	-	2981	2674	2655	2793	2748
BHS 500-129	-	10700	9100	9633	9601	11051
ILW Bunker 6	210000					
BHS 500-130	-	310	29	5	37	50
BHS 500-131	-	22	19	5	38	4
ILW Bunker 7	970000					
BHS 500-132	-	49	131	100	NR	94
BHS 500-133	-	16	<4	6	158	20
BHS 500-136	-	36	78	72	58	97

a Bunker values from 2015 samples
ND Not detected

WATER TABLE WELLS AND DEEP WELLS

Water samples were collected from wells in and around the WMA (Figure 13) in the spring and fall of 2021. The gross alpha and gross beta results are summarized in Table 82. The beta activity levels in the clay, clay till and basal zone wells remained below the drinking water screening level of 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs-137

(10 Bq/L) [34]. The average alpha activity in the samples collected from the Basal zone wells was below the screening level.

Uranium concentrations in the basal zone wells ranged from 0 to 0.59 Bq/L. The concentrations in the Clay zone wells ranged from 0.19 to 3.60 Bq/L, and in the clay till from 0 to 1.61 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [63], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (23.29 Bq/L) and clay-till (11.33 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA.

Table 82: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2017 Avg. (Bq/L)	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2020 Avg. (Bq/L)	2021 Avg (Bq/L)	2021 Avg. Range (Bq/L)
Total Beta [a]						
Clay	0.35	0.29	0.42	0.26	0.43	0.19 to 1.39
Clay Till	0.36	0.25	0.26	0.30	0.45	0.09 to 1.06
Basal	0.16	0.13	0.34	0.11	0.25	0.11 to 0.91
Total Alpha [b]						
Clay	1.01	1.03	0.87	0.52	0.67	0.27 to 2.81
Clay Till	0.77	0.72	0.75	0.80	0.58	0.07 to 1.21
Basal	0.10	0.12	0.22	0.14	0.19	0.03 to 0.48
Total Uranium [c]						
Clay	0.90	0.88	0.86	0.70	0.82	0.19 to 3.60
Clay Till	0.52	0.62	0.60	0.71	0.55	0.003 to 1.61
Basal	0.01	0.04	0.01	0.06	0.03	0.003 to 0.59
Total Tritium						
Clay	11.60	11.36	8.07	7.56	10.37	3.11 to 55
Clay Till	13.36	13.51	14.07	21.31	11.33	3.32 to 65.21
Basal	4.08	4.63	5.66	3.48	3.59	3.16 to 4.62

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value calculated from the concentration of uranium in the water sample

HIGH-LEVEL LIQUID WASTE TRAY WATER

Monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. This is sampled in the summer months. The sample results indicated no leakage has occurred from the tanks. The data are

summarized in Table 83. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 83: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2017 Avg (Bq/L)	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2020 Avg (Bq/L)	2021 Avg (Bq/L)	2021 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	13.8	13.8	12.1	11.2	17.7	13.6 to 25.3
Total Alpha [b]						
Tank Tray Water	0.65	0.69	1.5	0.95	0.2	0.1 to 0.4

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13Bq/L of the gross beta activity is due to K-40.

b The reference nuclide for total alpha is Pu-239

D.2.1.1 RADIATION FIELD MEASUREMENTS

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2021 radiation field measurements were similar to those in 2020. The data is summarized in Table 84.

Table 84: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021 Avg	2021 Range
Spring Survey						
South Fence	0.2	0.2	0.2	0.3	0.2	0.1 – 0.3
West Fence	0.4	0.4	0.4	0.3	0.3	0.1 – 0.6
North Fence	0.2	0.2	0.2	0.4	0.2	0.1 – 0.3
East Fence	0.3	0.3	0.3	0.2	0.4	0.1 – 0.5
Fall Survey						
South Fence	0.2	0.2	0.2	0.4	0.3	0.2 – 0.3
West Fence	0.4	0.4	0.5	0.3	0.4	0.2 – 0.6
North Fence	0.2	0.2	0.2	0.3	0.3	0.2 – 0.4
East Fence	0.3	0.3	0.4	0.3	0.2	0.1 – 0.5

D.2.1.2 VEGETATION

In 2021, vegetation samples were collected at monitoring locations within the WMA (Figure 13), and at a control location unaffected by WL operations. The gross beta results are

summarized in Table 85. Potassium (K)-40 represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. The average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90). Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 85: Waste Management Area Vegetation Monitoring Data

WMA Sample Locations	Average Gross Beta[a] (Bq/kg)				
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021Avg
North-East Area[d]	NA	672	450	196	207
Mid-West Area	1619	411	155	173	190
South-West Area	275	414	NA	296	243
South-East Area	460	409	441	230	246
Control Sample[b]	379	187	210	162	171
Background Sample[c]	419	324	317	203	157
East of ILW Bunkers 3 and 4	NA	672	450	NA	218

a The reference nuclide for beta is Sr-90
b Adjacent to the WMA outside of the fence boundary
c Ambient Radiation monitor Stations Background Samples
d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area. Only a single set of vegetation samples was taken as of 2017 as uptake occurs over the summer. Range is no longer included because of this change.

In 2021, the Facility continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Three trainee operators were hired in 2021 to begin increasing staffing to meet with planned decommissioning activities. Staffing was maintained at levels to provide the needed operational and safety support.

D.3 Facility Changes

All facility changes are performed as per the approved Engineering Change Control procedure [13].

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2021 with most of the physical preparatory work done with continued fabrication of extraction equipment off site.

The pad to the east of the north access road had the requisite safety analysis and procedural documents prepared. The pad is now designated as the Recoverable Surface Staging and Storage Area and will be placed into service in 2022 to store Seacan containers containing

waste and oversized items. The Seacan containers or items will be awaiting processing, characterization and packaging for off-site shipment. This was required to allow Building 923 (SMAGS) to be converted to a Cask Loading Facility (CLF).

Building 923 is in the process of being converted to the CLF. In 2021 this included installation of a 15 ton overhead crane, additional lighting and ventilation ducting and an air handling unit. Interior shielding walls were also erected. The current interior equipment is awaiting commissioning and connection of additional power. Further installation work will be done in 2022.

The WR-1 Phase 1 decommissioning waste material was stored in Buildings 432 and 433 in the WMA. Approximately 96% of the WR-1 Phase 1 decommissioning waste stored in Buildings 432 and 433 had been processed by the end of 2016. One oversized crate along with five asbestos crates remain in Building 433 at the end of 2021. Through 2021, work to characterize the contents of B431, B432 and B433 occurred. This effort will continue in 2022 with off site shipping planned.

The marine container used for storing sealed sources that was transferred from Building 430 in the WMA to the Standpipes Protected Area to meet revised security regulations from the CNSC in 2015, remained in place through 2021. Sources are still held pending future dispositioning.

The process to convert Low Level Waste Bunker #6 to the Intermediate-Level Liquid Waste Treatment Centre, Building 202, began in 2021. Work consisted of removal of waste that had been temporarily returned to the bunker due to restrictions in work crews and shipments related to the COVID-19 Pandemic. Once the waste was removed, interior surveys were conducted in preparation for the next phases of work in 2022.

Removal of waste from Low Level Waste Bunker #5 began in 2021. The waste removal is a component of the decommissioning effort for the WMA, and will extend into 2022.

The Waste Transshipment Area outside the northern perimeter of the WMA had its footprint extended and pad upgraded to improve areas of formerly soft ground. The Waste Transshipment Area allows for holding shipments of waste that are ready to be shipped. The larger area will support the planned pace of waste extraction from the WMA.

In 2021, the Waste Transshipment Area also provided access through a west gate in that area to allow for construction of a road along the west side of the WMA. Pads off the west side of that road will host transformers and generators to provide Class IV and Class III power to waste extraction and processing equipment to be installed in the WMA. A non-active organic material laydown area was established on the north end stub of the west road to allow for an area for organic material from the development of the Waste Transshipment Area pad improvement and west road to be retained.

A replacement section of the north fence running from the west side of Building 923 to the east edge of the Recoverable Surface Staging and Storage Area was installed. This fence included an expanded width north gate to allow shipping containers to be transported without having to

raise them above the fence. The fence replacement was done to correct fence sections that were leaning outwards.

On the south side of the WMA, a new well nest was installed to the south of the south road. This well nest was installed to provide groundwater measurements outside of the zone of influence of the work conducted at the WMA. The previous wells fulfilling this role are now too close to the Protected Area expansion to be considered outside the zone of influence and will be used as part of the monitoring network for that area.

A bedrock well was installed to the west of the WMA-CCSF. This provided improved coverage at depth to monitor for potential contaminant migration.

D.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the bunkers and other structures in the WMA remained fit for service. Building 923 and Low Level Waste Bunker #6 were removed from operations pending their conversion to the Cask Loading Facility and Intermediate Level Liquid Waste Treatment Centre respectively. Building 421 continued to operate as a waste examination and re-packaging area, making use of the Temporary Ventilated Enclosure.

Medium-Level Waste Bunker 4 did not have new waste placed in 2021 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues. Medium-Level Waste Bunker 7 is ~86% full with one placement occurring. The percentage full values are estimates only. Road transportable totes of liquid waste remain in the heated Building 430 pending future processing. Building 431 contains historic waste which is in the process of being characterized and packaged. Building 432 and Building 433 also contain various historic wastes and wastes held in various stages of characterization and repacking operations.

A small seepage of an oily substance first noted in 2020 was again noted at the central gasket, near the south wall base of LLW Bunker 1. The substance was sampled in 2020 and found to contain oil and likely degraded liquid organic. The volume was small in 2020 and remained so in 2021. Seepage again only occurred during hot weather, and as weather cooled the seepage stopped. The area will continue to be monitored. The bunker is slated for remediation of its waste in the next few years.

The Soil Storage Compound remained empty of stored waste soil bags. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018 and 2021.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.2.1 under “Intermediate - Level Waste Bunkers Near Field Wells”, and indicates limited migration of tritium beside the ILW bunkers, in particular ILW Bunker 3. There is no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have only found limited levels of contaminants, below drinking water guidelines, suggesting the waste storage structures and natural barriers of low permeability clay soil and upwards groundwater flow are performing as expected. In 2021, the weather was extremely dry and spring melt similarly limited to surface water in ditches was limited to a single set of measurements on one date in May.

As required by Section 8 of the Facility Authorization [59], most routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, however, two tests, both on transformers were not completed in 2021. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [16], and is further discussed in Section 6.

D.5 Wastes Generated

Solid radioactive waste was generated in the WMA as part of routine operations. This was mostly bagged waste generated from routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of radioactive solid waste generated in the Waste Management Area in 2021.

Liquid radioactive waste was generated in the WMA as part of routine operations.

In 2021, approximately 564 L of water was removed from ILW Bunker 4, 863 L of water was removed from ILW Bunker 6 and approximately 114 L of water was removed from ILW Bunker 7. Low Level Waste Bunker 1 had 8 L from the west sump and 227 L from the east sump removed, and Low Level Waste Bunker 2 had 84 L from the west sump and 202 L from the removed from the east sump. The sumps are pumped out by Site and Nuclear Operations personnel using a WMA tanker with pump rig. The water collected in the tanker is later transferred to double walled totes. There totes are retained pending future processing.

The Building 923 sump tank and the Soil Storage Compound were both sampled as required and their water found not to be active in all cases. Water was directed to the WMA ditches. No other storage facilities and collection sumps at the WMA required pumping.

D.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the WMA as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection. There are no liquid effluents generated from this facility.

Appendix E Auxiliary Operation Facilities

E.1 Operations

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2021. There were no organizational changes.

No program changes were made for the auxiliary facilities in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contained experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops were located in the South High Bay.

The research program in the Stage 6 (RD-14M) area was completed in 2018, and operational shutdown was started. The operational shutdown, decontamination, and decommissioning of the remainder of the building was completed in 2015. The demolition of Stages 4 and 7 was completed in 2016. The demolition of Stage 6 was completed in 2019.

During 2021, WL Site and Nuclear Operation's staff and user groups in Building 300 carried out routine operations which included:

- Non-radiological laundry activities.
- Respirator fit test / maintenance activities.
- Ongoing CNL Nuclear Engineering & Systems Analysis R&D activities.
- Cleanup activities associated with decommissioning.
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

Health and Safety Facilities (Buildings 402 and 305)

Building 402 has three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

Environmental and Dosimetry services continued to operate in Building 402 until 2021 May.

In 2021, routine operations were carried out and supervised by Site and Nuclear Operations personnel. Operational cleanout of Buildings 402 and 305 continued and demolition of Building 402 started in 2021 November. Demolition of the building worked around the Whole Body Counter which was scheduled to move in early 2022.

E.2 Facility Changes

All facility changes were performed using the Engineering Change Control procedure [13]. The environmental and Dosimetry services were moved to Building 300. Building 402 was completely isolated and rendered cold and dark in 2021 July.

E.3 Equipment Performance, Planned Maintenance Testing and Inspections

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed up until Building 402 went cold and dark.

E.4 Wastes Generated

There were minimal amounts of radioactive and/or hazardous wastes generated in the facilities as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the facilities in 2021.

Building 300 generated 0.0 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

Building 402 generated 0.8 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

After processing at the Waste Handling Area, all waste was shipped to the WMA for storage.

See Table 86 for a summary of solid wastes for the last five years.

Table 86: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2017	2018	2019	2020	2021
Building 300 (m^3)	14.7	4.5	0.4	0.3	0.0
Building 402 (m^3)	2.8	1	0.7	0.2	0.8
Building 411 (m^3)	355.1	7.6**	0.2**	0.0	0.0

* Volume prior to compaction, all compactable waste is consolidated at the Waste Handling Area.

** Legacy waste processed in 2018 for Building 411 that was decommissioned in 2017.

There was no liquid radioactive and/or hazardous waste generated in 2021 in this facility.

RESEARCH AND DEVELOPMENT (BUILDING 300) LOW-LEVEL LIQUID WASTE SYSTEM

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in Building 300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The

sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2021, 78.3 m^3 of low-level liquid was processed through the Building 300 LLLWTS. Table 87 shows the historical volumes of LLLW processed through the Building 300 LLLWTS and also the total volume of Building 300 and Building 100 LLLW processed.

Table 87 - Historical Records of Low-Level Liquid Waste Processed

	2017	2018	2019	2020	2021
Total Combined Low-Level Waste Liquid Processed (m^3)[a]	172.3[b]	131.5[c]	189.3[c]	107	88.2
Low-Level Waste Liquid Processed in Building 300 (m^3)[d]	46	123	186.5	99	78.3

a All low-level liquid waste processed in Active Liquid Waste Treatment Centre for 2014-2016. This total includes laundry and decontamination and ALWTC facilities for 2014 and 2015. For 2016 the total is Building 100 and Building 300 and ALWTC. After 2017 all low-level liquid waste is processed in Building 100 and Building 300.

b This includes 126 m^3 of low-level liquid waste that was processed through the Active Liquid Waste Treatment Centre in Building 200.

c All Low-Level Liquid Waste processed through the low-level liquid waste treatment systems in Building 100 and Building 300.

d Building 300 LLLWTS came online in 2017 July.

The total activities given below are the combination of the Shielded Facilities, Building 300, and Building 100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the Building 300 and Building 100 LLLWTS during 2021 was 0.01 GBq, compared with 0.01 GBq released during 2020. The maximum release in a month during the year was 0.001 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.001 GBq for 2021 compared with 0.001 GBq released during 2020. The maximum release in a month during the year was 1.4E-04 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Am-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 88 provides a summary of the total activity released for both the Building 100 and Building 300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [30]. These values were revised in 2016. An error was discovered in Table 88, note “d” in previous years’ reports. The alpha DRL was listed as 1.11×10^1 GBq/month, and should have read 1.11 GBq/month. The annual release limits for alpha were calculated using the correct value for DRL. The % of monthly DRL for alpha was calculated using the wrong DRL value. This made the % of monthly DRL for alpha a factor of 10 lower than the true value.

Observed levels of alpha in WL's LLLW active releases are sufficiently low that even with this correction, levels are well below the DRL. This correction was made for the 2021 values.

Table 88 – Building 100 and Building 300 LLLWTS Radioactive Releases

Radionuclide	**Total 2021 Effluent (GBq)**	**Annual Release Limit[a] (GBq/a)**	**Total 2021 Effluent as a % of Annual Release Limit**	**Peak Release**	
				Max. Monthly Release (GBq)	**% of[b] Monthly DRL**
Total (Total-Beta Analysis) [c]	0.01	–	–	0.001	–
Sr-90	1.02×10^{-3}	1.56×10^{2}	0.76×10^{-3}	2.18×10^{-4}	1.87×10^{-3}
Cs-137	3.74×10^{-3}	1.39×10^{2}	2.69×10^{-3}	5.95×10^{-4}	5.12×10^{-3}
Total Alpha (As Pu-239 Equivalent) [d]	0.86×10^{-3}	1.33×10^{1}	6.46×10^{-3}	1.35 x 10-4	1.22×10^{-2}
Historical Data Total Effluent (GBq)					
	2017[e]	2018[e]	2019[e]	2020[e]	2021
Total (Total-Beta Analysis) [c]	0.04	0.02	0.01	0.01	0.01

a The annual release limit is calculated by multiplying the DRL by 12.

b DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [30].

c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.

d DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11 GBq/month [30].

e Year's 2014 to 2016 effluent was all processed in ALWTC. 2017 effluent was processed in ALWTC and Building 300 LLWTS. From 2018 on, all effluent was processed in Buildings 300 and 100 LLWTS.

E.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in Building 300 Room B-33.

Any liquid and/or gaseous releases from the facilities are provided and discussed in Section 9, Environmental Protection.

Appendix F WR-1 Facility

F.1 Operations

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [65]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64].

Routine operations in the WR-1 facility, as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64], were carried out by the five (four and one trainee) Site and Nuclear Operations Technologists assigned to Building 100. Throughout the course of 2021, the number of Building 100 staff dropped to three (two and one trainee) with plans to hire additional staff. Building 100 continued to maintain the minimum staffing requirements outlined in the Facility Authorization [64]. Staffing was maintained at levels to provide the needed operational and safety support.

In 2018, approximately 20 m³ of low concentration (3.4 E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained. Investigation is also ongoing to determine what the impact would be if this water is left in situ as part of the proposed in situ disposal of WR-1.

No program changes were made for WR-1 in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

F.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

F.3 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the operations status of WR-1 remained unchanged. There were no changes to the reactor's equipment.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence. All Monthly housekeeping and fire prevention inspections were completed.

F.4 Wastes Generated

Solid Radioactive and/or Hazardous Wastes

See Section 11.1 Waste Management Program for summaries of the volume of any volume of radioactive solid and/or liquid waste generated in WR-1 in 2021.

Solid radioactive waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

During 2021, 1.5 m^3 of low-level radioactive compactable waste and no non-compactible waste were generated from Building 100/WR-1 operations and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

Liquid Radioactive and/or Hazardous Wastes

Liquid radioactive and no hazardous waste was generated in the facility as part of routine operations.

During 2021, 9.9 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the facility as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix G Non-Nuclear Facilities

G.1 Operations

The WL non-nuclear facilities status and changes for 2021 are as noted in Table 89.

Table 89: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
304	Waste Clearance Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
306	Waste Clearance Facility	Removed in 2016	None	None	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Operational	None	None	All Site/Visitors	No change
408	Stores	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Shut down	None	None	Security and Common Services	Preparing for demolition

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
415	Warm Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Shut down	None	None	Transportation, Security and Stores	Preparing for demolition
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Removed in 2020 l	None	None	Facilities	Building removed,, End-State Report to be completed
426	Quonset: Cold Storage	Shut down	None	None	Utility	Preparing for demolition
427	Cold Mechanical Storage	Removed in 2016	None	None	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Shut down	None	None	Maintenance	Preparing for demolition
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
540	Modular Office Complex	Operational	None	New	Facilities	Modular Trailer office complex installed in parking lot
543	Dosimetry Building	Under Construction	None	New	Facilities	Start of construction 2021 To be completed 2022

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	Relocated from Building 402 to near Building 300 Shielded Facilities. Placed back in Operation.
597	Portable Boiler Building 1	Out of Operation	None	None	Powerhouse Operators and Maintenance	Taken out of Service due to shutdown of Building 200
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hy dro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

[a] Security personnel perform regular patrols of all site buildings

There were no policy, program or procedural changes for the non-nuclear facilities in 2021. There were no changes in organization in 2021.

In 2021, the Facility continued to maintain the minimum staffing requirements to provide the needed operational and safety support.

G.2 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13].

G.3 Equipment Performance, Planned Maintenance Testing and Inspections

Systems and equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2021 with the exception of Compressed Air Systems where one of the three compressors was not operational (awaiting parts). In addition, issues with some gas detection systems were part of the missed preventive maintenance activities that was reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Routine maintenance was carried out, and equipment tests and inspection were completed in 2021 with no significant results.

G.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the non-nuclear facilities as part of routine operations.

G.5 Effluents Released

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the facilities as part of routine operations.

There was 1.15E+09 L of effluent released from buildings Building 422 (Outfall Monitoring Station) and 0 L of effluent released from Building 907 (Sewage Lift Station and Lagoons) as there was no lagoon release in 2021.

Landfill Dugout Water Monitoring

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2021, the precipitation was low over the year (395 mm) and the dugouts had low water levels during the summer sampling period. The location of the dugouts are shown in Figure 14. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

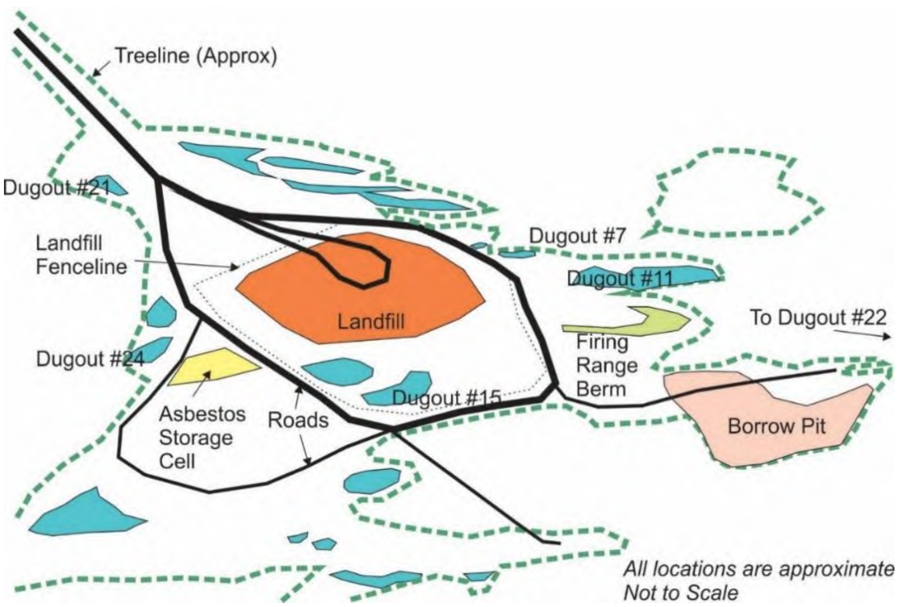

Figure 14: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Table 90 and Table 91 respectively. All alpha results for 2021 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. All beta results for 2021 were near the detection limits, and are below the drinking water screening level of 1.0 Bq/L. Both alpha and beta results for 2021 are consistent with previous results obtained from 2016 to 2020.

Table 90: Gross Alpha Results from the Landfill Dugouts

Sample	Gross Alpha (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	< 0.14	< 0.17	< 0.17	0.07	<0.05	<0.05
Dugout #11	< 0.10	< 0.14	< 0.14	< 0.05	<0.05	0.05
Dugout #15	0.16	0.10	0.10	0.28	<0.05	0.05
Dugout #21	0.16	0.07	0.07	Dry	<0.05	<0.05
Dugout #22	< 0.11	< 0.14	< 0.14	0.11	<0.05	<0.05
Dugout #24	< 0.18	< 0.19	< 0.19	0.29	<0.05	<0.05

Table 91: Gross Beta Results from the Landfill Dugouts

Sample	Gross Beta (Bq/L)					
Location	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Dugout #7	0.19	0.17	0.17	0.11	0.07	0.08
Dugout #11	0.07	0.02	< 0.10	< 0.05	< 0.05	0.01
Dugout #15	0.35	< 0.07	< 0.07	0.12	0.16	0.30
Dugout #21	0.12	< 0.05	< 0.05	Dry	< 0.05	0.13
Dugout #22	< 0.06	< 0.13	0.13	< 0.05	0.05	0.05
Dugout #24	0.26	0.08	< 0.08	0.25	0.06	0.10

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a low value was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there through 2021. The higher tritium level in Dugout 15 was 93 Bq/L, approximately one-half of that measured in 2019 (212 Bq/L). All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2021 that contain < 5 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 92.

Table 92: Results from the Landfill Dugouts

Sample	Tritium (Bq/L)					
Location	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Dugout #7	< 4	< 4	< 4	< 3	< 4	< 5
Dugout #11	< 4	< 4	< 4	< 4	18	< 5
Dugout #15	98	82	105	212	54	93
Dugout #21	< 4	NA	< 4	Dry	< 3	< 5
Dugout #22	< 4	< 4	< 4	< 4	< 3	< 5
Dugout #24	5.5	< 4	76	< 4	< 4	< 5

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has

a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill had been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing conducted in 2018 included Sr-90 and Tc-99, two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. In 2019, only Sr-90 was tested, and was found to be at the detection limit. In 2020, both Sr-90 and Tc-99 were again measured. Sr-90 was at the detection limit and Tc-99 was not detected. In 2021 (Table 93), no Sr-90 analysis was conducted as per the instructions provided to lab to only analyze if gross Beta exceeded 5 Bq/L. Tc-99 was again below the detection limit. The water from these dugouts and wells is not used for human consumption. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99.

Table 93: Sr-90 and Tc-99 Results from the landfill Dugouts in 2021

Sample Location	(Bq/L)	
	Sr-90	Tc-99
Dugout #7	NA	ND
Dugout #11	NA	ND
Dugout #15	NA	ND
Dugout #21	NA	ND
Dugout #22	NA	ND
Dugout #24	NA	ND

NA – No Analysis Gross Beta below analysis trigger limit.

ND – Non Detect

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia (N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron were detected in Dugout #15, a continuation of results from 2017 onwards (Table 94). The value in 2021 remained under the Drinking Water Guideline for Boron (5,000 µg/L). Dugout #24 showed 431 µg/L in 2021, all other dugouts showed values below detection limits.

Table 94: Boron Results from the Landfill Dugout #15

Sample Location	(µg/L)				
	2017	2018	2019	2020	2021
Dugout #15	1630	5460	8460	2040	3760

Molybdenum remained at detection limits from 2020 through 2021. In 2021, Manganese remained higher than drinking water guidelines of 50 µg/L in Dugout #15 (509 µg/L). No other parameters were detected at concentrations of concern.

Groundwater results will be discussed in the annual Environmental Monitoring report [29]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [28].

Landfill Dugout Sediment Monitoring

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, as such no sediment sampling was conducted in 2021.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program [28].

Landfill Radiological Monitoring

Annual radiological monitoring of the landfill surface is performed as a confirmatory measure. The results show readings consistent with background levels at the landfill fence line. Table 95 provides a five year listing of survey results at the top of the landfill. For some years monitoring was performed at the base of the pile, and more recently monitoring was performed around the perimeter of the fenced area of the landfill.

Table 95: Landfill Radiological Monitoring

Sample Location	(µR/h)				
	2017	2018	2019	2020	2021
Landfill Top Surface	10-16	8 - 10	6 -12	6 - 12[2]	10
Landfill Base	< 20	NR	5 - 8[1]	5 - 8[1]	10

NR – Not recorded

[1] Taken at the fence line instead of base of landfill

[2] Metal waste collection bins sited at top of landfill

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Regulatory Requirement Document

DERIVED RELEASE LIMITS FOR CNL'S WHITESHELL LABORATORIES

WL-509211-RRD-001

Revision 5

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Regulatory Requirement Document

Derived Release Limits for CNL's Whiteshell Laboratories

Whiteshell Site Documentation

WL-509211-RRD-001
Revision 5

2018 December | décembre 2018

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D1	2010/12/01	Issued for "Review and Comment."	S. Chouhan N. Scheier	M. Audet A. Ethier K. Ross	
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4D1	2018/09/20	Issued for "Review and Comment". This revision includes the recalculation of the airborne DRLs based on the introduction of three new systems in the Waste Management Area (WMA) and the release of HTO from one or more of these systems. There is no change to the liquid effluents DRLs.	S. Chouhan L. Campagna	B. Reavie K. Ross R. Bilinsky R. Swartz	
4	2018/10/30	Issued as "Approved for review by AECL Safety Review Committee (SRC)."	S. Chouhan L. Campagna	B. Reavie K. Ross R. Bilinsky R. Swartz	J Olfert G. Dolinar
5	2018/12/05	Addressed SRC review. Issued as "Approved for review by CNSC."	S. Chouhan L. Campagna	B. Reavie K. Ross R. Bilinsky R. Swartz	J Olfert G. Dolinar

EXECUTIVE SUMMARY

This report provides revised Derived Release Limits (DRLs) for the operation of Canadian Nuclear Laboratories' (CNL's) Whiteshell Laboratories (WL). These DRLs supersede the values established in 2016 [1].

The DRLs were calculated using the same methodology as in 2016 [1], which is based on Canadian Standards Association (CSA) Guideline N288.1-08, which was developed with Canadian Nuclear Safety Commission (CNSC) involvement. The DRL calculations were performed using the Integrated Model for Probabilistic Assessment of Contaminant Transport (IMPACT) computer code, which embodies the recommended methodology. Previous versions of this code have been validated against experimental data and have been confirmed to be compliant with CSA Standard N286.7, which addresses the quality assurance of computer programs. The results of the DRL assessment were extensively verified to ensure the accuracy of the calculations.

The assumptions regarding the locations and characteristics of population groups located around the WL site are documented and justified. In following the current DRL modelling guidance, conservative assumptions and parameter values were adopted for exposures and intakes, and best-estimate values were used for many environmental transfer parameters and contaminated food source fractions. To the extent possible, site-specific values were used for parameters describing environmental conditions at the WL site, adding to the accuracy of the assessment.

In 2016, DRL's were calculated for one stack location, two roof vent locations and one Waste Management Area (WMA) location for airborne effluents, and for one liquid effluent release location. However, based on the introduction of three new systems in the WMA and the release of tritiated water (HTO) from one or more of these systems, the airborne DRLs had to be recalculated.

The potential critical groups considered in the assessment were the same as in 2016 [1], which include three farm groups having full-time occupancy and a farm group that has limited occupancy. Within these groups, six different age classes were considered, and for the two infant age classes, three milk sources were assessed (cow milk, breast milk and formula milk). Considering the number of release locations, potential critical groups and age classes included in the modelling, the WL DRL study is deemed comprehensive.

For airborne effluents, DRLs for 12 radionuclides are approximately 2% lower than the 2016 DRLs [1]. For one radionuclide (Zn-65), the bounding release location changed from B200 to the WMA and the magnitude of the DRL was lowered by 1%. A new DRL was added for HTO released from the WMA (5.61E+14 Bq week^{-1}) and the previous DRL for HTO released from B100 (1.65E+15 Bq week $^{-1}$) [1] is still valid.

There is no change to the liquid effluent from the 2016 DRLs [1].

ACRONYMS AND ABBREVIATIONS

B100	Building 100
B200	Building 200
B300	Building 300
B401	Building 401
B402	Building 402
BWRS/SCU	Bunker Waste Retrieval System/Sorting and Conditioning Unit
CDG	COG DRL Guidance
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owner's Group
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
DCFs	Dose Coefficients
DRL	Derived Release Limits
HTO	Tritiated Water
ICRP	International Commission on Radiological Protection
ILLTS	Intermediate Level Liquid Treatment System
IMPACT	Integrated Model for Probabilistic Assessment of Contaminant Transport
N288.1	CSA Standard N288.1-08
OBT	Organically Bound Tritium
SA	Specific Activity
SWRS	Standpipe Waste Retrieval System
WL	Whiteshell Laboratories
WMA	Waste Management Area

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APPENDICES

1. INTRODUCTION

1.1 Revision of WL DRLs

This report provides revised Derived Release Limits (DRLs) for emissions of radioactive materials in both airborne and liquid effluents from Canadian Nuclear Laboratories' (CNL) Whiteshell Laboratories (WL) site during normal operation. The WL DRLs have been revised because of the introduction of three new systems in the Waste Management Area (WMA) and the release of tritiated water (HTO) from one or more of these systems. As a result of these changes, the airborne effluent DRLs had to be recalculated. The airborne effluent DRLs in this report supersede those established in 2016 [1], with no change to the liquid effluent DRLs.

The methodology used in the recalculation of the DRLs is identical to that used in 2016 [1]. It is the recommended DRL calculation methodology that is documented in the Canadian Standards Association (CSA) Guideline N288.1-08 [2] (hereafter referred to as N288.1), which is based on the earlier CANDU Owner's Group (COG) DRL Guidance (hereafter referred to as the CDG) [3]. The Canadian Nuclear Safety Commission (CNSC) participated in the preparation of N288.1 [2].

In following N288.1 [2], only values associated with critical group exposure factors, occupancy factors and intake rates are treated conservatively. Other parameters such as the fractions of food and water intakes drawn from contaminated sources have been assigned realistic values. This is intended to reduce the degree of conservatism in the DRLs, as it is broadly recognized that multiple conservatisms yield dose projections that are not representative of the critical group concept (i.e., the projections are representative of extreme individuals). On the same basis, best-estimate values were used for environmental transfer parameters to provide better agreement between model predictions and actual measured environmental concentrations.

1.2 The IMPACT Computer Code

Integrated Model for Probabilistic Assessment of Contaminant Transport (IMPACT) [4], the modelling software used to calculate the DRLs, implements almost all aspects of the methodology recommended in the N288.1 [2]. It includes a database of parameter values, as well as user-friendly interfaces to facilitate the input of scenario-specific information. It outputs compartmental radionuclide concentrations and dose rates as well as DRLs.

The DRL calculations reported here were carried out using the same version (Version 5.4.0) of the IMPACT [4] code and database that was used in 2016 [1]. This version of the code incorporates all the sub models required for application at WL, including methods for calculating dispersion in a river and air immersion dose rates from three-dimensional plumes of contaminated airborne material. The default database has been updated with error corrections as of 2010 July 9 [5]. The software has been subject to validation and verification testing as discussed in [6] and [7]. The development of the previous version of the code (Version 5.2.2) was analyzed and found to be consistent [8] with the requirements of CSA Standard N286.7 [9], which relates to software quality assurance. The development of Version 5.4.0 was also guided by, and is expected to meet the requirements of, that standard.

1.3 The Whiteshell Laboratories Site

The 4,375-hectare WL site is located in the Local Government District of Pinawa in southeastern Manitoba, about 100 km northeast of Winnipeg. Most of the site and all the facilities are located on the east bank of the Winnipeg River (Figure 1-1), which in this area, flows from south to north.

The WL site is in the zone of transition between farmland to the west and the exposed part of the Precambrian Shield to the east, and is overlain by glacial till and sediments. The surrounding terrain is relatively flat, except for the small hills on both sides of the river. Part of the surrounding land is used for farming, with the rest being wooded. Sport fishing is carried out in the Winnipeg River, but there is no commercial fishing in the area.

The area surrounding WL is sparsely populated. The nearest population centres are Lac du Bonnet (population approximately 1,000, located 8.6 km north), Pinawa (population approximately 1,500, located 13.4 km east-southeast), River Hills (population less than 100, located 11.8 km south) and Seven Sisters (population less than 100, located 8.9 km south-southeast) (Figure 1-1). Of greater interest for this study are farms which are much closer to WL.

A near-field map of the WL site is shown in Figure 1-2. There are four main sources of airborne radioactive effluents at WL: Building 100 (B100) (reactor building), Building 200 (B200) (Active – Liquid Waste Treatment Centre) and Building 300 (B300) (shielded facilities and other laboratories), which are located in the complex of buildings in the main part of the site (WL-Main), and the WMA. In the previous DRL [1], the only sources of airborne effluents in the WMA were from the compactor/baler and incinerator. However, three new systems in the WMA will be introduced; the Standpipe Waste Retrieval System (SWRS), the Bunker Waste Retrieval System/Sorting and Conditioning Unit (BWRS/SCU), and the Intermediate Level Liquid Treatment System (ILLTS), which will also contribute to airborne effluents. The compactor/baler and incinerator are no longer in service, but they are discussed in this report to clarify the changes between the 2016 DRL [1] report and this assessment. The only significant source of liquid radioactive effluents from the site is the process outfall from the new Level Liquid Waste (LLLW) processing systems, which began operation in B100 and B300. All of the B100 low level liquid waste is now being tested, treated and released in a controlled manner to the river in the B100 LLLW system and likewise in B300. All of the collection tanks in B200 were then isolated and taken out of service. The B200 sumps have also been taken out of service, and any water collected from the sumps and associated piping was put into drums for processing.

The WL site is currently being decommissioned by CNL. There are no longer tenant businesses on site. There are farm workers on land leased from CNL on the west bank of the Winnipeg River (Farm E). They are not classified as Nuclear Energy Workers and their radiation exposure is not required to be monitored.

Farm E is the farming location which is closest to a source of WL effluents. However, farm workers are present at this location for only a limited duration each year. The closest farming property with year-round occupancy (Farm F) is also on the west bank of the Winnipeg River, but it is further downriver.

The DRLs presented in this report were calculated assuming the current WL site boundary and the supervised area, as shown by a black line in Figure 1-2. If the site boundary and/or the supervised area are to be reduced as a result of ongoing decommissioning of the WL site, and there are changes in the use of affected land, then the impact on DRLs will need to be evaluated.

Figure 1-1 Location of WL Site

Figure 1-2 Near-Field Map of WL Site Showing Effluent Release Locations and Potential Critical Group Locations

2. DERIVED RELEASE LIMITS

CNL's nuclear facilities are required to operate in such a way that radionuclide releases to the environment are well below their DRLs. These limits represent release rates that correspond to critical group exposures at the public dose limit. They are calculated by the licensee from the combined radiation dose that a member of the public receives through all pathways of exposure to a radionuclide that is routinely released to the environment. The DRLs are based on individual doses to average members of a critical group. The critical group is defined so as to represent a group of individuals likely to receive the highest exposures to radionuclides released from a particular source.

Where two or more potential critical groups exist and it is not obvious which would receive the greatest dose, separate calculations are made for each group. Similarly, separate calculations are performed for each age class within a group. The DRL for the radionuclide in question is set equal to the smallest DRL across the age classes and potential critical groups.

N288.1 considers only three age classes (adult, 10-year-old child and 1-year-old infant). However, in the current assessment, the six age classes defined in the International Commission on Radiological Protection (ICRP)-72 [10] and the CDG were considered. These are adult, 15-year-old teenager, 10-year-old child, 5-year-old child, 1-year-old infant and 3-month-old infant.

A separate DRL is calculated for each radionuclide released. However, in order to simplify compliance monitoring some radionuclides can be grouped. For example, the gross beta/gamma-emitting radionuclides released to air (and similarly to water) can be grouped together and the DRL for the most restrictive radionuclide can be applied to that group.

Since the DRL for a given radionuclide (or radionuclide group) is calculated as though only that radionuclide was present in the effluent, facilities must operate to satisfy the following additional condition:

$$\sum \frac{R_i}{DRL_i} < 1.0 \qquad (1)$$

where: R_i is the release rate of the i^{th} radionuclide (or group), DRL_i is the derived release limit for that radionuclide, and the summation takes place over all n radionuclides for releases to both air and water from all effluents.

This condition ensures that all releases combined will not cause a member of the public to receive a dose in excess of the public dose limit.

In order to ensure that this condition is met, and in order to keep public doses as low as reasonably achievable, WL facilities operate with releases at a small fraction of the DRL.

DRLs are calculated assuming that releases from the facility are reasonably continuous and that long-term steady-state is reached in the environment. Consequently, the doses and DRLs calculated in this report are not likely to be indicative of doses that would result from short-term incidents involving abnormal radioactive releases.

Since DRLs reflect the annual dose limit, they can be calculated as annual releases. However, for operational control purposes, airborne release limits are expressed in terms of a period of one week and liquid limits are expressed in terms of a period of one month. Therefore, the DRLs calculated in this assessment are also expressed in these terms.

3. DOSE LIMITS FOR MEMBERS OF THE PUBLIC

The dose limits for members of the public, as set out in the CNSC Radiation Protection Regulations [11], are given in Table 3-1. These limits are based on the 1991 recommendations of the ICRP [12], and are intended to prevent deterministic effects and to limit the occurrence of stochastic effects to an acceptable level.

Table 3-1
Dose Limits for Members of the Public

Application		**Annual Dose Limits ($mSv\ a^{-1}$)**
Effective Dose ($D_{effective}$)		1
Equivalent Dose	Skin (D_{skin})	50
	Lens of the Eye (D_L)	15
	Hands and Feet	50

Paragraph S29 of ICRP Publication 60 [12] recommends that restrictions on effective dose are sufficient to ensure the avoidance of deterministic effects in all body tissues and organs except possibly the lens of the eye and the skin, which may be subject to localized exposures. Hence, there is no equivalent dose limit for other body tissues and organs.

Section 2.1.2 of the CDG [3] states "It has been shown that the equivalent dose to the lens of the eye will not be limiting for the purpose of setting Derived Release Limits [13]. For the lens dose (D_L) to be limiting, it must be true that D_L >15* ($D_{effective}$) and D_L >0.3* (D_{skin}). This condition is met only for Kr-83m, and the dose from this radionuclide is insignificant in comparison to other noble gases. Thus, calculations of effective dose and skin dose are sufficient for determining facility DRLs." Accordingly, only the effective and the skin doses were calculated in this WL analysis.

The possibility of the release of some energetic beta-emitting radionuclides being limited by skin dose was checked. Skin dose calculations were made for all external dose situations (air immersion, groundshine, beachshine and water immersion) for all radionuclides. In no case was the DRL based on skin dose lower than the DRL based on effective dose; hence, only the results for effective doses are discussed further.

4. CALCULATION OF DERIVED RELEASE LIMITS

The steps taken in this assessment to recalculate the DRLs for WL were identical to those used in 2016 [1], which are as follows:

1. Identify the potentially most affected members of the public, determine their characteristics with respect to exposure to radionuclides released from WL to the environment, and select a set of potential critical groups that will form the basis for the DRLs. Determine the parameter values for these groups (Section 5).
2. Identify and characterize the sources of airborne and liquid effluents, the factors influencing atmospheric and aquatic dispersion, and the specific radionuclides to be included (Sections 6 and 7).
3. Identify the environmental pathways models to be used in calculating the DRLs and any assumptions to be made in applying them (Sections 5 and 8).
4. Specify values for the transfer parameters and other data used in the model calculations and any assumptions to be made in applying them (Sections 5, 6 and 8).
5. Set up the model scenarios with the appropriate modelling software (IMPACT) (Section 9).
6. Perform a screening analysis to reduce the number of potential critical groups and release locations for which detailed dose calculations are required (Section 10).
7. Execute the final DRL calculations for each combination of effluent type, radionuclide, critical group, age class and potentially bounding release location (Section 9).
8. Determine the most restrictive DRLs for each radionuclide for airborne and liquid effluents from the DRLs based on the different age classes of the critical group and potentially bounding release locations (Section 11).
9. Confirm the results (Section 12).

Site-specific data were used in the calculations, where possible.

5. CRITICAL GROUPS

5.1 General Discussion

A critical group is a relatively homogeneous group of members of the public who represent the people most highly exposed to radionuclides released from a facility. This may be by virtue of their location or characteristics. DRLs are calculated from the mean dose in the critical group per unit radionuclide release. Recently, N288.1 has replaced the term "average member of the critical group" with the term "representative person". This is a purely cosmetic change. N288.1 states that the representative person "is the equivalent of … the average member of the critical group". The term "critical group" will be used here.

The critical groups considered in the recalculation of the DRLs for WL are identical to those used in 2016 [1]. Potential critical groups have been characterized based on site-specific information rather than by making hypothetical worst-case assumptions. Assumptions related to exposure pathways, occupancy factors, and fractions of the diet that consisted of local food and water were confirmed by interviewing some WL employees residing in surrounding communities. The local fractions applied in this DRL assessment were checked against the default recommendations in Table G.9c of N288.1 in 2016 [1] and were found to be conservative. Assumptions related to newly added pathways in IMPACT were consistent with the recent 2007 Chalk River Laboratories (CRL) DRL calculations [6] and 2010 Nuclear Power Demonstration Site DRL calculations [14].

5.2 Potential Critical Groups

In applying the critical group concept discussed above, a range of types of potential critical groups were identified as being representative of different locations and characteristics of population groups residing in the vicinity of WL.

5.2.1 Potential Critical Groups for Airborne Effluents

For airborne effluents, two types of potential critical groups were considered: farms that have year-round occupants and raise livestock (Farms A, D and F in Figure 1-2), and a farm that has limited occupancy and grows canola (Farm E). Table 5-1 gives the distances and directions of these groups from B200 at WL. The livestock farms are located adjacent to the WL site boundary and lie in high-frequency wind-direction sectors (N, S and NNW) from the effluent sources. A potential critical group location closer to the WMA than Farm A was not selected because the terrain to the east of Farm A is not suitable for farming.

Table 5-1
Distance and Direction of Airborne Effluent Potential Critical Groups from Building 200

Potential Critical Group	Location Relative to Building 200		
	Distance (m)	Direction	
		Degrees from North	Sector
Farm A (livestock)	2,993	353	N
Farm D (livestock and honey)	2,913	177	S
Farm E (canola)	1,313	258	WSW
Farm F (livestock)	2,708	335	NNW

A wide range of types and scales of farming exists on both sides of the Winnipeg River from Seven Sisters Falls to Lac du Bonnet. While it is more common for a particular farm to specialize in one animal product, in this assessment it was conservatively assumed that the livestock farm groups grow most of the animal products that they consume. All the livestock farms were assumed to be identical, except that honey is only produced at Farm D and is supplied to all others.

The canola farm (Farm E) was conservatively assumed to be occupied for only 16 hours per day, for two weeks for planting, two weeks for fertilizing and two weeks for harvesting (total of 672 hours per year).

Individual members of the public who occasionally carry out recreational activities (e.g., boating, fishing and swimming) on the Winnipeg River, closer to the WL site than the locations of the above mentioned potential critical groups, are not explicitly considered in the DRL assessment. This is because these activities are not typical for population groups in the area, but are done by a few extreme individuals. In the recent CRL DRL calculations [6], a scoping analysis was carried out to show that the radiological risk from short-term, occasional occupancy of the river close to CRL is not significantly higher than that from the chronic exposure received by the more remote critical groups over extended periods of time. There is no reason to suspect that the risk for similar extreme individuals at WL would be significantly higher.

In view of the nature of the potential critical groups, screening calculations were performed to reduce the number of combinations of potential critical groups and release location for which detailed dose calculations were required. The screening calculations identified Farm A as the critical group for all nuclides except HTO (see Section 10.1 for details). For an HTO release from B100, Farm F was identified as the critical group. The characteristics of these two groups are the same and only the characteristics of these groups are discussed further in subsequent sections.

5.2.2 Critical Group for Liquid Effluents

Dilution and dispersion studies by Merritt ([15] and [16]) have shown that effluents released from the process outfall move downstream along the east bank of the Winnipeg River and do not reach the west bank in the vicinity of WL. Therefore, the critical group for liquid effluents is obvious, being Farm A on the east bank of the Winnipeg River, adjacent to the site boundary and 2,810 m downstream of the release point (Figure 1-2).

5.3 Characteristics of the Critical Groups

5.3.1 Critical Groups for Airborne Effluents (Farm A or F)

The group members:

- reside on a full-time basis at their assumed locations,
- maintain a large garden from which they obtain a significant fraction of their fruit and vegetable needs (see Section 5.4.2 for information on food sources),
- are self-sufficient in meeting their milk, poultry and egg requirements, and semi self-sufficient in beef and pork,
- feed their animals entirely on forage grown on their farm,
- meet their honey requirements by acquiring it from another local farm,
- partake in hunting on their own property to fulfill their game (deer) meat requirement,
- obtain their water from a well located on the property, and
- use a backyard swimming pool filled with well water during four months of the year.

The exposure pathways applicable to the critical groups are summarized in Table 5-2.

Table 5-2
Airborne Exposure Pathways Applicable to the Critical Groups (Farm A or F)

Pathway	Comments
Air Inhalation	✔
Air Immersion	✔
Water Immersion	✔ (well)
Groundshine (airborne deposition)	✔
Incidental Soil Ingestion	✔
Water Ingestion	✔ (well)
Plant Ingestion	✔
a) Plant Uptake via Roots	✔
b) Plant Uptake via Foliar Deposition	✔
Animal Product Ingestion	✔ Beef (on site) Pork (on site) Poultry (on site) Eggs (on site) Game (on site) Milk (on site) Honey (from Farm D)
a) Animal Uptake via Forage Ingestion	✔
b) Animal Uptake via Water Ingestion	✔ Livestock – well Game – pond
c) Animal Uptake via Inhalation	✔
d) Animal Uptake via Soil Ingestion	✔

5.3.2 Critical Group for Liquid Effluents (Farm A)

The group members:

- reside on a full-time basis at their assumed location,
- obtain their water for domestic needs (drinking, washing) from the river,
- maintain a large garden from which they supply a significant fraction of their fruit and vegetable needs,
- irrigate their lawns and gardens (a total area of 2,500 m^2) with river water,
- do not irrigate forage crops (hay, grain, corn),

- are self-sufficient in meeting their milk, poultry and egg requirements, and semi self-sufficient for beef and pork,
- water their animals with river water,
- swim in the river during the summer months and in a pool filled with river water during the remainder of the year,
- spend a fraction of the time occupying the shoreline for recreational purposes, and
- fish in the Winnipeg River, from which they obtain a fraction of their fish ingestion needs.

The exposure pathways applicable to the critical group are summarized in Table 5-3.

Table 5-3
Liquid Exposure Pathways Applicable to the Critical Group (Farm A)

Pathway	Comments
Air Inhalation (from volatilized radionuclides following irrigation)	✔
Air Immersion (from volatilized radionuclides following irrigation)	✔
Water Immersion	✔
Groundshine (irrigation)	✔
Incidental Soil Ingestion	✔
Beach Shine	✔
Incidental Sediment Ingestion	✔
Water Ingestion	✔
Fish Ingestion	✔
Fruit/Vegetable Ingestion	✔
a) Plant Uptake via Roots (irrigation)	✔
b) Plant Uptake via Foliar Deposition (irrigation)	✔
Animal Produce Ingestion	✔ Beef (on site) Pork (on site) Poultry (on site) Eggs (on site) Milk (on site)
a) Animal Uptake via Water Ingestion	✔

5.4 Critical Group Parameters

5.4.1 Water Sources

The water source assumptions for the critical groups are summarized in Table 5-4 and are justified in the discussions below.

Table 5-4
Water Source Assumptions

Critical Group	Drinking		Washing and Bathing		Swimming		Irrigation		Animals	
	Source	Percentage	Source	Percentage	Source	Percentage	Source	Percentage	Source	Percentage
Airborne Effluents	Well	100	Well	100	Pool filled with well water	100*	Well**	100	Well for livestock, Pond for deer	100
Liquid Effluents	Winnipeg River	100	Winnipeg River	100	Winnipeg River beaches and swimming pools filled with Winnipeg River water	100	Winnipeg River	100	Winnipeg River for livestock Pond for deer	100

* An outdoor pool is assumed to be operated for only four summer months in a year.
** Grey shading indicates pathways and exposures that are not included in the calculations.

For the groups considered in this assessment, water was assumed to be used for the following applications:

- drinking by humans,
- showering, washing and other domestic uses,
- swimming,
- lawn and/or garden irrigation, and
- animal watering.

Some inhabitants of the banks of the Winnipeg River, in the vicinity of WL, use well water and some use river water. In the absence of detailed population survey information, average values for the usage of water that is radiologically contaminated by WL effluents could not be derived and applied. Instead, it was generally assumed that 100% of the water is obtained from sources that are radiologically contaminated by WL effluents.

In N288.1 [2], the only surface water bodies that are assumed to become contaminated by airborne effluents are small ponds. This distinction is made because larger bodies (lakes and rivers) provide significant dilution of activity deposited locally from the atmosphere. Moreover, natural removal processes are more effective for larger water bodies. As a result, concentrations are lower in large water bodies, reducing the significance of the water exposure pathways.

5.4.1.1 Drinking Water Assumptions

For liquid effluent modelling, the critical group was conservatively assumed to draw all their water from the Winnipeg River. Thus, 100% of the drinking water was assumed to be contaminated.

For modelling airborne effluents, the critical groups were assumed to obtain their drinking water from wells, which were assumed to be contaminated.

5.4.1.2 Immersion Assumptions (external exposures from washing, bathing and swimming)

For modelling airborne effluents, the critical groups were conservatively assumed to obtain all their water for washing and bathing from wells, which were assumed to be contaminated.

For liquid effluent modelling, 100% of the water for washing and bathing was assumed to be contaminated because it was conservatively assumed to come from the Winnipeg River.

Immersion exposure from swimming in the Winnipeg River during three summer months was assumed for the critical group for liquid effluents. Immersion exposures from swimming in a pool, supplied with water from the Winnipeg River, for the remainder of the year was also assumed. In reality, a pool at a hotel in Lac du Bonnet (filled with municipal water taken from the River) is accessible to the public. However, in this assessment, a community pool was conservatively assumed to be located at the location of the critical group, where river water concentrations are much higher than those at the Lac du Bonnet municipal water intake point.

For modelling airborne effluents, members of the critical groups were assumed to swim in a pool filled with well water during four months of the year.

5.4.1.3 Irrigation Assumptions

In N288.1 [2], lawn and garden irrigation with well water is not included in the modelling of airborne effluents. Inclusion is normally not warranted because the relative contribution of radioactivity to soil and plant tissue from irrigation is usually minor compared to the contribution from direct atmospheric deposition. On this basis, irrigation was not included in the modelling of the critical groups for airborne effluents.

In contrast, irrigation was included in the modelling of the critical group for liquid effluents. Lawn and garden watering was assumed to be done using water from the Winnipeg River.

5.4.1.4 Animal Watering Assumptions

It is discussed in the 2007 CRL DRL report [6] that a well (and not a river) is commonly used for watering of livestock. However, to be conservative, in this assessment it was assumed that livestock are watered from wells when modelling airborne effluents, and they receive water drawn from the Winnipeg River when modelling liquid effluents.

Deer are more likely to drink from small streams and ponds in forested areas than the exposed banks of the Winnipeg River. Therefore, it was assumed that game (deer) drink only from small contaminated ponds at the locations of the critical groups. Therefore, the ingestion of contaminated water by deer was modelled for airborne effluents only.

5.4.2 Food Sources

The percentages of the various food items in the diet of the critical groups that were assumed to come from contaminated sources are summarized in Table 5-5. The percentages are based upon site-specific information and judgement rather than statistical analysis, and are justified in the discussions in Sections 5.4.2.1 through 5.4.2.3 below.

Table 5-5
Percentage of Food from Contaminated Sources

Critical Group	Terrestrial Animal Products							Plant Products				Fish
	Beef	Pork	Poultry	Venison	Eggs	Cow or Breast Milk	Honey	Fruit	Above-Ground Vegetables	Potatoes	Grain	
Airborne Effluents	50	50	100	100	100	100	100*	15	25	100	0**	0
Liquid Effluents	50	50	100	0	100	100	0	15	25	100	0	30

* Honey is produced on Farm D only and supplied to the critical group.
** Grey shading indicates pathways and exposures that are not included in the calculations.

In general, the percentages of food products from contaminated sources were assumed to be higher than those recommended in Table G9c of N288.1 [2]. The exceptions were: the contaminated fruit percentage was reduced from 20% to 15 %, the contaminated grain percentage was reduced from 1% to 0% and the contaminated fish percentage was reduced from 100% to 30%.

5.4.2.1 Plant Products

The critical groups were assumed to grow 15% of the fruit that they eat. N288.1 gives a default value of 20%, which is appropriate for climate conditions in southern Ontario, Quebec and New Brunswick. Since southern Manitoba has a harsher climate, a lower percentage is considered reasonable.

The critical groups were assumed to grow 25% of the above ground vegetables and 100% of the potatoes (including other root vegetables) in their diet.

As stated in the 2001 DRL report [17], there are some farms in the neighbourhood of WL that produce grain (wheat and oats), but these crops are sold to large companies and the contamination in the final food products is diluted to negligible levels. Therefore, consumption of contaminated grain was not included in the calculations.

The contaminated percentages discussed above apply for modelling both airborne and liquid effluents, for which crop contamination occurs through airborne deposition and irrigation, respectively.

5.4.2.2 Terrestrial Animal Products

Currently, no animal products are produced at the locations of the critical groups. However, within 10 km of WL there is a mix of beef and dairy farms, with some of their products are being consumed on the farms. At about 20 km south-southeast from WL, there are farmers who are self-sufficient in milk, chicken and eggs, and semi self-sufficient in beef and pork. It is possible that a farmer in the vicinity of WL could start producing beef, pork, poultry, eggs and milk, with some being for their own consumption. However, it is unlikely that they would be self-sufficient in beef and pork. Therefore, it was conservatively assumed that the critical groups are 50% self-sufficient in beef and pork, and 100% self-sufficient in poultry, eggs and milk, as was done in the 2001 DRL calculations [17].

The milk consumed by the 1-year-old infant was assumed to be either 100% cow milk or 100% formula milk. The formula milk was assumed to be prepared with local contaminated water. Either 100% formula milk or 100% breast milk was assumed to be the source of milk for the 3-month-old infant.

Deer is the main game animal in the area, and the critical groups were assumed to hunt and get all the venison required from their own property. As the deer are assumed to drink from small ponds on the property and not from the Winnipeg River, the venison is contaminated by airborne effluents from WL, but not by liquid effluents.

For modelling airborne effluents, it was assumed that 100% of the honey consumed is contaminated because it is available locally from Farm D. For modelling liquid effluents, the honey was assumed to be uncontaminated because the bees generally feed on forage crops, which are not contaminated by liquid effluents.

5.4.2.3 Fish

The critical group exposed to liquid effluents was assumed to eat fish caught nearby in the Winnipeg River. This is reasonable given that fishing is a popular activity in the area. It was assumed that 30% of the total fish consumed is contaminated. This was based on interviews with local sportsmen.

5.4.3 Intake Rates for Humans

The assumed intake rates for food, water, soil, sediment and air are shown in Table 5-6. Most of these values are the recommended default values provided in Tables 17, 18, 19 and G9c, and Clause 7.10.2 of N288.1 for three of the age classes; and Tables 4-15, 4-16, 4-17 and G20c, and Clause 5.11 of the CDG for all of the age classes. These are the 90th or 95th percentiles of their respective distributions, which is consistent with the philosophy of using conservative values for intake rates. The adult intake rates are those for a male.

Table 5-6
Intake Rates of Food, Water, Soil and Air

Food Categories and Items	3-Month-Old Nursing Infant	3-Month-Old Formula-Milk-Drinking Infant	1-Year-Old Cow-Milk-Drinking Infant	1-Year-Old Formula-Milk-Drinking Infant	5-Year-Old Child	10-Year-Old Child	15-Year-Old Teenager	Adult (Male)	Nursing Mother
Freshwater Fish(kg a^{-1})	0.31	0.31	0.91	0.91	2.69	3.1	3.48	7.41	4.75
Milk (mother's milk or cow’s milk) (L a^{-1})	416	0*	371	0*	277	305	327	265	170
Beef + Beef Offal + Veal + Lamb + Rabbit (kg a^{-1})	6.1	6.1	5.4	5.4	9.6	15	20	34	22
Venison (kg a^{-1})	6.1	6.1	5.4	5.4	9.6	15	20	34	22
Pork (kg a^{-1})	0	0	3.2	3.2	7.3	11	15	29	19
Poultry (kg a^{-1})	0	0	4.6	4.6	7.7	9.8	11	20	13
Eggs (kg a^{-1})	2.9	2.9	8.4	8.4	9.6	11	15	30	19
Honey (kg a^{-1})	0.8	0.8	0.34	0.34	0.91	1.1	1.1	2	1.3
Fruit and Berries (kg a^{-1})	69	69	66	66	92	93	91	174	112
Above-Ground Vegetables + Mushrooms (kg a^{-1})	26	26	44	44	91	114	144	236	152
Potatoes (kg a^{-1})	4.6	4.6	23	23	47	63	80	104	67
Total Water Intake (L a^{-1})	0	347	0	358	365	511	657	840	840
Soil Intake (kg a^{-1})	0.044	0.044	0.044	0.044	0.12	0.12	0.12	0.12	0.12
Sediment Intake (kg a^{-1})	0.044	0.044	0.044	0.044	0.12	0.12	0.12	0.12	0.12
Inhalation Rates (m^3 a^{-1})	1,140	1,140	2,740	2,740	6,390	7,850	8,210	8,400	8,400

* Formula-milk-drinking infants (3-month-old and 1-year-old) have zero milk intake and proportionately higher water intake.

Since beef offal, veal, lamb and rabbit are a small percentage of the diet in the WL area, they were combined into the “beef +” category in Table 5-6. Similarly, mushrooms were combined with above-ground vegetables.

The venison intake rates of the critical groups were assumed to be much higher than those recommended in N288.1 and the CDG because deer hunting is much more common among farmers in the WL area than in the general population. The intakes for the “beef +” category in Table 5-6 were assumed to be correspondingly lower, such that the total intake from these two categories is the same as in N288.1 and the CDG. This adjustment ensures a balanced energy intake for the receptors. Because of the abundance of deer in the area, it was assumed that the intakes from the venison and “beef +” categories were equal, which is similar to what was assumed in the 2007 CRL DRL calculations [6].

The DRLs were not calculated for a nursing mother, but her intake rates were required to estimate radionuclide concentrations in breast milk fed to infants. The nursing mother was modelled in the same way as a terrestrial animal, but with intake rates being at the 90th percentiles rather than the median values that were used for other terrestrial animals. The higher values were used because of the increased energy requirements resulting from lactation. These intake rates are similar to those recommended by Wong [18].

5.4.4 Occupancy Factors

The occupancy factors applied to the critical groups and the different age classes were in general the recommended default values in N288.1, which include full-time residential occupancy at the assumed receptor location.

An exception was with respect to swimming occupancy. For modelling liquid effluents, beach swimming was assumed to be based on a three-month period per year, rather than a four-month period, because the Winnipeg River water is colder than the average on which the N288.1 recommendations are based. N288.1 assumes that swimming takes place indoors during the period when beach swimming does not, so the pool occupancy is based on eight months per year. However, for the WL calculations, it was assumed that the critical group swims in an indoor pool during nine months per year.

6. SOURCE CHARACTERISTICS AND DISPERSION

6.1 Airborne Effluents

6.1.1 Sources

Airborne effluents are discharged at four locations: the B100 stack, the B200 roof vent, the B300 roof vent and the WMA. In the 2016 DRL [1], although the WMA had two sources (the incinerator and the compactor/baler), they were treated as one. This was reasonable because they were close to each other and had similar release heights, so that at the downwind distances of the potential critical groups, the differences had a marginal impact on radionuclide concentrations. However, now that three new systems (the SWRS, the BWRS/SCU and the ILLTS) will be introduced in the WMA, the sources of airborne effluents in the WMA were re-evaluated.

6.1.2 Atmospheric Dispersion Model

Atmospheric dispersion was modelled using the sector-averaged Gaussian model described in N288.1 and implemented in IMPACT 5.4.0.

The characteristics of the sources are shown in Table 6-1, together with the dimensions of the adjacent building.

Table 6-1
Source Characteristics and Building Dimensions Considered in the Atmospheric Dispersion Model

Parameter	B100	B200	B300	WMA			
				Compactor/ Baler**	SWRS	BWRS/ SCU	ILLTS
Physical Height of Release (m)	30.4	0	0	7.3	7.92	7.92	5.18
Stack Inside Diameter (m)	1.98	-	-	-	0.203	0.254	0.127
Stack Exit Velocity (m s^{-1})	4.6	-	-	-	15.24	15.24	0.00080
Stack Gas Temperature (°C)	25	-	-	-	28.06*	28.06*	10
Ambient Air Temperature (°C)	0.4	-	-	-	0.4	0.4	0.4
Height of Nearby Building (m)	18.5	7.6	12	5.5	5.5	5.5	5.5
Smallest Horizontal Dimension of Nearby Building (m)	55	12.8	35	12.5	12.5	12.5	12.5
Cross-Sectional Area of Nearby Building (m^2)	1,000	100	400	70	70	70	70

* An average of the winter and summer values.

** The compactor/baler is no longer in service, but it is discussed in this report to clarify the changes between 2016 DRL [1] and this assessment.

The B100 stack was treated as an elevated source with excess momentum and buoyancy, and accompanying plume rise. The release was assumed to be affected to some extent by the wake of the adjacent building. The B200 and B300 roof vents were treated as ground-level sources because of building entrainment occurring at them.

In the 2016 DRL [1], the WMA was treated as an elevated source, but without excess momentum and buoyancy. Even though the incinerator stack (12.2 m high) and the roof vent of the compactor/baler (7.3 m high) were both sources of airborne effluents, a conservative value of 7.3 m was used for the release height in the calculations. However, with the introduction of the three new systems (SWRS, BWRS/SCU and ILLTS), all the WMA parameter values need to be compared to determine which ones should be used in the new DRL calculations.

Effective release height is an important intermediate parameter when modelling releases from different geometries. When comparing the parameter values in Table 6-1, it is expected that the effective release heights corresponding to the SWRS and the BWRS/SCU will be higher than that of the compactor/baler, as modelled in the 2016 DRL [1]. On the other hand, the effective release height of the ILLTS will be lower to the ground than that of the compactor/baler, as modelled in the previous DRL [1], resulting in higher air concentrations from that source. This initially indicates that the doses will be the highest from the ILLTS, and the WMA DRLs should be calculated using its release geometry. However, effective release height is not only dependent on release geometry, but also on the stability class and the wind speed class (as defined in Table 6-3). To establish their overall effect, the effective release heights were extracted using a research and development (R&D) tool CSA-DRL [19]. The results (see Figure 6-1) demonstrate that the effective release height corresponding to the ILLTS geometry will be lowest in all cases compared to the other three release geometries. This also indicates that the doses will be the highest from the ILLTS and, thus, the DRL will be the lowest (and most conservative) for all radionuclides when calculated using the ILLTS geometry.

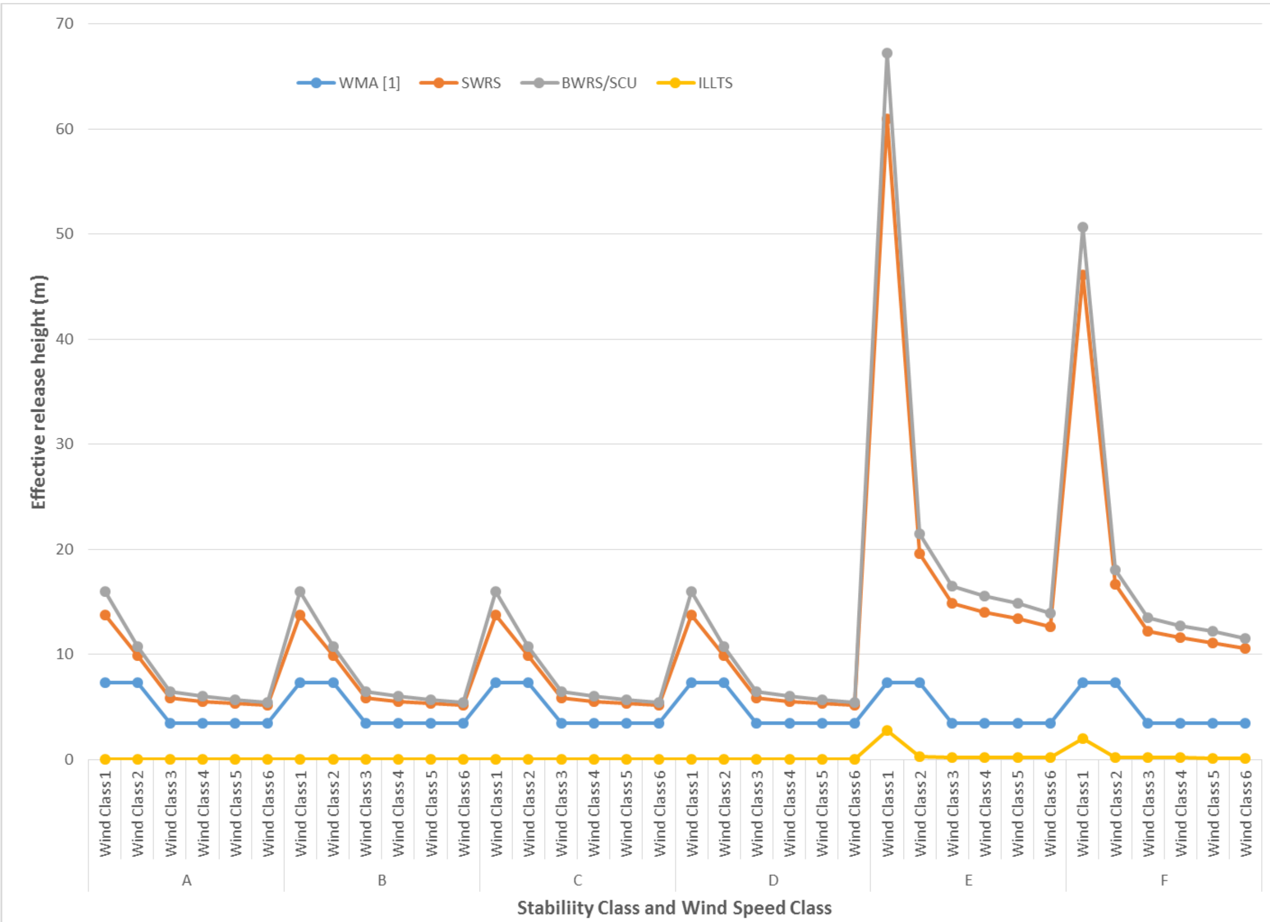

Figure 6-1 Comparison of the Effective Release Heights Corresponding to Each Stability Class and Each Wind Speed Class for the WMA Release Location

A sample calculation was then carried out in IMPACT [4] for a unit release (1 Bq s^{-1}) of Cs-137 from the SWRS, the BWRS/SCU and the ILLTS to compare the total dose to an adult at the critical group A location. The results from the 2016 DRL [1] and the current calculations are compared in Table 6-2. It can be seen that the highest dose was predicted using the ILLTS geometry and, therefore, all WMA DRLs calculated using this geometry will be conservative.

Table 6-2
Example Dose from Unit Release of Cs-137 to Show a Combined Effect of Release Geometry, Stability Classes and Wind Speed Classes

Release Location	Total Dose (Sv a^{-1})
Compactor/Baler	4.01E-08
SWRS	2.07E-08
BWRS/SCU	1.90E-08
ILLTS	4.08E-08

Site-specific meteorological data collected routinely by CNL at WL in the past were used in the dispersion calculations. Temperature, wind speed, wind direction and standard deviation of wind direction were measured at heights of 6, 25 and 61 m on the tower located within a 2-ha clearing about 300 m south-west of B300. Quality-assured values for each of these variables are available every hour from 1988 to 1995. The data from the 6-year period (1990-1995, inclusive) were used for the present calculations. The 25-m level of the tower is at about the same height as the B100 stack. Meteorological conditions are, therefore, similar at the two locations and the 25-m data were used in calculations involving releases from B100. In contrast, B200 and B300 were treated as the ground-level sources and releases from the WMA occur from a short stack. The 6-m data represent best the meteorological conditions experienced by low-level releases and were used for these sources.

Limited, more recent meteorological data is available for the WL site. Environment Canada routinely measures temperature and wind data at a single level above the ground surface. However, the older CNL data is more suitable for the current DRL calculations for the following reasons:

- multi-level temperature measurements can be used to significantly improve estimates of the atmospheric stability class,
- higher-level data better represents the meteorological conditions experienced by the release from B100,
- the quality assurance of the selected CNL data is believed to be better than that of the Environment Canada data, and
- although there may have been some changes in meteorological conditions over the last 23 years, these are relatively small considering the uncertainties in the atmospheric dispersion modelling.

The CNL data from the period of 1990-1995 were also used in the 2001 DRL [17] calculations.

For each tower level, triple joint frequency distributions of wind speed, wind direction and stability class were calculated from the hourly data. The full triple joint frequency distributions are reported in Appendix A. Wind roses for the two measurement levels are shown in

Figure 6-2 and Figure 6-3. The average wind speeds in each wind speed class, which were also required by the model, are listed in Table 6-3.

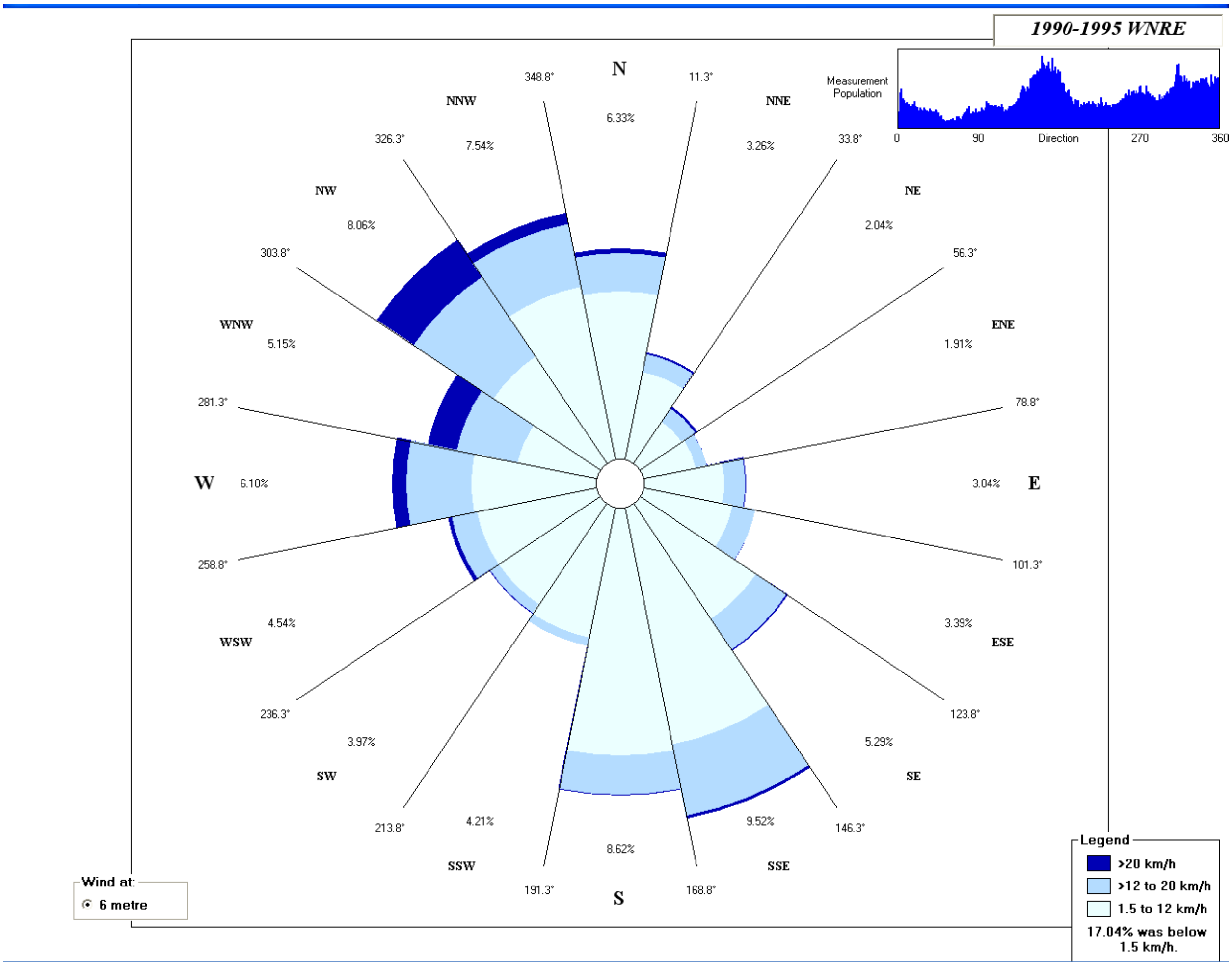

Figure 6-2 Wind Rose Diagram for the 6-m Level

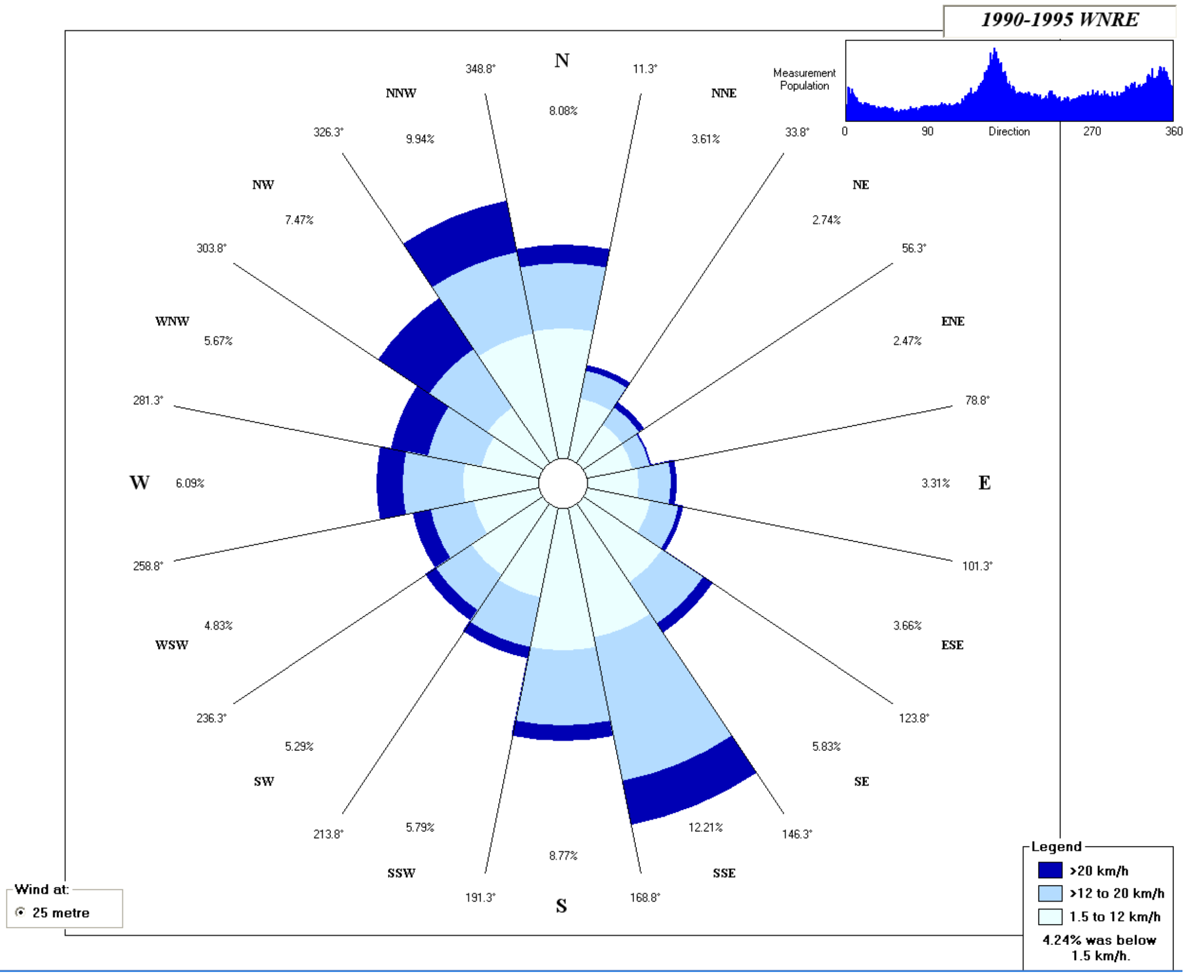

Figure 6-3 Wind Rose Diagram for the 25-m Level

Table 6-3
Mean Wind Speeds for each Wind Speed Class

Wind Speed Class	Wind Speed Range ($m\ s^{-1}$)	Mean Speed ($m\ s^{-1}$)	
		6-m Level	25-m Level
1	0-2	0.85	1.14
2	2-3	2.47	2.50
3	3-4	3.44	3.47
4	4-5	4.42	4.45
5	5-6	5.44	5.45
6	> 6	7.05	7.28

The land between the sources and the potential critical groups is partly wooded and partly farmland. Therefore, the meteorological roughness length was set equal to 0.4 m, as was done in the 2001 DRL [17] calculations.

All other parameters required to calculate atmospheric dispersion were assigned the values recommended in N288.1 [2].

6.2 Liquid Effluents

6.2.1 Sources

At the WL site, liquid effluents are discharged to the Winnipeg River continuously through the process outfall, twice a year from the sewage lagoon and intermittently through small natural streams. Of these sources, only the process outfall (shown as “Outfall” in Figure 1-2) is significant enough for explicit inclusion in the calculation of DRLs. As has been done in the past, the DRLs calculated for the process outfall can be applied to the sewage lagoons because the distance between the two sources is small compared to their distances from the critical group.

6.2.2 River Dispersion Model

The concentrations of radionuclides in the river water, at the location of the water intake for the critical group, have been calculated using the two-dimensional advection-dispersion model of N288.1 [2]. The model parameters include the river width, the river depth, the current velocity, the longitudinal and lateral dispersion coefficients, the offshore distance to the release point and the offshore distance to the point of water intake.

The river width was estimated from a topographic map to be 470 m. Based on the average river flow rate of 1.01E6 L s^{-1} for the period 2003-2008 [20] and Merritt’s study [15], the current velocity was estimated to be 0.28 m s^{-1}. Based on this width, flow rate and velocity, the river depth was estimated to be 7.7 m. The release point is located 8 m offshore. The offshore distance to the point of water intake was conservatively assumed to be 8 m also.

N288.1 [2] recommends that values of longitudinal and lateral dispersion coefficients for the model are best determined from site-specific dispersion studies. In the 2001 DRL calculations [17], the dilution resulting at the location of the water intake was estimated based on the results of a short-term tracer test [15]. However, the radionuclide concentrations measured subsequently during routine monitoring of river water at a location 1,930 m downstream of the release point and 880 m upstream of the point of water intake were consistently much higher than estimates based on the measured release rates and the dilution estimated from the tracer test. This has led to doubts as to the applicability of the results of the tracer test in the DRL calculations.

Therefore, for the 2016 DRL [1] calculations, it was decided to calibrate the river model using Sr-90 and C-137 concentration data obtained from ten years (2003-2012) of routine monitoring of the river water at the location 1,930 m downstream of the release point, the river water upstream of the release point and the effluent in the process outfall ([20], [21], [22] and [23]). In this calibration, the longitudinal dispersion coefficient was set equal to 150 $m^2\ s^{-1}$, the value recommended by N288.1 [2] for the Ottawa River downstream of the CRL site. This was done because data limitations made it impossible to estimate independent values of the longitudinal and lateral coefficients, and because the model predictions are very insensitive to the value of the longitudinal dispersion coefficient. The value for the Ottawa River was selected because the Ottawa River is similar in size to the Winnipeg River. The lateral dispersion coefficient was calibrated to be 7.4E-7 $m^2\ s^{-1}$.

7. RADIONUCLIDES

The DRLs have been calculated for all thirty radionuclides that have been recently found or are reasonably expected to be found in WL's airborne and liquid effluents (see Table 7-1). In the 2016 DRL [1], an airborne effluent DRL was calculated for HTO released from B100 only. However, based on the introduction of three new systems in the WMA and the release of HTO from one or more of these systems, a separate airborne effluent DRL was calculated for HTO released from the WMA.

Table 7-1
Radionuclides Considered for Airborne and Liquid Effluents

Am-241	Fe-55	Pu-240
Am-243 (Np-239d, Pu-239dd)	HTO**	Pu-241 (Am-241d)
C-14*	I-129	Pu-242
Ce-144 (Pr-144d)	Mn-54	Sb-125 (Te-125md)
Cm-244	Nb-94	Sr-90 (Y-90d)
Co-60	Ni-63	Tc-99
Cs-134	Np-237 (Pa-233d)	U-234
Cs-137 (Ba-137md)	Pm-147	U-235 (Th-231d)
Eu-152	Pu-238 (U-234d)	U-238 (Th-234d, Pa-234mdd)
Eu-154	Pu-239	Zn-65

* For airborne effluents, C-14 was assumed to be released as CO_2.

** For airborne effluents, HTO was assumed to be released from B100 and the WMA.

In Table 7-1, radioactive daughters which are possibly significant (e.g., Np-239d, Pu-239dd) are given in parentheses after their parent (e.g., Am-243). They are not released directly, but the ingrowth of these daughters and their transfer through the environment were modelled explicitly in IMPACT [4], and were taken into account in determining the DRL for the parent. The letter 'd' following the radionuclide name indicates the first daughter, and the letters "dd" indicates the second daughter.

8. ENVIRONMENTAL PATHWAYS MODELS

8.1 General Discussion

The environmental pathways models described in N288.1 [2] were used in this analysis. These are illustrated in Figure 8-1 and Figure 8-2 as flowcharts, which provide a summary of the environmental compartments and transfer mechanisms applied in the current modelling for the critical groups. Each compartment treated in the model is numbered and the quantity in compartment i is denoted by X_i. Transfer from compartment i to compartment j is characterized by a transfer parameter P_{ij}, such that the amount present in compartment j under steady-state conditions due to transfer from compartment i is $P_{ij}X_i$. The various compartments, transfer parameters and their units are summarized in Table 8-1 and Table 8-2.

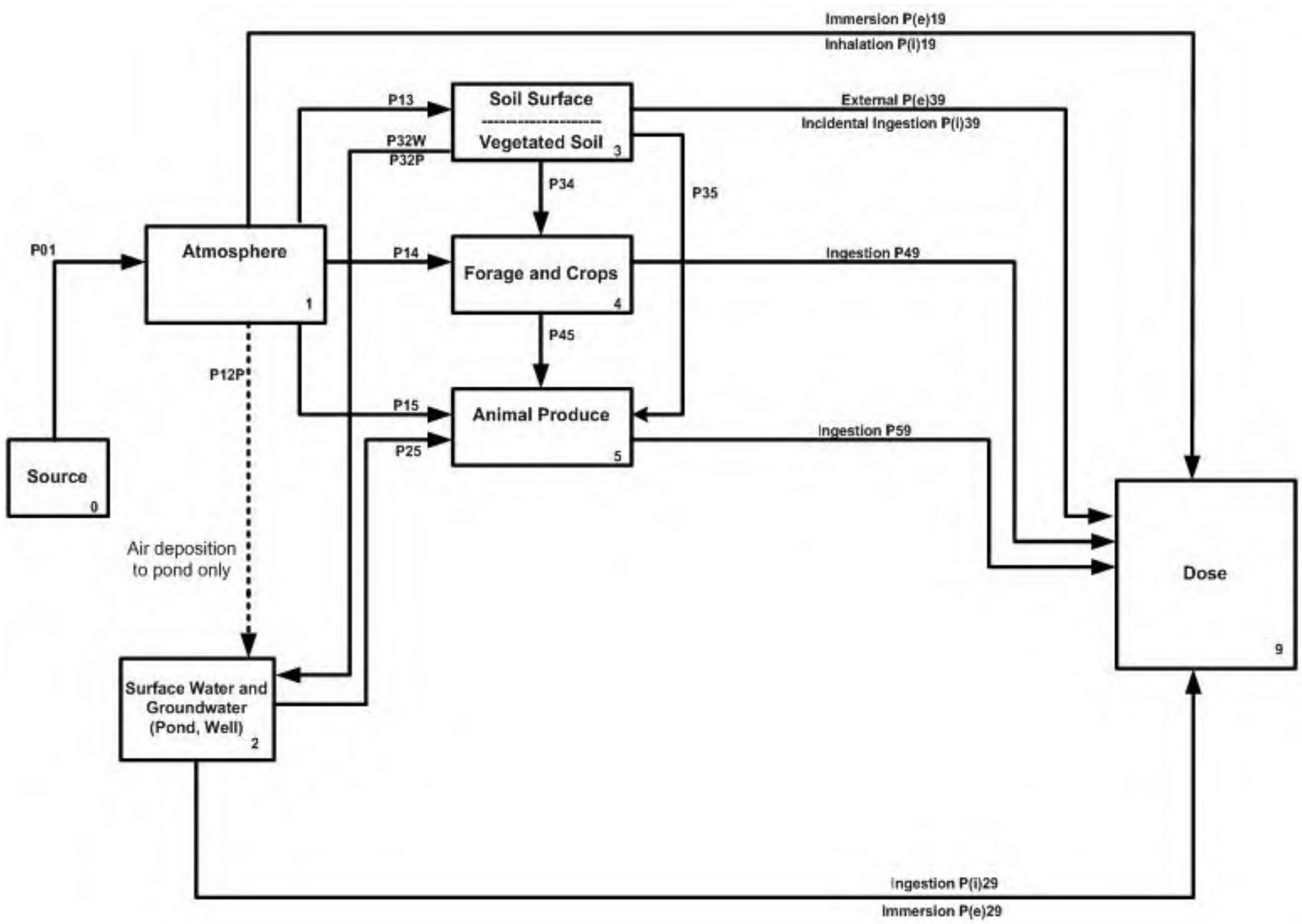

Figure 8-1 Environmental Transfer Model for Airborne Effluent Modelling

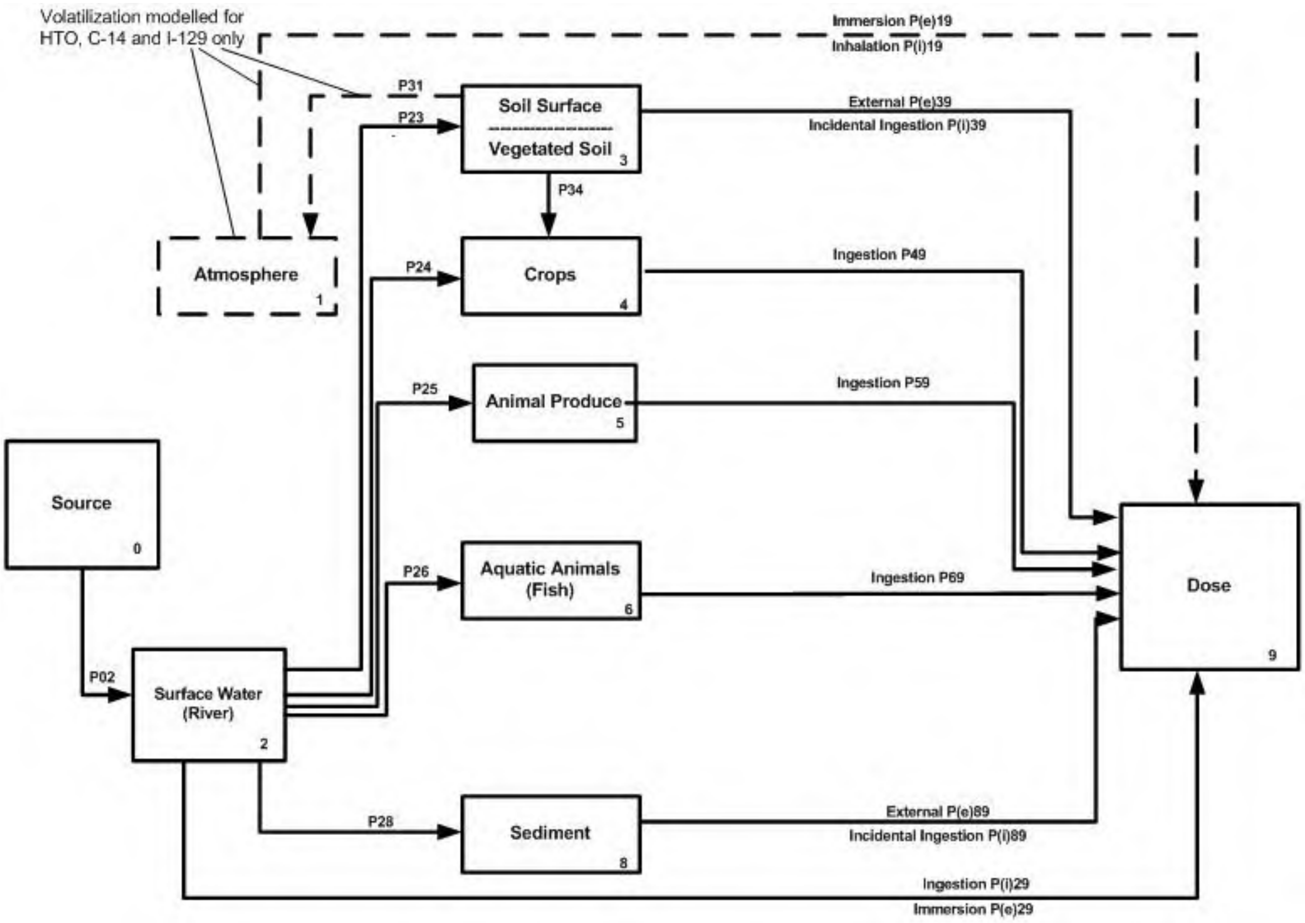

Figure 8-2 Environmental Transfer Model for Liquid Effluent Modelling

Table 8-1
Transfer Compartments and their Units

Compartment Number	Compartment Name	Units
0	Source	Bq • s^{-1}
1	Atmosphere	Bq • m^{-3}
2	Surface Water (river)	Bq • L^{-1}
2p	Surface Water (pond)	Bq • L^{-1}
2w	Ground Water (well)	Bq • L^{-1}
3area	Surface Soil	Bq • m^{-2}
3mass	Bulk Soil	Bq • kg^{-1} dw*
3spw	Soil Pore Water	Bq • L^{-1}
4	Forage and Crops	Bq • kg^{-1} fw†
5	Animal Produce	Bq • kg^{-1} fw
6	Aquatic Animals (fish)	Bq • kg^{-1} fw
8	Sediment	Bq • kg^{-1} dw
9	Dose	Sv • a^{-1}

* Dry weight.
† Fresh weight.

Table 8-2
Transfer Parameters and their Units

Transfer Parameter	Compartments		Parameter Units
	From	To	
P_{01}	Source	Atmosphere	s•m^{-3}
P_{3area1}	Surface Soil	Atmosphere	m^{2}•m^{-3}
$P_{3mass1}{}^{*}$	Bulk Soil	Atmosphere	kg dw • m^{-3}
P_{12p}	Atmosphere	Surface Water (pond)	m^{3}•L^{-1}
P_{13area}	Atmosphere	Surface Soil	m^{3}•m^{-2}
P_{13mass}	Atmosphere	Bulk Soil	m^{3}•kg^{-1} dw
P_{13spw}	Atmosphere	Soil Water	m^{3}•L^{-1}
P_{14}	Atmosphere	Forage and Crops	m^{3}•kg^{-1} fw
P_{15}	Atmosphere	Animal Produce	m^{3}•kg^{-1} fw
$P(i)_{19}$	Atmosphere	Dose (inhalation)	Sv•a^{-1}•Bq^{-1}•m^{3}
$P(e)_{19}$	Atmosphere	Dose (immersion)	Sv•a^{-1}•Bq^{-1}•m^{3}
P_{02}	Source	Surface Water (river)	s•L^{-1}
$P_{3spw1}{}^{**}$	Soil Water	Atmosphere	L • m^{-3}
$P_{3area2p}$	Surface Soil	Surface Water (pond)	m^{2}•L^{-1}
$P_{3area2w}$	Surface Soil	Groundwater (well)	m^{2}•L^{-1}
$P_{3area3spw}$	Surface Soil	Soil Water	m^{2}•L^{-1}
P_{3spw2w}	Soil Water	Groundwater (well)	unitless
P_{3spw2p}	Soil Water	Surface Water (pond)	unitless
P_{23area}	Surface Water	Surface Soil	L•m^{-2}
P_{23mass}	Surface Water	Bulk Soil	L•kg^{-1} dw
$P_{23spw}{}^{**}$	Surface Water	Soil Water	unitless
P_{24}	Surface Water	Forage and Crops	L•kg^{-1} fw
P_{25}	Surface Water (lake, river)	Animal Produce	L•kg^{-1} fw
P_{2p5}	Surface Water (pond)	Animal Produce	L•kg^{-1} fw
P_{2w5}	Well Water	Animal Produce	L•kg^{-1} fw
P_{26}	Surface Water	Aquatic Animal	L•kg^{-1} fw
P_{28}	Surface Water	Sediment	L•kg^{-1} dw
$P(i)_{29}$	Surface Water	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•L
$P(i)_{2w9}$	Well Water	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}• L
$P(e)_{29}$	Surface Water	Dose (immersion)	Sv•a^{-1}•Bq^{-1}•L
$P(e)_{2w9}$	Well Water	Dose (immersion)	Sv•a^{-1}•Bq^{-1}•L
P_{3mass4}	Bulk Soil	Forage and Crops	kg dw•kg^{-1} fw
P_{3mass5}	Bulk Soil	Animal Produce	kg dw•kg^{-1} fw
$P(i)_{3mass9}$	Bulk Soil	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•kg dw
$P(e)_{3area9}$	Surface Soil	Dose (groundshine)	Sv•a^{-1}•Bq^{-1}•m^{2}
P_{45}	Forage and Crops	Animal Produce	kg fw•kg^{-1} fw
P_{49}	Forage and Crops	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•kg fw
P_{59}	Animal Produce	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•kg fw
P_{69}	Aquatic Animals	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•kg fw
$P(i)_{89}$	Sediment	Dose (ingestion)	Sv•a^{-1}•Bq^{-1}•kg dw
$P(e)_{89}$	Sediment	Dose (beachshine)	Sv•a^{-1}•Bq^{-1}•kg dw

* For C-14 and radioiodine only.

** For HTO only.

The application of the models from N288.1 [2] to the WL assessment is discussed briefly in the sections below, emphasizing the few cases where it was necessary to deviate from the recommended models and parameter values.

8.2 Special Radionuclides

8.2.1 Tritium and Carbon 14

As recommended in N288.1 [2], the models used to calculate the DRLs for HTO and C-14 were based mainly on specific activity (SA) concepts. For tritium, SA models were used for all pathways except for the final calculation of doses, where an uptake model was used instead. For C-14, SA models were used for all pathways except transfers to animals (where a transfer factor was used, which was still derived from SA consideration), and the calculation of dose (where an uptake model was used). HTO absorption by skin was taken into account by increasing the dose from HTO inhalation by 50%, as recommended in N288.1 [2].

HTO can form stable bonds with carbon in plants and animals, in which case it is known as organically bound tritium (OBT). The DRLs for HTO take into account OBT formed in the environment.

The default parameter values recommended in N288.1 [2] were used throughout the tritium and C-14 models.

8.2.2 I-129

I-129 was modelled in the same manner as other radionuclides except that, in the case of liquid effluents, its volatile nature was taken into account by including volatilization following irrigation. Resulting air inhalation and immersion doses were calculated from the air concentrations estimated by the model.

8.3 Special Receptors

In order to facilitate the modelling of infant dose from the consumption of mother's breast milk, the concentrations of radionuclides in the milk were calculated. This modelling was carried out in IMPACT by modelling the lactating mother in the same way as a terrestrial animal and considering breast milk to be an animal product. The animal transfer models in N288.1 [2] were used for the mother, as shown in Figure 8-3. The nursing mother's intakes of food, water and air were discussed and listed in Section 5.4.3 and Table 5-6. Values for all of the other parameters required by the model were left at the default values in the IMPACT database. Figure 8-3 is provided to demonstrate only the contribution from mother's milk to infant's ingestion dose. Infants receive additional doses from other pathways as shown in Figure 8-1 and Figure 8-2.

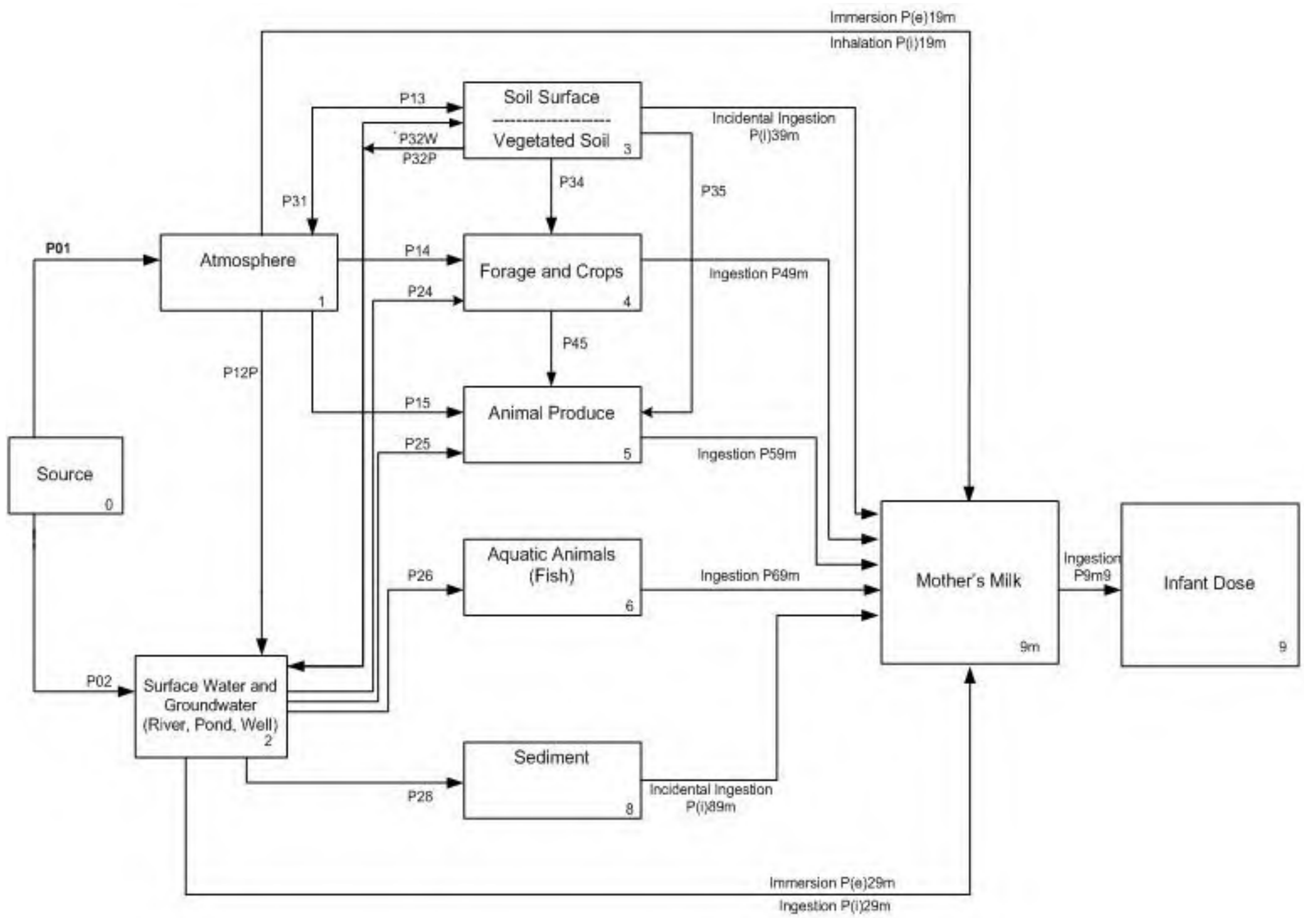

Figure 8-3 Supplemental Model for Mother's Milk

8.4 Other Parameter Values

8.4.1 Soil Types

The surface soil in the vicinity of WL was assumed to be clay, based on the recommendations of Killey [24]. The subsoil was conservatively assumed to be sand.

8.4.2 Well Depth

In areas having clay over bedrock, water supply wells are most likely to extend into the bedrock until some sufficiently permeable fracture zone is encountered, possibly at depths up to 100 m [22]. However, in some areas close to the WL site, sands and sandy till are present and it is possible to obtain a domestic water supply with a very shallow (5-10 m depth) dug well. Since the shallow supply well is conservative, a well depth of 6 m was assumed in this assessment.

The dose results generated from the DRL modelling demonstrate that the groundwater pathway is not of great importance for most radionuclides. However, for HTO, Tc-99 and Np-237, well water ingestion is one of the dominant pathways.

8.4.3 Pond Model

Although, in reality, ponds are fed by precipitation, groundwater and surface water inflows, only precipitation and groundwater inflow were included in the IMPACT pond model. This is conservative because uncontaminated surface water inflow flushes radioactivity from the pond.

The parameter values assumed for the small ponds that were assumed to provide drinking water for deer are listed in Table 8-3. These are the values suggested in N288.1 [2]. In the IMPACT default database, the value for the sediment dry bulk density was found to be incorrect and the database maintainers were notified of this error.

Table 8-3
Parameters Values used in the Pond Model

Parameter	Value
Effective Soil Porosity	0.2
Pond Surface Area (m^2)	5000
Pond Depth (m)	2
Horizontal Linear Groundwater Velocity (m s^{-1})	1.58E-7
Groundwater Inflow Rate to Pond (L s^{-1})	5.06E-3
Sediment Dry Bulk Density (kg m^{-3})	400

8.4.4 Wet Deposition Velocity

The calculation of the wet deposition velocity involves a term f_{pj}, which is defined as the fraction of the time that precipitation occurs when the wind blows from sector j. Precipitation data routinely collected by CNL at WL, in the past, is incomplete in that it does not include the contribution from snow. Therefore, the f_{pj} values were created using Environment Canada's meteorological data for the WL site for the period of 2004 May to 2009 April, inclusive (see Table 8-4).

Table 8-4
Values of f_{pj}

Sector	f_{pj} Value
N	0.087
NNE	0.114
NE	0.111
ENE	0.084
E	0.072
ESE	0.064
SE	0.061
SSE	0.04
S	0.047
SSW	0.047
SW	0.052
WSW	0.053
W	0.057
WNW	0.071
NW	0.065
NNW	0.061

The calculation of the wet deposition velocity also requires a value for the annual average precipitation (rain + snow). The value measured at WL for the period of 1971 to 2000 [25], 565 mm, was used.

8.4.5 Volatilization from Irrigation Water

The critical group associated with liquid releases was assumed to irrigate its backyard gardens and lawns with contaminated water. In the calculations, the size of the irrigated area was assumed to be 50 m by 50 m, which was intended to account for a front yard, a back yard and a large garden plot. In calculating air concentrations following volatilization of volatile radionuclides (HTO, C-14 and I-129), the receptor was placed on the contaminated field, implying continuous exposure to the re-emitted activity.

8.4.6 Absolute Humidity

Values of annual average absolute humidity, average absolute humidity over the snow-free period and average absolute humidity over the growing season are required for modelling HTO. For the WL area, the snow-free period is approximately from May 15 to November 15, and the growing season is estimated to be from June 1 to September 30. Based on Environment Canada data measured at the WL site between 2008 October 1 and 2009 September 30, the following humidity values were used: annual average absolute humidity 0.00541 L m^{-3}, average absolute humidity over the snow-free period 0.0085 L m^{-3}, and average absolute humidity over the growing season 0.0102 L m^{-3}.

8.4.7 External Dose Coefficients

There are two approaches to modelling the contributions of daughter radionuclides to the dose resulting from the release of a parent radionuclide to the environment. The preferred approach is to explicitly model the ingrowth of these daughters, their transfer through the environment and the resulting dose from them. A second approach which is simpler, but in certain cases less accurate, is to explicitly model the parent only and include the contributions to dose from the daughters in the dose coefficients (DCFs). IMPACT has been designed so that either approach can be used. For the current DRL calculations, the explicit approach was used. However, the external DCFs in the default IMPACT database include the contributions of daughters. Since there is a potential for errors when correcting the many external DCFs, and since the external doses are either much less than the ingestion doses or the contributions from the daughters to external doses are much less than those from the parent, the default external DCFs were used for the current calculations. This approach is slightly conservative.

8.4.8 Additional Changes to IMPACT Default Database

Table 8-5 shows changes to parameter values in the IMPACT default database that were made for the WL assessment and are not described elsewhere in this report.

Table 8-5
Other Parameter Values in the IMPACT Default Database that were Modified for the WL Calculations

Compartment	Parameter Name	Unit	IMPACT Default Database Value	Value Used in WL Model	Reference and Comment
Surface Water (River)	Partition coefficient for Np	$L\ kg^{-1}$	25	40	N288.1 Clause 7.8.2
Surface Water (Pond)	Partition coefficient for Np	$L\ kg^{-1}$	65	125	N288.1 Clause 6.6.2.2
Surface Water (Pond)	Net Precipitation Rate	$mm\ a^{-1}$	369	6	=WL precipitation rate – WL evapotranspiration rate, [26]
Groundwater (Well)	Rate of Infiltration to Aquifer	$m^3\ m^{-2}\ s^{-1}$	4.757E-9	4.043E-9	Assumed same as soil infiltration rate below, although N288.1 Clause 6.5.2.2 suggests that it can be lower than soil.
Soil	Infiltration Rate	$m^3\ m^{-2}\ s^{-1}$	1.142E-8	4.043E-9	= 0.5 (WL precipitation rate – 0.31) $m\ a^{-1}$, N288.1 Clause 6.3.6.3
Soil (link from water via air)	Annual Average Irrigation Rate	$L\ m^{-2}\ s^{-1}$	Not available	1.1E-5	N288.1 Clause 7.2.3.2.2
Terrestrial Plants	Fraction of Plant Carbon Derived from Air (all sources other than irrigation water)	-	1	0.7 or 1.0*	N288.1 Clauses 6.4.9.3 and 7.3.4.3
Sediment (River)	Partition coefficient for Np	$L\ kg^{-1}$	25	40	N288.1 Clause 7.8.2
Sediment (Pond)	Partition coefficient for Np	$L\ kg^{-1}$	65	125	N288.1 Clause 6.6.2.2
Dose	Fraction of Year Spent Swimming in a Surface Water Body (Beach Swimming)	-	0.014	0.011	Based on 3 months per year
Dose	Fraction of Year Spent Swimming in a Pool Filled with River Water	-	0.028	0.032	Based on 9 months per year
Full Simulation	Facility Life	years	Not available	57	When the 2010 DRLs were calculated, WL site had been in existence for 47 years (opened in 1963) and the DRLs were expected to be used for another 10 years.

* This value is set at 0.7 when calculating liquid effluent DRLs, but is set at 1 when calculating airborne effluent DRLs.

9. MODELLING SCENARIOS

9.1 General Discussion

In the 2016 DRL [1], a scenario file was set up using IMPACT [4]. A map covering the region of interest was imported into the model and calibrated to ensure the UTM coordinates were properly aligned. All effluent release locations and potential critical group locations were then entered into the model. Links between compartments were set up, including transfers between adjacent environmental compartments, and between the potential critical groups and their food supply locations. All site-specific and scenario-specific parameters needed by the pathways models were then incorporated.

Once the scenario file was finalized, eight sub-scenario files were created. Four of these were for screening calculations for airborne effluents. Two were for detailed calculations for airborne releases of all radionuclides, except HTO, one for each potentially bounding release location. Another was for detailed calculations of the release of HTO from B100. The final one was for detailed calculations for liquid effluents. For each combination of effluent type, radionuclide, critical group, age class and potentially bounding release location, calculations of dose rate per unit release were carried out by running IMPACT. The results were searched to identify the highest dose rates per unit release for each combination of effluent type and radionuclide among all age classes and potentially bounding release locations. These dose rates per unit release were then used to calculate the DRLs for each combination of effluent type and radionuclide. For each of these combinations, the dominant exposure pathway and its percent contribution to the dose rate were also determined.

In the current assessment, from the scenario files described above, the file corresponding to the WMA airborne releases was modified to include the release of HTO and to replace the release geometry of the compactor/baler with that of the ILLTS. The results of the analysis are presented in Section 11.

9.2 Scenarios for Airborne Effluent Modelling

Table 9-1 lists the UTM coordinates of the release locations and potential critical group locations considered in the analysis of airborne effluents.

Table 9-1
Release and Potential Critical Group Locations for Airborne Effluent Modelling

Location	Easting (m)	Northing (m)
Release		
Building 100 Stack	709,909	5,562,658
Building 200	709,928	5,562,834
Building 300	709,714	5,562,668
WMA Gate	711,322	5,564,260
Potential Critical Group		
Farm A	709,547	5,565,803
Farm D	710,067	5,559,924
Farm E	708,642	5,562,571
Farm F	708,783	5,565,288

The exposure pathways for the critical groups for airborne effluents are air inhalation, air immersion, water immersion, groundshine, soil ingestion, water ingestion, plant ingestion and ingestion of terrestrial animal products.

9.3 Scenario for Liquid Effluent Modelling

Table 9-2 lists the UTM coordinates of the release and critical group locations considered in the analysis of liquid effluents.

Table 9-2
Release and Critical Group Locations for Liquid Effluent Modelling

Location	Easting (m)	Northing (m)
Release		
WL Process Outfall	709,474	5,562,997
Critical Group		
Farm A	709,547	5,565,803

The exposure pathways for the critical group for liquid effluents are air inhalation, air immersion, water immersion, groundshine, soil and sediment ingestion, water ingestion, plant ingestion, ingestion of terrestrial animal products, fish ingestion and beach shine.

10. SCREENING CALCULATIONS FOR AIRBORNE EFFLUENTS

10.1 Potential Critical Groups and Release Locations

As in the 2016 DRL [1], screening calculations for airborne effluents were performed to reduce the number of combinations of potential critical groups and release locations for which detailed dose calculations were required.

In view of the similar nature of the potential critical groups, the screening was based on:

1. The predicted annual-average air concentrations at each group location, resulting from a unit release of each radionuclide at a release location. Concentrations at Farm E were multiplied by a factor of 0.08 to account for the fact that it has limited occupancy (672 hrs per year).
2. The predicted annual-average soil concentration at each group location, resulting from a unit release of each radionuclide at a release location, except for C-14 and HTO, for which doses do not depend on soil concentration. Concentrations at Farm E were multiplied by a factor of 0.08 to account for the limited occupancy.

Table 10-1 shows the predicted air concentrations for a subset of the radionuclides released, along with the predicted air concentrations of their daughters. Predictions for all released radionuclides having daughters are included to illustrate the differing effects of ingrowth for different combinations of potential critical groups and release locations. Also included in Table 10-1 are predictions for the slowest- and fastest-decaying released radionuclides that have no daughters, I-129 and Zn-65. Predictions for HTO, which was previously released from B100 only, now includes separate predictions for HTO released from the WMA. The highest concentrations for each radionuclide are indicated by yellow shading.

Even though the air concentrations in the WMA have increased by approximately 2% for all radionuclides, the release location and critical group corresponding to the highest concentration for each radionuclide remain the same as in the 2016 DRL [1]. For all radionuclides, except Pu-239dd (second daughter of released radionuclide Am-243) and HTO (released from both B100 and the WMA), the highest predicted air concentrations are for the combination of Farm A and release from B200. For Pu-239dd, the air concentration is also highest at Farm A, but in this case in combination with release from B300. However, the air concentrations of Pu-239dd are ten orders of magnitude lower than those of its parent, Am-243, so the dose contribution from Pu-239dd will be negligible compared to that of Am-243 and it need not be considered further. Although Farm E is the potential critical group closest to release locations B100, B200 and B300, it has limited occupancy and is not located in one of the high-frequency wind-direction sectors relative to them (Figure 1-2, Figure 6-2 and Figure 6-3). Therefore, the scaled predicted air concentrations at this group location are lower than the concentrations at other group locations. Although the WMA is closer to Farm A than B200 is, the WMA is not the bounding release location for air concentrations because Farm A is in a low-frequency wind-direction sector relative to the WMA (Figure 1-2 and Figure 6-2).

For HTO released from the WMA, the air concentration is also highest at Farm A, but in this case in combination with release from the WMA. This is because HTO is only released from B100 and the WMA, and each case was treated individually to allow for separate DRLs. For HTO released from the B100, the highest predicted air concentration is at Farm F, not at Farm A. This is because releases from B100 were assumed to be driven by the meteorological conditions typical of a height of 25 m, whereas releases from the other locations were assumed to be driven by the meteorological conditions typical of a height of 6 m. The meteorological conditions at these two heights differ significantly (Figure 1-2 and Figure 6-2).

Table 10-1
Predicted Air Concentrations (Bq m^{-3}) at Potential Critical Group Locations as a Result of the Unit Release of Radionuclide (1 Bq s^{-1}) to the Atmosphere at a Release Location

Radionuclide	Release from B100				Release from B200				Release from B300				Release from WMA**			
	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F
Am-243	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Np-239d	1.05E-09	9.85E-10	3.08E-11	1.03E-09	8.44E-09	4.06E-09	2.82E-10	7.21E-09	8.38E-09	4.10E-09	3.32E-10	7.35E-09	6.05E-09	1.88E-09	1.07E-10	3.74E-09
Pu-239dd	1.03E-18	8.64E-19	1.15E-20	8.20E-19	1.32E-17	6.14E-18	1.92E-19	1.01E-17	1.38E-17	5.88E-18	1.84E-19	1.05E-17	7.42E-18	4.39E-18	1.75E-19	5.36E-18
Ce-144	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Pr-144d	1.14E-07	1.12E-07	4.67E-09	1.24E-07	6.59E-07	3.26E-07	3.51E-08	6.14E-07	6.29E-07	3.42E-07	4.46E-08	6.13E-07	5.56E-07	1.08E-07	8.07E-09	3.11E-07
Cs-137	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Ba-137md	1.85E-07	1.86E-07	1.26E-08	2.30E-07	7.63E-07	3.87E-07	5.85E-08	7.53E-07	7.16E-07	4.13E-07	8.41E-08	7.45E-07	6.96E-07	1.16E-07	9.39E-09	3.69E-07
HTO	1.87E-07	1.90E-07	1.46E-08	2.37E-07†	-	-	-	-	-	-	-	-	6.99E-07†	1.16E-07	9.41E-09	3.70E-07
I-129	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Np-237	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Pa-233d	9.20E-11	8.60E-11	2.68E-12	8.99E-11	7.39E-10	3.56E-10	2.46E-11	6.31E-10	7.34E-10	3.59E-10	2.90E-11	6.43E-10	5.29E-10	1.65E-10	9.33E-12	3.28E-10
Pu-238	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
U-234d	2.78E-17	2.60E-17	8.10E-19	2.71E-17	2.23E-16	1.07E-16	7.44E-18	1.91E-16	2.22E-16	1.09E-16	8.75E-18	1.94E-16	1.60E-16	4.98E-17	2.82E-18	9.90E-17
Pu-241	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Am-241d	1.58E-14	1.47E-14	4.60E-16	1.54E-14	1.27E-13	6.10E-14	4.22E-15	1.08E-13	1.26E-13	6.16E-14	4.97E-15	1.10E-13	9.07E-14	2.82E-14	1.60E-15	5.62E-14
Sb-125	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Te-125md	4.28E-11	4.00E-11	1.25E-12	4.18E-11	3.44E-10	1.66E-10	1.15E-11	2.94E-10	3.41E-10	1.67E-10	1.35E-11	2.99E-10	2.46E-10	7.67E-11	4.34E-12	1.52E-10
Sr-90	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Y-90d	9.30E-10	8.69E-10	2.72E-11	9.09E-10	7.45E-09	3.59E-09	2.49E-10	6.37E-09	7.40E-09	3.62E-09	2.93E-10	6.49E-09	5.34E-09	1.66E-09	9.41E-11	3.31E-09
U-235	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Th-231d	2.32E-09	2.17E-09	6.78E-11	2.27E-09	1.85E-08	8.92E-09	6.21E-10	1.58E-08	1.84E-08	9.01E-09	7.32E-10	1.61E-08	1.33E-08	4.10E-09	2.34E-10	8.22E-09
U-238	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07
Th-234d	1.03E-10	9.64E-11	3.01E-12	1.01E-10	8.28E-10	3.99E-10	2.76E-11	7.07E-10	8.22E-10	4.03E-10	3.25E-11	7.21E-10	5.93E-10	1.85E-10	1.05E-11	3.67E-10
Pa-234mdd	9.68E-11	9.00E-11	2.53E-12	9.27E-11	8.02E-10	3.86E-10	2.56E-11	6.82E-10	7.98E-10	3.89E-10	2.95E-11	6.96E-10	5.69E-10	1.81E-10	1.01E-11	3.55E-10
Zn-65	1.87E-07	1.90E-07	1.46E-08	2.37E-07	7.64E-07	3.89E-07	5.97E-08	7.56E-07	7.17E-07	4.14E-07	8.70E-08	7.47E-07	6.99E-07	1.16E-07	9.41E-09	3.70E-07

* The values listed for Farm E are the predicted concentrations multiplied by a factor of 0.08 to account for the limited occupancy.

** The predicted air concentrations for releases from the WMA are revised values from the 2016 DRL [1].

† Separate HTO DRLs are required for B100 and the WMA, thus, both are shaded yellow.

Table 10-2 shows the predicted soil concentrations for a subset of the radionuclides released (except for C-14 and HTO), along with the predicted soil concentrations of their daughters. The highest concentrations for each radionuclide are indicated by yellow shading.

Even though the soil concentrations in the WMA have increased by approximately 2% for all radionuclides, the release location and critical group corresponding to the highest concentration for each radionuclide remain the same as in the 2016 DRL [1]. The highest predicted soil concentrations are for the combination of Farm A and release from the WMA for all parent radionuclides, except I-129. Farm A also has the highest predicted air concentrations, but the release location resulting in the highest air concentrations is different (B200). The difference is because precipitation occurs more frequently when the wind is blowing toward Farm A from the WMA than when it is blowing from B200 (see Figure 1-2 and Table 8-4), with the net result being more wet deposition and higher soil concentrations, even though the air concentrations are lower.

For I-129, the highest predicted soil concentration is for the same combination as the highest predicted air concentration (Farm A and B200). This is because, for I-129, wet deposition is less significant than dry deposition, whereas the opposite is true for the other radionuclides of interest. The washout ratio for I-129 is much lower than that for the other radionuclides (1.6e5 vs 5.5e6), and the dry deposition velocity for I-129 is higher (7.5e-3 m s^{-1} vs. 1.4E-3 m s^{-1}).

For many of the daughter radionuclides, the highest predicted soil concentrations are for the combination of Farm A and release from B300. However, the soil concentrations of the daughters are several orders of magnitude lower than those of the parents, so they can be ignored.

In summary, based on the results of the screening calculations in the 2016 DRL [1], detailed dose calculations were required for only three combinations of potential critical group and release locations: Farm F and B100 for HTO, Farm A and B200 for radionuclides other than HTO, and Farm A and the WMA for radionuclides other than HTO. However, based on the results of the current screening calculations, detailed dose calculations need to be revised for the combination of Farm A and the WMA (using the ILLTS geometry) for all radionuclides with the addition of HTO.

Table 10-2
Predicted Soil Concentrations (Bq kg^{-1}dw) at Potential Critical Group Locations as a Result of the Unit Release of Radionuclide (1 Bq s^{-1}) to the Atmosphere at a Release Location

Radionuclide	Release from B100				Release from B200				Release from B300				Release from WMA			
	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F	Farm A	Farm D	Farm E *	Farm F
Am-243	5.97E-03	9.99E-03	6.93E-04	7.01E-03	2.43E-02	2.05E-02	2.97E-03	2.30E-02	2.33E-02	2.07E-02	4.17E-03	2.22E-02	**2.85E-02**	**7.56E-03**	**5.57E-04**	**1.56E-02**
Np-239d	6.42E-09	9.88E-09	2.80E-10	5.82E-09	5.12E-08	4.11E-08	2.69E-09	4.20E-08	5.20E-08	3.92E-08	3.04E-09	4.17E-08	**4.72E-08**	**2.33E-08**	**1.21E-09**	**3.02E-08**
Pu-239dd	3.27E-14	4.54E-14	5.48E-16	2.43E-14	4.20E-13	3.25E-13	9.55E-15	3.07E-13	4.48E-13	2.94E-13	8.82E-15	3.13E-13	**3.03E-13**	**2.85E-13**	**1.04E-14**	**2.27E-13**
Ce-144	1.37E-04	2.30E-04	1.60E-05	1.61E-04	5.59E-04	4.73E-04	6.84E-05	5.30E-04	5.36E-04	4.77E-04	9.61E-05	5.11E-04	**6.57E-04**	**1.74E-04**	**1.28E-05**	**3.60E-04**
Pr-144d	3.57E-09	5.75E-09	2.18E-10	3.58E-09	2.05E-08	1.69E-08	1.71E-09	1.83E-08	2.00E-08	1.67E-08	2.10E-09	1.78E-08	**2.22E-08**	**6.85E-09**	**4.68E-10**	**1.29E-08**
Cs-137	3.43E-03	5.74E-03	3.98E-04	4.03E-03	1.39E-02	1.18E-02	1.71E-03	1.32E-02	1.34E-02	1.19E-02	2.40E-03	1.27E-02	**1.64E-02**	**4.35E-03**	**3.20E-04**	**8.98E-03**
Ba-137md	8.48E-10	1.41E-09	8.64E-11	9.80E-10	3.49E-09	2.95E-09	4.20E-10	3.31E-09	3.35E-09	2.98E-09	5.81E-10	3.19E-09	**4.10E-09**	**1.09E-09**	**8.02E-11**	**2.25E-09**
I-129	2.45E-03	2.53E-03	1.93E-04	3.10E-03	1.00E-02	5.16E-03	7.91E-04	9.88E-03	9.38E-03	5.49E-03	1.15E-03	9.76E-03	**9.20E-03**	**1.56E-03**	**1.25E-04**	**4.88E-03**
Np-237	4.85E-03	8.10E-03	5.62E-04	5.69E-03	1.97E-02	1.67E-02	2.41E-03	1.87E-02	1.89E-02	1.68E-02	3.39E-03	1.80E-02	**2.31E-02**	**6.14E-03**	**4.52E-04**	**1.27E-02**
Pa-233d	6.44E-09	9.91E-09	2.80E-10	5.83E-09	5.15E-08	4.13E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.74E-08**	**2.35E-08**	**1.21E-09**	**3.04E-08**
Pu-238	4.87E-03	8.15E-03	5.66E-04	5.72E-03	1.98E-02	1.68E-02	2.43E-03	1.88E-02	1.90E-02	1.69E-02	3.41E-03	1.81E-02	**2.33E-02**	**6.18E-03**	**4.55E-04**	**1.28E-02**
U-234d	8.82E-13	1.36E-12	3.84E-14	7.99E-13	7.06E-12	5.66E-12	3.69E-13	5.79E-12	7.17E-12	5.40E-12	4.18E-13	5.75E-12	**6.49E-12**	**3.22E-12**	**1.66E-13**	**4.16E-12**
Pu-241	2.17E-03	3.63E-03	2.52E-04	2.55E-03	8.84E-03	7.47E-03	1.08E-03	8.38E-03	8.47E-03	7.54E-03	1.52E-03	8.07E-03	**1.04E-02**	**2.75E-03**	**2.03E-04**	**5.69E-03**
Am-241d	4.83E-10	7.43E-10	2.10E-11	4.37E-10	3.86E-09	3.10E-09	2.02E-10	3.17E-09	3.92E-09	2.96E-09	2.29E-10	3.15E-09	**3.55E-09**	**1.76E-09**	**9.10E-11**	**2.28E-09**
Sb-125	4.77E-04	7.98E-04	5.54E-05	5.60E-04	1.94E-03	1.64E-03	2.37E-04	1.84E-03	1.86E-03	1.66E-03	3.34E-04	1.77E-03	**2.28E-03**	**6.05E-04**	**4.45E-05**	**1.25E-03**
Te-125md	6.43E-09	9.90E-09	2.80E-10	5.83E-09	5.15E-08	4.12E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.73E-08**	**2.35E-08**	**1.21E-09**	**3.03E-08**
Sr-90	3.12E-03	5.22E-03	3.62E-04	3.66E-03	1.27E-02	1.07E-02	1.55E-03	1.20E-02	1.22E-02	1.08E-02	2.18E-03	1.16E-02	**1.49E-02**	**3.95E-03**	**2.91E-04**	**8.17E-03**
Y-90d	6.42E-09	9.89E-09	2.80E-10	5.82E-09	5.13E-08	4.11E-08	2.69E-09	4.21E-08	5.21E-08	3.93E-08	3.04E-09	4.18E-08	**4.72E-08**	**2.33E-08**	**1.21E-09**	**3.03E-08**
U-235	5.95E-03	9.94E-03	6.90E-04	6.98E-03	2.42E-02	2.04E-02	2.96E-03	2.29E-02	2.32E-02	2.06E-02	4.16E-03	2.21E-02	**2.84E-02**	**7.53E-03**	**5.55E-04**	**1.56E-02**
Th-231d	6.39E-09	9.84E-09	2.79E-10	5.80E-09	5.09E-08	4.08E-08	2.68E-09	4.18E-08	5.16E-08	3.90E-08	3.04E-09	4.15E-08	**4.69E-08**	**2.31E-08**	**1.20E-09**	**3.00E-08**
U-238	5.95E-03	9.94E-03	6.90E-04	6.98E-03	2.42E-02	2.04E-02	2.96E-03	2.29E-02	2.32E-02	2.06E-02	4.16E-03	2.21E-02	**2.84E-02**	**7.53E-03**	**5.55E-04**	**1.56E-02**
Th-234d	6.44E-09	9.91E-09	2.80E-10	5.83E-09	5.15E-08	4.13E-08	2.69E-09	4.22E-08	5.23E-08	3.94E-08	3.05E-09	4.19E-08	**4.74E-08**	**2.35E-08**	**1.21E-09**	**3.04E-08**
Pa-234mdd	2.04E-13	3.12E-13	7.95E-15	1.81E-13	1.68E-12	1.35E-12	8.43E-14	1.37E-12	1.71E-12	1.28E-12	9.37E-14	1.37E-12	**1.54E-12**	**7.76E-13**	**3.97E-14**	**9.91E-13**
Zn-65	1.18E-04	1.97E-04	1.37E-05	1.38E-04	4.80E-04	4.06E-04	5.87E-05	4.55E-04	4.60E-04	4.09E-04	8.25E-05	4.38E-04	**5.64E-04**	**1.49E-04**	**1.10E-05**	**3.09E-04**

* The values listed for Farm E are the predicted concentrations multiplied by a factor of 0.08 to account for the limited occupancy.

11. DRL RESULTS

For each effluent type, the DRL for a given radionuclide was calculated from:

$$DRL_i = \frac{DL_{eff}}{D_i} \quad (2)$$

where: DRL_i is the derived release limit for radionuclide i (Bq s^{-1}), DL_{eff} is the annual effective dose limit for members of the public (0.001 Sv a^{-1}), D_i is the dose rate per unit release rate ((Sv a^{-1})/(Bq s^{-1})) for radionuclide i, summed over all applicable exposure pathways, for the age class leading to the highest dose.

The calculated DRLs for each radionuclide are summarized in Table 11-1 and Table 11-2 for airborne and liquid effluents, respectively. For airborne effluents, the DRLs are expressed on a weekly basis and for liquid effluents they are expressed on a monthly basis. The tables also provide information on the bounding age classes, the dominant exposure pathways and the percent contributions from the dominant pathways to the total dose rates.

Table 11-1
DRLs for Airborne Effluents Released from WL

Radionuclide (and daughters)	DRL (Bq week^{-1})	Bounding Release Location	Bounding Critical Group	Bounding Age Class*	Dominant Pathway**	Percent Contribution from Dominant Pathway to Total Dose Rate
Am-241	2.07E+09	B200	Farm A	Adult	AI	92
Am-243 (Np-239d, Pu-239dd)	2.04E+09	B200	Farm A	Adult	AI	89
C-14 (CO_2)	8.61E+11	B200	Farm A	1y CMDI	TAMM	97
Ce-144 (Pr-144d)	3.52E+11	B200	Farm A	1y CMDI	TP	45
Cm-244	3.20E+09	B200	Farm A	Child-5y	AI	96
Co-60	1.78E+10	WMA	Farm A	1y CMDI	SLE	83
Cs-134	1.36E+10	WMA	Farm A	Adult	TAMM	78
Cs-137 (Ba-137md)	1.48E+10	WMA	Farm A	Adult	TAMM	65
Eu-152	1.96E+10	WMA	Farm A	3mo NI	SLE	98
Eu-154	2.53E+10	WMA	Farm A	3mo NI	SLE	97
Fe-55	1.74E+12	B200	Farm A	3mo NI	TAMM	74
HTO †	1.65E+15	B100	Farm F	Adult	WI	39
HTO †	5.61E+14	WMA	Farm A	Adult	WI	39
I-129	4.71E+08	B200	Farm A	1y CMDI	TAMM	98
Mn-54	3.05E+11	WMA	Farm A	1y CMDI	SLE	83
Nb-94	4.95E+09	WMA	Farm A	1y CMDI	SLE	100
Ni-63	1.50E+11	WMA	Farm A	1y CMDI	TAMM	97
Np-237 (Pa-233d)	1.63E+09	WMA	Farm A	3mo FMDI	WI	78
Pm-147	5.18E+12	B200	Farm A	3mo NI	TAMM	47
Pu-238 (U-234d)	1.89E+09	B200	Farm A	Adult	AI	92
Pu-239	1.73E+09	B200	Farm A	Adult	AI	92
Pu-240	1.74E+09	B200	Farm A	Adult	AI	92
Pu-241 (Am-241d)	9.60E+10	B200	Farm A	Adult	AI	92
Pu-242	1.80E+09	B200	Farm A	Adult	AI	92
Sb-125 (Te-125md)	2.03E+11	WMA	Farm A	1y CMDI	SLE	92
Sr-90 (Y-90d)	6.79E+09	WMA	Farm A	3mo NI	TAMM	81
Tc-99	1.18E+11	WMA	Farm A	3mo FMDI	WI	86
U-234	4.78E+09	B200	Farm A	3mo FMDI	TAMM	84
U-235 (Th-231d)	4.67E+09	B200	Farm A	3mo FMDI	TAMM	78
U-238 (Th-234d, Pa-234mdd)	4.92E+09	B200	Farm A	3mo FMDI	TAMM	80
Zn-65	1.97E+10	WMA	Farm A	1y CMDI	TAMM	94

† For all radionuclides, except HTO, there is only one DRL. For HTO, there are two separate DRLs, one for releases from B100 and one for the WMA.

*** Acronyms for Age Class:**

1y CMDI: 1-year-old cow-milk-drinking infant

3mo NI: 3-month-old nursing infant

3mo FMDI: 3-month-old formula-milk-drinking infant

**** Acronyms for Pathway:**

AI: air (inhalation)

TAMM: terrestrial animals + mother's milk (ingestion)

TP: terrestrial plants (ingestion)

SLE: soil external (groundshine)

WI: water (ingestion)

Table 11-2
DRLs for Liquid Effluents Released from WL

Radionuclide (and daughters)	DRL (Bq month^{-1})	Bounding Critical Group	Bounding Age Class *	Dominant Pathway **	Percent Contribution from Dominant Pathway to Total Dose Rate
Am-241	1.04E+09	Farm A	3mo FMDI	WI	74
Am-243 (Np-239d, Pu-239dd)	1.04E+09	Farm A	3mo FMDI	WI	72
C-14	7.67E+10	Farm A	3mo NI	TAMM	89
Ce-144 (Pr-144d)	6.50E+10	Farm A	3mo FMDI	WI	82
Cm-244	1.08E+09	Farm A	3mo FMDI	WI	60
Co-60	2.09E+10	Farm A	3mo FMDI	SLE	69
Cs-134	8.94E+09	Farm A	Adult	FI	73
Cs-137 (Ba-137md)	1.16E+10	Farm A	Adult	FI	65
Eu-152	2.37E+10	Farm A	3mo FMDI	SLE	84
Eu-154	2.78E+10	Farm A	3mo FMDI	SLE	75
Fe-55	6.05E+11	Farm A	3mo FMDI	WI	88
HTO	6.80E+13	Farm A	3mo FMDI	WI	91
I-129	8.94E+09	Farm A	Child-10y	WI	48
Mn-54	2.41E+11	Farm A	3mo FMDI	SLE	46
Nb-94	6.59E+09	Farm A	3mo FMDI	SLE	94
Ni-63	1.09E+12	Farm A	1y CMDI	TAMM	87
Np-237 (Pa-233d)	2.40E+09	Farm A	3mo FMDI	WI	92
Pm-147	1.37E+12	Farm A	3mo FMDI	WI	94
Pu-238 (U-234d)	1.16E+09	Farm A	3mo FMDI	WI	89
Pu-239	1.11E+09	Farm A	3mo FMDI	WI	89
Pu-240	1.11E+09	Farm A	3mo FMDI	WI	89
Pu-241 (Am-241d)	8.32E+10	Farm A	3mo FMDI	WI	89
Pu-242	1.16E+09	Farm A	3mo FMDI	WI	89
Sb-125 (Te-125md)	1.71E+11	Farm A	3mo FMDI	SLE	54
Sr-90 (Y-90d)	1.30E+10	Farm A	3mo NI	TAMM	80
Tc-99	4.38E+11	Farm A	3mo FMDI	WI	84
U-234	1.34E+10	Farm A	3mo FMDI	WI	95
U-235 (Th-231d)	1.17E+10	Farm A	3mo FMDI	WI	78
U-238 (Th-234d, Pa-234mdd)	1.25E+10	Farm A	3mo FMDI	WI	82
Zn-65	3.29E+10	Farm A	Adult	FI	79

*** Acronyms for Age Class:**

3mo FMDI: 3-month-old formula-milk-drinking infant

3mo NI: 3-month-old nursing infant

1y CMDI: 1-year-old cow-milk-drinking infant

**** Acronyms for Pathway:**

WI: water (ingestion)

TAMM: terrestrial animals + mother's milk (ingestion)

SLE: soil external (groundshine)

FI: fish (ingestion)

For airborne effluents, B200 is the bounding release location for sixteen of the thirty radionuclides. The WMA is the bounding release location for all others, except for HTO, released from B100. The adult is the bounding age class for eleven radionuclides, with air inhalation being the dominant pathway for seven of these. For all other radionuclides, except one, infant age classes are bounding with ingestion of terrestrial animal products and mother's milk being the dominant pathway for half of these.

For liquid effluents, there are no changes from the 2016 DRLs [1]. The 3-month-old formula-milk-drinking infant is the bounding age class for twenty-three radionuclides, with water ingestion being the dominant pathway for seventeen of these and groundshine being the dominant pathway for the remainder.

12. VERIFICATION

In the 2016 DRL [1], the analysis assumptions, the selection of input parameter values, the contents of IMPACT code input files and the determination of DRLs were verified in several ways. Draft assumptions and the selection of some key input parameter values were reviewed by appropriate CNL staff prior to the start of calculations. As the DRL results were generated, those for selected radionuclides (C-14, Co-60, Cs-134, Cs-137 (Ba-137m), HTO (OBT), I-129, Pu-239, Sr-90 (Y-90) and Ce-144 (Pr-144)) were checked using the independent code CSA-DRL. Finally, the assumptions, input files and calculated DRLs were independently verified through a comprehensive internal CNL review [27].

The initial checking using the CSA-DRL code did not identify any problems with the results generated using the IMPACT code. The final CNL verification identified two errors with the selection of input parameter values, one of which was significant. This review also identified one minor transcription error in the input files. These errors were subsequently corrected.

Subsequently, it was realized by the authors that there was an error in the screening calculations. This was corrected, although it did not significantly change the results.

In the current assessment, all the changes relating to the airborne effluent DRL calculations were made by Sohan Chouhan and independently verified by Bruce Reavie and Lisa Campagna [28] to ensure that they were successfully transcribed into the IMPACT code [4]. Compilations of the IMPACT results into the summary DRLs were also verified.

13. COMPARISON OF REVISED DRLS WITH PREVIOUS VALUES

The revised DRLs have been compared with those established in 2016 [1]. Reasons for the differences were mentioned briefly in Section 1 and 6 of this report.

In summary, for 12 radionuclides from airborne effluents, the revised DRLs are approximately 2% lower than the 2016 DRLs [1]. For one radionuclide (Zn-65), the bounding release location changed from B200 to the WMA and the magnitude of the DRL was lowered by 1%. The main reason for the decreases in the DRLs is the introduction of the three new systems (SWRS, BWRS/SCU and ILLTS) in the WMA, which resulted in lowering the effective release height. A new DRL was added for HTO released from the WMA (5.61E+14 Bq week^{-1}) and the previous DRL for HTO released from B100 (1.65E+15 Bq week $^{-1}$) [1] is still valid. The reason for this addition is the release of HTO from one or more of the three new systems in the WMA.

There is no change to the liquid effluent DRLs.

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Appendix A

Triple Joint Frequency Distribution of Wind Speed, Wind Direction and Stability Class

Table A-1
Triple Joint Frequency Distribution data obtained at the 6-m Level

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
N	A	0.00536	0.002556	0.000887	0.000103	0.000062	0
NNE	A	0.002948	0.001237	0.000371	0.000041	0.000021	0
NE	A	0.001649	0.000598	0.000392	0.000082	0	0
ENE	A	0.001567	0.00066	0.00033	0.000021	0	0
ENE	A	0.001835	0.000845	0.00035	0.000021	0	0
ESE	A	0.002165	0.000474	0.000186	0.000041	0	0
SE	A	0.002783	0.000763	0.000247	0	0.000021	0
SSE	A	0.003381	0.000825	0.000206	0.000041	0.000021	0
S	A	0.004371	0.001134	0.000206	0.000021	0	0
SSW	A	0.004165	0.001299	0.000227	0.000041	0	0
SW	A	0.004494	0.001567	0.000515	0.000062	0	0
WSW	A	0.00369	0.001587	0.000763	0.000103	0.000021	0.000021
W	A	0.003525	0.001814	0.000969	0.000227	0.000062	0.000103
WNW	A	0.002618	0.001237	0.00099	0.000309	0.000206	0.000124
NW	A	0.004247	0.002433	0.001587	0.000536	0.000268	0.000165
NNW	A	0.005298	0.002783	0.001258	0.000412	0.000082	0.000041
N	B	0.005855	0.004865	0.004	0.001567	0.000618	0.000309
NNE	B	0.002082	0.001794	0.001051	0.000371	0.000103	0
NE	B	0.001319	0.00099	0.000515	0.000309	0.000041	0.000021
ENE	B	0.001031	0.000433	0.000412	0.000103	0.000041	0
ENE	B	0.000825	0.000639	0.000598	0.000206	0.000062	0
ESE	B	0.001464	0.000866	0.000618	0.000247	0.000041	0
SE	B	0.002515	0.001752	0.001072	0.000206	0.000041	0.000021
SSE	B	0.002598	0.001876	0.001051	0.000268	0.000021	0
S	B	0.005195	0.003567	0.001855	0.000907	0.000247	0.000021
SSW	B	0.004927	0.00503	0.002103	0.000639	0.000062	0
SW	B	0.004639	0.003484	0.001464	0.00033	0.000062	0
WSW	B	0.003381	0.002453	0.00134	0.000515	0.000082	0.000041
W	B	0.002247	0.001443	0.001361	0.001113	0.000289	0.000082
WNW	B	0.001732	0.001691	0.00202	0.001505	0.000742	0.00033
NW	B	0.004247	0.00367	0.004391	0.003072	0.002185	0.001443
NNW	B	0.007236	0.006989	0.006721	0.004783	0.002144	0.00099

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
N	C	0.010721	0.006948	0.004762	0.002082	0.000536	0.000392
NNE	C	0.005484	0.004618	0.002783	0.001319	0.000474	0.000206
NE	C	0.002041	0.002371	0.001402	0.000928	0.000289	0.000021
ENE	C	0.002474	0.001278	0.000804	0.000495	0.000186	0
ENE	C	0.00167	0.001773	0.00202	0.000928	0.000227	0.000041
ESE	C	0.003257	0.002433	0.002474	0.001134	0.000289	0.000021
SE	C	0.005505	0.00501	0.00402	0.002144	0.000825	0.000144
SSE	C	0.008638	0.009648	0.007855	0.004206	0.001113	0.00035
S	C	0.013009	0.009669	0.007628	0.002928	0.000763	0.000021
SSW	C	0.012906	0.004371	0.001402	0.000144	0.000021	0
SW	C	0.009917	0.003958	0.002206	0.000536	0.00033	0.000041
WSW	C	0.005546	0.004783	0.002866	0.001464	0.000701	0.00035
W	C	0.003773	0.003567	0.004288	0.002763	0.001691	0.001175
WNW	C	0.003299	0.002886	0.003628	0.003938	0.003051	0.004288
NW	C	0.00703	0.005422	0.006164	0.00635	0.005546	0.005999
NNW	C	0.010473	0.007463	0.005298	0.003134	0.001361	0.000742
N	D	0.005752	0.001216	0.000495	0.000309	0.000124	0.000041
NNE	D	0.004268	0.002185	0.000763	0.000371	0.000227	0.000021
NE	D	0.001608	0.002123	0.001464	0.000866	0.000763	0.00035
ENE	D	0.003154	0.002206	0.001196	0.000577	0.000103	0.000082
ENE	D	0.004577	0.00468	0.00369	0.001072	0.00035	0.000289
ESE	D	0.006391	0.004103	0.002845	0.001155	0.00033	0.000041
SE	D	0.008494	0.006577	0.003938	0.001587	0.000371	0
SSE	D	0.015174	0.015091	0.009071	0.004082	0.000969	0.000165
S	D	0.017751	0.006494	0.003505	0.000598	0.000082	0.000021
SSW	D	0.005999	0.000186	0	0	0	0
SW	D	0.006577	0.000577	0.000227	0.000041	0	0
WSW	D	0.007628	0.003814	0.001423	0.000928	0.000289	0.000433
W	D	0.006102	0.007175	0.006206	0.003649	0.002082	0.001402
WNW	D	0.002742	0.003051	0.003381	0.002783	0.001484	0.001711
NW	D	0.004144	0.002144	0.002845	0.003031	0.002288	0.002206
NNW	D	0.005608	0.001587	0.000845	0.000392	0.000247	0.000227
N	E	0.003196	0.000495	0.000845	0.000639	0.000433	0.000103
NNE	E	0.001051	0.000082	0.000021	0	0	0
NE	E	0.000866	0.000186	0.000124	0	0	0
ENE	E	0.002474	0.000309	0.000041	0	0	0
ENE	E	0.004103	0.000804	0.000041	0	0	0
ESE	E	0.004618	0.000577	0.000082	0.000021	0	0
SE	E	0.005731	0.000887	0.000268	0.000082	0.000021	0

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	**2 to 3 m/s**	**3 to 4 m/s**	**4 to 5 m/s**	**5 to 6 m/s**	**>6 m/s**
		Average Wind Speed (m/s) for Each Wind Speed Class					
		0.853882	2.466141	3.439265	4.417175	5.43651	7.052884
		Triple Joint Frequencies					
SSE	E	0.008329	0.001484	0.000412	0.000041	0	0
S	E	0.010741	0.000227	0	0	0	0
SSW	E	0.005237	0.000021	0	0	0	0
SW	E	0.004845	0.000021	0	0	0	0
WSW	E	0.004927	0.00035	0.000124	0.000041	0.000021	0
W	E	0.003587	0.001299	0.00101	0.000144	0.000103	0.000021
WNW	E	0.001876	0.000454	0.000144	0.000103	0.000082	0.000144
NW	E	0.001876	0.000041	0	0	0	0
NNW	E	0.002618	0.000124	0	0	0	0.000021
N	F	0.005711	0.000309	0.000186	0.000082	0	0.000021
NNE	F	0.002227	0	0	0	0	0
NE	F	0.001464	0	0	0	0	0
ENE	F	0.002206	0	0	0	0	0
ENE	F	0.003628	0.000021	0	0	0	0
ESE	F	0.005855	0.000021	0	0	0	0
SE	F	0.010143	0	0.000062	0	0	0
SSE	F	0.01004	0.000062	0.000062	0.000041	0.000021	0.000021
S	F	0.014514	0.000124	0.000021	0	0	0
SSW	F	0.013792	0	0	0	0	0
SW	F	0.014225	0.000124	0	0	0	0
WSW	F	0.011772	0	0	0	0	0
W	F	0.009875	0	0.000021	0.000021	0.000041	0.000021
WNW	F	0.007257	0.000041	0.000041	0.000082	0.000062	0.000021
NW	F	0.00635	0	0	0	0	0
NNW	F	0.006123	0.000021	0	0	0	0

Table A-2
Triple Joint Frequency Distribution data obtained at the 25-m Level

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
N	A	0.002515	0.001718	0.000736	0.000245	0.000082	0.000102
NNE	A	0.001411	0.000634	0.000368	0.000143	0.000102	0
NE	A	0.001043	0.000409	0.000286	0.000123	0.000061	0
ENE	A	0.001043	0.000491	0.000225	0.000061	0.000061	0
ENE	A	0.001268	0.000757	0.000348	0.000164	0.00002	0
ESE	A	0.001043	0.000573	0.000389	0.000061	0	0
SE	A	0.001636	0.000634	0.000123	0.000041	0.000061	0.00002
SSE	A	0.001902	0.00092	0.000429	0.000143	0.000041	0
S	A	0.001984	0.000838	0.000348	0.000164	0.000061	0.000041
SSW	A	0.002413	0.000777	0.000348	0.000184	0.000041	0.000041
SW	A	0.002208	0.001043	0.000348	0.000204	0.000041	0.000123
WSW	A	0.0018	0.000716	0.000716	0.000123	0.000061	0.000102
W	A	0.002147	0.001084	0.000941	0.000368	0.000164	0.000204
WNW	A	0.00182	0.000757	0.000838	0.00047	0.000184	0.000225
NW	A	0.002249	0.001104	0.000798	0.000491	0.000184	0.000143
NNW	A	0.002945	0.001431	0.000675	0.000245	0.000164	0.000204
N	B	0.001963	0.002597	0.001145	0.000777	0.000204	0.00002
NNE	B	0.000941	0.000982	0.000654	0.000164	0.000082	0
NE	B	0.000859	0.000695	0.000654	0.000184	0.000061	0.00002
ENE	B	0.000838	0.000552	0.000389	0.000225	0	0
ENE	B	0.000552	0.00047	0.000429	0.000245	0.00002	0
ESE	B	0.000654	0.000573	0.000327	0.000184	0.000082	0.00002
SE	B	0.001288	0.000777	0.000552	0.000204	0.000102	0
SSE	B	0.00135	0.000982	0.000491	0.000286	0.000143	0.00002
S	B	0.002024	0.001063	0.000634	0.000511	0.000266	0.000143
SSW	B	0.001922	0.001247	0.001125	0.000818	0.000348	0.000184
SW	B	0.001636	0.001247	0.001534	0.000777	0.000286	0.000123
WSW	B	0.00137	0.001329	0.001043	0.000757	0.000348	0.000348
W	B	0.001309	0.000961	0.001043	0.000798	0.000327	0.000245
WNW	B	0.001513	0.000818	0.001104	0.0009	0.00045	0.000348
NW	B	0.001615	0.001125	0.001309	0.001206	0.000941	0.000613
NNW	B	0.002086	0.002352	0.001575	0.000818	0.000593	0.000511
N	C	0.003619	0.00638	0.005726	0.00499	0.003026	0.002699
NNE	C	0.001615	0.002536	0.001963	0.00135	0.000695	0.00047
NE	C	0.00182	0.001636	0.001309	0.0009	0.000348	0.000204
ENE	C	0.001493	0.001022	0.000777	0.000654	0.000348	0.000041

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
ENE	C	0.001288	0.000982	0.001268	0.000941	0.000368	0.000245
ESE	C	0.001575	0.001677	0.001043	0.000859	0.000654	0.000266
SE	C	0.003006	0.002372	0.002045	0.001738	0.000695	0.000409
SSE	C	0.003047	0.003517	0.003619	0.003026	0.002311	0.001227
S	C	0.00454	0.004315	0.004499	0.003742	0.002454	0.001922
SSW	C	0.003844	0.003742	0.004744	0.003824	0.002842	0.002045
SW	C	0.003865	0.003415	0.003354	0.00272	0.002045	0.001411
WSW	C	0.002393	0.002352	0.002208	0.001902	0.000859	0.00135
W	C	0.003026	0.001881	0.00272	0.002127	0.001227	0.002127
WNW	C	0.002699	0.002147	0.001963	0.00227	0.001984	0.003211
NW	C	0.003497	0.003129	0.004253	0.003804	0.003988	0.006441
NNW	C	0.005419	0.007014	0.007341	0.008364	0.007341	0.010265
N	D	0.006973	0.009141	0.006728	0.004887	0.002311	0.002086
NNE	D	0.002495	0.00503	0.005071	0.002147	0.001452	0.001125
NE	D	0.002924	0.003599	0.003354	0.002147	0.001247	0.001431
ENE	D	0.002904	0.004253	0.00274	0.001595	0.0009	0.000389
ENE	D	0.002433	0.003456	0.00411	0.003476	0.001902	0.001145
ESE	D	0.003988	0.005337	0.004785	0.003149	0.00135	0.000757
SE	D	0.005174	0.006666	0.008282	0.005705	0.003558	0.002045
SSE	D	0.004744	0.01094	0.018261	0.018241	0.013374	0.009325
S	D	0.007178	0.011922	0.009611	0.006891	0.003231	0.001697
SSW	D	0.00499	0.005992	0.005726	0.003395	0.001206	0.000675
SW	D	0.00499	0.005705	0.00454	0.002945	0.001922	0.001677
WSW	D	0.004642	0.004213	0.005071	0.003538	0.002249	0.003088
W	D	0.004192	0.004417	0.00548	0.005215	0.003517	0.005092
WNW	D	0.003333	0.003108	0.004335	0.004785	0.003313	0.006687
NW	D	0.003211	0.004458	0.004785	0.005726	0.005808	0.011615
NNW	D	0.006585	0.008814	0.006421	0.004785	0.003906	0.004233
N	E	0.003865	0.003517	0.002208	0.000777	0.000184	0.000143
NNE	E	0.002536	0.002106	0.000941	0.000061	0.00002	0
NE	E	0.001022	0.001022	0.000634	0.000061	0.000061	0.000041
ENE	E	0.001738	0.001452	0.000941	0.000225	0.000041	0
ENE	E	0.002352	0.002413	0.00182	0.000757	0.000061	0
ESE	E	0.002495	0.003067	0.00137	0.000409	0.000041	0
SE	E	0.003967	0.004172	0.001227	0.000204	0.000041	0.000041
SSE	E	0.004213	0.00638	0.006176	0.003088	0.001063	0.000225
S	E	0.004621	0.007239	0.003517	0.000716	0.000286	0.000082
SSW	E	0.002515	0.002699	0.001166	0.000286	0.000061	0
SW	E	0.002474	0.001534	0.001186	0.000204	0	0

Wind from Sector	Stability Class	Wind Speed Classes					
		0 to 2 m/s	2 to 3 m/s	3 to 4 m/s	4 to 5 m/s	5 to 6 m/s	>6 m/s
		Average Wind Speed (m/s) for Each Wind Speed Class					
		1.136575	2.49576	3.465201	4.452005	5.446335	7.277126
		Triple Joint Frequencies					
WSW	E	0.002168	0.001186	0.001247	0.000634	0.000204	0.000204
W	E	0.00274	0.002372	0.002842	0.001493	0.000695	0.000327
WNW	E	0.001513	0.001472	0.001718	0.001513	0.000757	0.000777
NW	E	0.001922	0.000654	0.000573	0.000409	0.000327	0.000164
NNW	E	0.00364	0.003006	0.00092	0.000286	0.000061	0.000061
N	F	0.002536	0.000879	0.00047	0	0	0
NNE	F	0.001166	0.000204	0.00002	0	0	0
NE	F	0.001227	0.00002	0.00002	0	0	0
ENE	F	0.001125	0.000082	0.000061	0	0	0
ENE	F	0.001329	0.00045	0.000368	0	0	0
ESE	F	0.001391	0.000389	0.000102	0	0	0
SE	F	0.002413	0.000593	0	0	0	0
SSE	F	0.002352	0.000961	0.000532	0.00002	0	0
S	F	0.002045	0.001002	0.000368	0.000041	0	0
SSW	F	0.001452	0.000204	0.00002	0	0	0
SW	F	0.002208	0.000123	0.00002	0	0	0
WSW	F	0.001738	0.000082	0.000082	0	0	0
W	F	0.002188	0.000164	0.000061	0.00002	0	0
WNW	F	0.00184	0.000102	0.000184	0.00002	0	0
NW	F	0.00182	0.00002	0	0	0	0
NNW	F	0.002393	0.000307	0.000266	0	0	0

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

ANNUAL COMPLIANCE MONITORING REPORT

WHITESHELL LABORATORIES ANNUAL COMPLIANCE MONITORING REPORT FOR 2019 UNDER LICENCE NRTEDL-W5-8.00/2024

WHITESHELL SITE DOCUMENTATION

WL-514300-ACMR-2019

Revision 0

Prepared by:	R. Swartz Manager, Licensing and Quality Management	2020/04/29 Date
Reviewed by:	S. Cotham Sr. Director, Compliance / Chief Regulatory Officer	2020/04/29 Date
Approved by:	J. Gilbert Head of WL Closure Project	2020/04/29 Date
Effective date:	2020/04/30	

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REVISION HISTORY

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By		Approved By
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This annual compliance monitoring report for the 2019 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories (WL) Licence NRTEDL-W5-8.00/2024 and CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* as a summary report of annual compliance monitoring and operational performance.

This annual compliance report provides Canadian Nuclear Laboratories (CNL) 2019 performance data for WL and is organized by 14 Safety and Control Areas (SCAs)[1], as well as a report on each of the WL nuclear and non-nuclear facilities.

The following provides overall performance highlights for 2019 activities:

- There were no serious process failures at WL.
- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2019 were below their respective derived release limits.
- Significant progress was made on decommissioning of Building 200, the former Active Liquid Waste Treatment Centre.
- The RD-14M (Building 300, Stage 6) and Large-Scale Vented Combustion test facilities were decommissioned and demolished.
- The WL site licence was successfully renewed for five years, effective 2020 January 01.

Below is a summary of the annual compliance report for calendar year 2019.

- **SCA - Management System:** WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning, based on Canadian Standards Association (CSA) N286.6 and aligned with CSA N286-12, monitored through many means including audits, inspections, self-assessments and program/management system reviews.
- **SCA - Human Performance Management:** WL initiated a “Pay it Forward Parking” initiative to recognize the outstanding work that goes on in the workplace, promoting CNL’s Safety Culture and use of Event Free Tools, and recognizing those who go above and beyond their normal duties.
- **SCA - Operating Performance:** WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of “events”. The total number of internal event reports raised continues to show a strong reporting culture. There was one Canadian Nuclear Safety Commission (CNSC) reportable event.

[1] The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas.

- **SCA - Safety Analysis:** Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL's nuclear facilities, helping meet health, safety, security, environmental and regulatory requirements.
- **SCA - Physical Design:** The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba.
- **SCA - Fitness for Service:** The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. The PIP was revised to address some changes. Regular preventative or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service.
- **SCA - Radiation Protection:** No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 3.1 mSv and collective doses remained below 50 person-mSv (49.6 person-mSv) for 2019. Members of the public received no measureable radiation doses. The Controlled Area reduction initiative was completed for the WL site north side.
- **SCA - Conventional Health and Safety:** Implementation of CNL's Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture, resulting in no lost time injuries in 2019.
- **SCA - Environmental Protection:** The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment. Radiological emmissions were 0.00023% of the Derived Release Limit (DRL) for air emissions and 0.93% of the DRL for liquids. The monitoring program confirms that the WL site is operating in a manner that protects workers, the public, and the environment. WL maintained their ISO-14001 registration, and are compliant to a number of CSA environmental standards.
- **SCA - Emergency Management and Fire Protection**: The Emergency Management program at WL was focussed on supporting the establshment of a Tiered Response Force (TRF). For the Fire Protection program, a fire response needs analysis was completed.
- **SCA - Waste Management:** WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 1,511 m^3 of radioactive waste to CRL, and 410 m^3 (804,170 kg) of recycled waste shipped off-site.
- **SCA – Security:** The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for security. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC. As a result of a CNSC Order, an implementation plan addressing the Order was accepted by the CNSC, and includes the standing up of a Tiered Response Force, for which training has commenced. A "Force-on-Force" security training exercise under direct CNSC Staff observation was successfully completed.

- **SCA - Safeguards:** There were no issues identified with International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL. One internal verification inspection was conducted with no recordable findings.
- **SCA - Packaging and Transport:** There was approximately 1,483 m³ of low-level waste and 28 m³ of intermediate-level waste safely shipped to Chalk River Laboratories (CRL).
- **Other matters of regulatory interest:** Two meetings of the WL Public Liaison Committee took place, an Open House was held attracting approximately 300 visitors, and numerous public information sessions and Indigenous engagements were held on the Whiteshell Reactor 1 (WR-1) in-situ decommissioning and overall activities of the WL Closure Project. A traditional Indigenous ceremony with Sagkeeng First Nation and Turtle Lodge was held on site.
- **Facilities** (operating nuclear facilities, permanently shutdown facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: significant progress in decommissioning the Active Liquid Waste Treatment Centre, Building 200; two significant former experimental facilities, RD-14M and the Large-Scale Vented Combustion Test Facilty, were decommissioned and demolished; at the Waste Management Area (WMA) the old Protected Area fence that enclosed the standpipes area alone was removed, and the Soil Storage Compound was emptied of stored soil bags, with the waste packaged and shipped off site; and commenced decommissioning of the Containment Test Facility (B303) and Waste Clearance Facility (B304).

CNL is committed to achieving high standards of operational safety and security. The information and data presented in the report support the conclusion that safe and secure performance is being achieved at the Whiteshell Laboratories (WL) site, while enhancements are being implemented to further improve results.

ACKNOWLEDGEMENT

The “Author” of this document would like to thank the many WL authors and reviewers from Facilities and Program for their production of the individual sections of the report.

0. INTRODUCTION

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the east bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL.

In 2014, Canadian Nuclear Laboratories (CNL) Ltd. was created as a wholly owned subsidiary of AECL. Implementation of the Government-Owned, Contractor-Operated model was achieved with share transfer of CNL from AECL to Canadian National Energy Alliance (CNEA) in 2015 September.

Activities are now underway to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see Section 0.5).

0.1 Site/Facility Name, Location & Ownership

Name: Whiteshell Laboratories (WL)

Location: 1 Ara Mooradian Way
Pinawa, Manitoba
R0E 1L0

0.2 Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories (WL) Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook* for Whiteshell Laboratories (WL), herein referred to as “Licence Conditions Handbook” [2]., and Section 3 Annual Compliance Monitoring Report of CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2019 January 01 to December 31.

This report provides site-specific information to supplement information in *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to 14 Safety and Control Areas as they are applied across all CNL sites.

The intent of this report is to provide sufficient detail to demonstrate how WL programs are meeting the regulatory requirements as it pertains to the licence [1] and *Licence Conditions Handbook for* Whiteshell Laboratories (WL) [2].

0.3 Facilities Included in this Report

Appendices A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and B305), and WR-1 Reactor.

0.4 Summary of Licenced Activities

There are no new licenced activities. The WL Site Licence was successfully renewed in 2019 for five years, effective 2020 January 01.

0.5 Site Development, Investment and/or Decommissioning Strategies

As discussed in 2015, work is underway to complete decommissioning of the entire WL site (current schedule is to be complete in 2027). This includes leaving in-situ the selected Waste Management Area (WMA) trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this change. The Environmental Impact Statement supporting this is in progress.

0.6 Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [5], advising that as an agent of Her Majesty in Right of Canada, AECL’s liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee is mpt time limited, thus remains valid and in effect.

1. MANAGEMENT SYSTEM

1.1 Management System Program

Whiteshell Laboratories (WL) adheres to the Corporate Management System. See Section 1 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL Quality Assurance Plan [6] supports the CNL Management System Manual [7] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to CSA N286-12 [8] and N286.6-98 [9].

1.1.1 Updates to Management System Documents

The Canadian Nuclear Safety Commission (CNSC) has previously been notified of revisions to the Quality Assurance Plans and/or other high level documents, as per the *Licence Conditions Handbook* [2]. There were no updates specific to WL in 2019.

1.2 Audits and Inspections

See Section 1.2 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL External Audits for the reporting year 2019.

As per the requirements of the Management System [7], both Safety Control Areas (SCA's) and Facilities conduct various self-assessments to ensure that the management system is functioning in according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate action taken to resolve any deficiencies.

One audit was conducted at WL in 2019:

- SAI Global audit on WL Environmental Management System to ISO 14001:2015 – This audit identified six opportunities for improvement which resulted in six actions. Five actions have been completed and one is in progress, none of the actions are overdue.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Corrective Action Program (CAP).

1.2.1 Internal Quality Audits

There were no internal audits completed by the Quality Audits and Processes branch specific to WL in 2019.

1.2.2 Inspections

1.2.2.1 CNSC Inspections

The following CNSC Inspections were conducted at **Whiteshell Laboratories (WL)**.

Table 1: CNSC Inspections for 2019

Inspection No.	Date	Area Inspected	No. of Actions Notices	No. of Actions in Progress
CNL-WL-2019-01	June 06-07	Packaging and Transport Program	2	1
CNL-WL-2019-02	August 06-08	Emergency Management and Fire Protection Programs	2	3
WL-SEC-19-T2-001	August 26-28	Security	1	n/a

Two Type II Compliance inspections were conducted at WL by CNSC staff in 2019. The first compliance based inspection, focussed on Packaging and Transport program, had two Action Notices (ensure procedure for shipping and receiving is up to date and ensure the status of re-useable packages is clearly labelled and easily identified) and two recommendations. Four actions were raised. Three actions are closed, one is open, and none are overdue. The second compliance based inspection, focussed on the Emergency Management and Fire Protection programs, resulted in two Action Notices (ensure SCBA[2] cylinders are marked, purged, and refilled on an annual basis and repair a damaged fire door), and four recommendations. Four actions were raised. One action is closed, three are open, and none are overdue. The CNSC has closed all Action Notices from both compliance inspections.

A Type II Security inspection was also conducted, and is discussed in Section 12.

1.2.2.2 Inspections by Other Regulatory Bodies

A Design Information Verification inspection was carried out by the International Atomic Energy Agency (IAEA) on 2019 September 06. This inspection verified the information provided in the Design Information Questionnaire (DIQ). The IAEA requested that the DIQ be updated to reflect the changes to the WMA fence line and new buildings.

Transport Canada conducted an Transport of Dangerous Goods (TDG) inspection at WL in 2019 and noted four non-conformances (missing parentheses of subsidiary class for a shipment of Chlorine, inconsistent wording with the consignor's declaration as specified by the IAEA Safe Transport paragraph 547 on WL's bill of lading, proof of classification not clearly demonstrated on documentation and incorrect label category applied based on a package's transport index) and three recommendations. Four actions were raised. All actions are closed and resolved.

[2] SCBA - Self-Contained Breathing Apparatus

1.3 Management Reviews

A WL Quality Assurance Program/Management System Review was completed for 2017/18 to evaluate the effectiveness of the management system. The review identified one action, which is complete. The 2018/19 review has been initiated.

2. HUMAN PERFORMANCE MANAGEMENT

2.1 Human Performance Program

Whiteshell Laboratories (WL) adheres to the Corporate Human Performance Program. See Section 2 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The effectiveness of the CNL's Human Performance Program (HU) has been enhanced through the following improvement:

"Pay it Forward Parking" Initiative: WL participates in a program called "Pay it Forward Parking" that provides a prime parking spot for an individual for one month. Created in an effort to recognize the outstanding work that goes on in WL's workplace, HU is working towards recognizing employees who promote CNL's Safety Culture, use the Event Free Tools, as well as those who go above and beyond their normal duties.

2.2 Training program

2.2.1 Required Training

All WL personnel, both employees and contractors are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work at WL. Table 2 summarizes training completed by WL operational employees during 2019.

The WL training plans are consistent with CNL's corporate training policies and programs. Employee training plans are based on CNL policies, according to position specific requirement and Managers discretion.

Table 2: WL Operating Staff Training in 2019

Course Code	Course Title	No. of Attendees
OSH-1001	Crane (Safe Indoor Hoist) – Theory	2
OSH-1002	Lift Truck Operation – Theory	2
OSH-1003	Aerial Platform – Theory (R3)	11
OSH-1004	Lock Out / Tag Out	110
OSH-1005	Working at Heights	89
OSH-1007	Asbestos Module 6E	22
OSH-3001-A	Crane (Safe Indoor Hoist) – Generic Practical	2
OSH-3002-A	Lift Truck Operation – Generic Practical	2
OSH-3003	Aerial Platform – Generic Practical	5
ODT-577	Employee Orientation – WL	11
HU-1038	Human Performance Awareness – Fundamentals & Nuclear Safety Culture	6
HU-2001	Human Performance and Event Free Tools Line Led Refresher	6
HU-1036-Online	Pre job Brief	17

3. OPERATING PERFORMANCE

3.1 Operating Program

Whiteshell Laboratories (WL) adheres to the Corporate Operating and Decommissioning Programs. See Section 3.1 and Section 11.2 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review and other internal assessment activities such as self-assessments and audits (see Section 1.2).

3.1.1 Operations / Decommissioning Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [10] for WL are given in Appendix A through Appendix F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [11] processes.

Relevant modifications to WL facilities are given in Appendix A through Appendix G.

3.2 Reporting Requirements

3.2.1 Reportable Events

In 2019, there was one event that occurred at WL that was deemed reportable to the CNSC. It is listed in Table 3.

Table 3: Reportable Events (CNSC) at WL in 2019

Event No.	Title	SCA	Facility (if applicable)
P&NO-19-0177	Security Equipment Malfunction	Security	WL Waste Management Area

A summary of events reportable to CNSC staff for 2019 and the previous four years by significance level are provided in Table 4.

Table 4: Total of WL Reportable Events by Significance Level – Five Year Summary

Year	Level 1	Level 2	Level 3	Level 4	Total
2015	0	0	0	0	0
2016	0	0	4	1	5
2017	0	0	3	1	4
2018	0	0	0	0	0
2019	0	0	1	0	1

Table 5 provides a summary, comparing the total number of reportable events categorized as Nuclear Facility, Health, Safety, Security, Environment and Quality (HSSE&Q) Program, and Other, for the years 2015 through 2019. The Improvement Action (ImpAct[3]) number and event title of all WL reportable events is provided in Table 3.

Table 5: Total Number of WL Reportable Events Categorized by Nuclear Facility, Program and Other

	Nuclear Facility	HSSE Program	Other	Total
Reportable Events in 2015	0	0	0	0
Reportable Events in 2016	1	4	0	5
Reportable Events in 2017	1	3	0	4
Reportable Events in 2018	0	0	0	0
Reportable Events in 2019	0	1	0	1

Reports to other regulatory agencies consisted of one Hazardous Occurrence Investigation Report (HOIR) made to Employment and Social Development Canada (see Section 8 Conventional Health and Safety for further details) and two reports made to Environment and Climate Change Canada / Manitoba Sustainable Development (see Section 9 Environmental Protection for further details).

3.2.2 Trending of Events Related to Operational Activities

As events at WL occur, they are recorded in the ImpAct system. This information is regularly reviewed to identify any trends.

The use of the ImpAct process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

[3] ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

In 2019, a total of 609 ImpActs were raised by CNL employees at WL (report is based on responsible department). The total number of events categorized by significance level for 2019 and the previous four years is provided in Table 6. There was an increase this year, and is within the normal variation expected year-to-year. The level of reporting is indicative of a strong reporting culture, with better quality ImpActs being raised due to the maturity of the organization.

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

Table 6: Number of ImpActs raised at WL

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2015	12	0	3	44	577	636
2016	9	0	1	25	491	526
2017	5	0	0	42	448	496
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609

a Level 0 will be assigned if the ImpAct is deemed to be a “non - problem” and a recommendation to close the ImpAct will be given.

4. SAFETY ANALYSIS

4.1 Safety Analysis Program

Whiteshell Laboratories (WL) adheres to the Corporate Safety Analysis Program. See Section 4.1 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, four facilities have SARs and Facility Authorizations: Shielded Facilities (SF), Waste Management Area (WMA), Concrete Canister Storage Facility (CCSF), and Active Liquid Waste Treatment Centre (ALWTC). There were no changes to the SARs in 2019.

The ALWTC is undergoing decommissioning. During this process, hazards addressed in the SAR, including safety-related systems that are no longer needed, will be removed. The ALWTC SAR and Facility Authorization documents will be obsoleted once decommissioning of the ALWTC is complete.

A SAR is being developed for the standpipe/bunker remediation, Intermediate Level Liquid Waste (ILLW) Processing System and use of the Shielded Modular Above Ground Storage (SMAGS) building for cask loading/testing. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC for acceptance, before these facilities are operated.

4.2 Nuclear Criticality Safety Program

Whiteshell Laboratories (WL) adheres to the Corporate Nuclear Criticality Program. See Section 4.2 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The effectiveness of the Nuclear Criticality Safety (NCS) program was enhanced by:

- Continuing to provide technical and regulatory site-wide support to various CNL groups to improve and strengthen the Program processes.
- Holding semi-annual meetings with CNSC staff, to provide updates on the status of the NCS program.

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSD) for the CCSF (CSD-11), the WMA (CSD-27), and the SMAGS Building (CSD-73) were updated and acceptance was granted by the CNL's Nuclear Criticality Safety Panel. Note that the SMAGS Building CSD was previously included in the WMA CSD (CSD-27). The CNSC has previously been notified of revisions to these *Criticality Safety Documents* [12] and [13], as per the *Licence Condition Handbook* [2].

5. PHYSICAL DESIGN

5.1 Design Program

Whiteshell Laboratories (WL) adheres to the Corporate Design Program. See Section 5.1 of *CNL Annual Compliance Monitoring Report for 2019* for details [4].

In 2019 March, a Certificate of Authorization was renewed with Engineers Geoscientists Manitoba. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of The Engineering and Geoscientific Professions Act.

5.1.1 Safety Related Structures Systems and Components

Any changes affecting safety related Safety Related Structures at WL were controlled through the Engineering Change Control Process [11].

5.2 Pressure Boundary Program

Whiteshell Laboratories (WL) adheres to the Corporate Pressure Boundary Program. See Section 5.2 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The *WL Pressure* B*oundary Quality Assurance (QA) Manual* [14] defines the pressure boundary measures applicable to WL facilities and is consistent with CNL's PB Program requirements.

The *Pressure Boundary Quality Assurance Manual* [14] was previously accepted by Inspection and Technical Services Manitoba. A Certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Manual until expiry in 2021 March.

6. FITNESS FOR SERVICE

6.1 Fitness for Service Program

The Site and Nuclear Operations Branch provides monitoring and operation of building's, processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedures reviews are conducted on a five year cycle. As facilities are decommissioned procedures are obsoleted. Procedures to operate the facilities in order to enable decommissioning efforts are prepared as required.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service WL staff ensure that critical systems, structures and components related to the safe decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities that ensure that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the facility's Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plan are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed as they are identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

6.1.3 Condition of Structures

Waste storage structures include the WMA bunkers and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [15] has been developed and implemented to confirm the ongoing fitness-for-service of the concrete storage facilities (termed “bunkers”) at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site they will be removed from the inspection process. The annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [15]. In 2019 the PIP was updated to account for a reduction in the well water chemistry measurements from spring and fall to spring only. The reduction was acceptable due to the stability of the measurements.

Although the SMAGS building is not a bunker it is included in the bunker inspection. A repair, conducted in 2016, to the north wall of SMAGS that extended into the core of the slab, remained stable through 2019 with no new crack expressions (the walls of SMAGS are pre-cast concrete slabs). All other repair items for the bunkers and SMAGS were minor in nature and were tracked through the WL work request system.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes. Only minor patching was conducted in 2019. No increased field was noted. There was no degradation of the exposed metallic portions of the canisters. Note: no concrete canisters were opened in 2019

Environmental monitoring is conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers, SMAGS or concrete canisters.

7. RADIATION PROTECTION

7.1 Radiation Protection Program

Whiteshell Laboratories (WL) adheres to the Corporate Radiation Protection Program. See Section 7 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2019 include:

- WL Controlled Area reduction initiative completed for the WL site north side;
- Waste Transhipment Controlled Area established north of the WL WMA;
- Excel macro spreadsheet implemented for reporting weekly worker personal alarming dose summaries to support higher dose risk decommissioning activities;
- Introduction of air ventilated full body plastic suits for high airborne contamination risk work;
- Introduction of water and chemical resistant protective suits;
- Air dispersion model developed to support planning of nuclear facility demolition;
- Implementation of a radioactive and contaminated material transfer form and awareness training provided to nuclear facility and decommissioning project personnel; and
- Process established for the registration of radioactive material storage areas.

The planning of radiological work is integrated into the WL site work control and planning process. Health Physics and Radiation Surveyor staff are engaged in the provision of radiological safety and ALARA assessments, providing authoritative advice regarding radiation protection matters, preparing radiological safe work documents, providing oversight of the execution of radiation work and in the planning and conduct of radiological clearance surveys. Health Physics staff develop radiological work assessments in support of the safe planning and conduct of WL decommissioning activities. Radiological clearance plans, surveys and release reports are completed for building demolitions.

WL RP performance metrics are measured and tracked weekly through WL Closure Project status reports and quarterly through the WL Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies and opportunities for improvement, establish and effectively implement corrective and preventative action plans.

The following are planned RP Program and ALARA improvements activities for 2020:

- Reconfiguration of the WMA Controlled Area exit building and change facility;
- Implementation of gamma walk-through monitors at the exit from the WL site north side and entry into the new module office complex at the WMA;
- Introduction of alpha-beta scintillation floor contamination monitors for building release monitoring;
- Introduction of hooded powered air-purifying respirators;
- Formal registration of radioactive material storage areas;

- Preparation of site specific RP procedure for movement of materials and equipment; and
- Clarification of site processes for the de-registration and disposal of radiation sources.

7.1.2 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2019, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to Thermoluminescent Dosimeters (TLD) badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition. In 2019, the maximum PAD recorded daily dose received by a worker was 0.42 mSv and the highest dose rate measured in the year was 5.82 mSv/h. These were associated with planned exposures associated with decommissioning activities in the B200 ALWTC. There were no PAD dose alarms in 2019.

At the beginning of 2019 managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by First Line Managers and Supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified. At the end of 2019, there were 4 individuals with an assigned DCP of 4 mSv, 6 individuals with an assigned DCP of 3 mSv, 49 individuals with an assigned DCP of 2 and the remainder of workers with a DCP of 1 mSv. No worker dose exceeded their assigned DCP in 2019.

7.1.3 Contamination Control

Regular contamination surveys of workplaces, material transfers and personnel exiting nuclear facilities and controlled areas are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls and to warn of abnormal of unplanned airborne contamination conditions.

Table 7 shows the number of personnel, workplace and material contamination events identified in 2019 and over the past five years. None of the contamination events in 2019 resulted in a worker whole-body, skin or internal dose.

In 2019 April there was a series of skin and worker clothing contaminations during the removal of radioactive piping from the B200 ALWTC. A review of the events concluded the levels of contamination and the friability of the material exceeded the capability of available PPE&C (suit, hood and respirator). All potential high airborne contamination work on the WL site was suspended and new air ventilated pressurized suits were purchased, commissioned and implemented. There has been no reoccurrence of contamination incidences.

In 2019, material contaminations were associated with historical surplus equipment being found with low level contamination during operational clean-up surveys or during material transfer surveys.

In 2019, there were no airborne contamination exposure events and no radioactive material spills.

Table 7: Contamination Events 2015-2019

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	Personal Clothing[a]	Work Clothing[b]	Total	Surface[c,d]	Vehicle / Materials[b,c]
2019 Calendar year	3	0	4	7	2	4
2018/19 Fiscal year	1	0	5	6	6	0
2017/18 Fiscal year	0	0	1	1	3	
2016/17 Fiscal year	1	0	0	1	8	
2015/16 Fiscal year	0	0	0	0	3	

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area
b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area
c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas.
d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2019, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2019 December 31, the total number of registered sealed, or contained sources and x-ray emitting devices at WL, was 53. Four sources were added to the registry which included:

- AmBe neutron check source that was removed out of waste storage from the WL WMA,
- Co-60 Gamma Cell received from ACSION Industries for safe storage, and
- Two RP training check sources that were found to be unregistered

One source was removed from the registry which was a Cf-252 source sent for waste storage at the WL WMA.

7.2 Dosimetry

WL uses the Chalk River Laboratories (CRL) licensed Dosimetry Service Provider (DSP) for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory standard S-106 [16] has required external exposure measurements meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[4].

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a Committed Effective Dose (CED) from occupational intakes exceeding 1 mSv per year.

7.2.1 Radiation Doses to Personnel

Table 8 to Table 11 summarize the monitored radiation doses at the WL site for 2019. Doses are summarized for employees, contractors and visitors and are subdivided into Nuclear Energy Worker (NEW) and non-NEW status. Doses in the tables of this report do not include doses received by WL employees and contractors working at sites other than WL.

In 2019, there were five authorized exceptions for individual monitoring of non-CNL employees and visitors at WL. The exceptions were for several site tours, an open house and a CNSC nuclear security exercise.

There were no operations of exposure devices in 2019 which required employees or contractors to be placed on a two-week dosimetry period and there were no formal dose calculations required during 2019 for local area skin contamination.

Neutron dosimeters were assigned to six employees during the movement of neutron sources on site in 2019. All neutron doses were below the detection threshold. Doses are summarized in Table 11.

In 2019, 188 individuals underwent internal bioassay, which involved urinalysis and/or whole-body counting. Fourteen individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective doses estimates were necessary as a result of any bioassay sampling in 2019.

[4] Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.1).

For all dose tables reported in this section below, the following footnotes apply:

[a] All doses are in mSv unless otherwise identified.
[b] Average of all measured doses that excludes the zero dose values, rounded to two decimal places.
[c] Average of all measured doses that includes the zero dose values, rounded to two decimal places.

Table 8: Effective Dose[a]

Monitored Person Type		Total # Persons	Dose Range							Individual Dose			Collective Dose
			0	0.01-0.50	0.51 – 1.00	1.01 – 5.00	5.01 – 10.00	10.01 – 20.00	>20.00				
			Number of Persons							Max	Ø Avg[b]	Avg All[c]	(person-mSv)
NEW	Employee	411	152	238	7	14	-	-	-	3.09	0.19	0.12	48.75
	Contractor	72	62	10	-	-	-	-	-	0.48	0.09	0.01	0.86
	Visitor	6	6	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	117	117	-	-	-	-	-	-	0.00	-	0.00	0.00
	Visitor	418	418	-	-	-	-	-	-	0.00	-	0.00	0.00
Totals		1024	755	248	7	14	0	0	0				49.61

Table 9: Equivalent Dose to the Skin[a]

Monitored Person Type		Total # Persons	Dose Range							Individual Dose			Collective Dose
			0	0.01-0.50	0.51 – 1.00	1.01 – 5.00	5.01 – 10.00	10.01 – 20.00	>20.00				
			Number of Persons							Max	Ø Avg[b]	Avg All[c]	(person-mSv)
NEW	Employee	411	152	228	5	22	4	-	-	7.47	0.38	0.24	99.19
	Contractor	72	62	9	1	-	-	-	-	0.55	0.09	0.01	0.93
	Visitor	6	6	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	117	117	-	-	-	-	-	-	0.00	-	0.00	0.00
	Visitor	418	418	-	-	-	-	-	-	0.00	-	0.00	0.00
Totals		1024	755	237	6	22	4	0	0				100.12

Table 10: Equivalents Dose to the Hands and Feet[a]

Monitored Person Type		Total # Persons	Dose Range							Individual Dose			Collective Dose
			0	0.01-0.50	0.51 – 1.00	1.01 – 5.00	5.01 – 10.00	10.01 – 20.00	>20.00				
			Number of Persons							Max	Ø Avg[b]	Avg All[c]	(person-mSv)
NEW	Employee	56	7	15	1	15	9	8	1	37.77	5.54	4.85	271.63
	Contractor	1	-	-	-	1	-	-	-	1.98	1.98	1.98	1.98
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Totals		57	7	15	1	16	9	8	1				273.61

Table 11: Summary of Dose Components Received as a Result of Licensed Activities for 2019[a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]
NEW	Employee	411	48.75	3.09	0.19	0.12	411	99.19	7.47	0.38	0.24	56	271.63	37.77	5.54	4.85
	Contractor	72	0.86	0.48	0.09	0.01	72	0.93	0.55	0.09	0.01	1	1.98	1.98	1.98	1.98
	Visitor	6	0.00	0.00	-	0.00	6	0.00	0.00	-	0.00	0	-	-	-	-
Non-NEW	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	117	0.00	0.00	-	0.00	117	0.00	0.00	-	0.00	0	-	-	-	-
	Visitor	418	0.00	0.00	-	0.00	418	0.00	0.00	-	0.00	0	-	-	-	-
Totals		1024	49.61				1024	100.12				57	273.61			

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p-mSv)	Max	Ø Avg[b]	Avg All[c]
NEW	Employee	0	-	-	-	-	0	-	-	-	-	6	0.00	0.00	-	0.00
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Non-NEW	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Totals		0	0.00				0	0.00				6	0.00			

7.2.1.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2019 was 3.09 mSv and the site collective dose was 49.6 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the five-year dosimetry period from 2015 to 2019 at WL was 5.08 mSv.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2019 was 7.47 mSv and the site collective dose was 110.12 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2019 was 37.77 mSv and the site collective dose was 273.61 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2019, the maximum individual effective dose from the time the pregnancy was declared at WL was 0.00 mSv.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2019, the maximum individual effective dose to a non-NEW at WL was 0.00 mSv.

Table 12 provides a summary of radiation doses by worker group in 2019. The majority of radiation doses were received by RP staff and Trades staff and 85% of their doses being attributable to B200 ALWTC decommissioning activities.

7.2.1.2 Radiation Dose Changes or Trends

Table 13 shows external whole body dose received from 2015 to 2019 and Figure 1 displays the maximum individual and collective dose from 2001-2019.

Worker doses have been on the rise since 2017 as WL decommissioning activities began to focus on buildings and facilities with increased radiological hazards. The increase in dose in the past several years can be attributed primarily to the decommissioning activities of Building 200 (active liquid waste treatment center). The number of workers receiving occupational doses above 0.2 mSv in a calendar year has been staying steady at about 40 workers in recent years. The number of workers receiving doses above 1 mSv has also increased in the past two years but remains below 15 workers.

7.2.2 RP Program Exceedances

During 2019, radiation dose to all persons working at WL were below the WL dose Action Levels [1] and the respective CNSC regulatory limits [17]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 12: Summary of Worker Group Radiation Doses at WL for 2019

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	Person·mSv	Person·mSv	Person·mSv
Nuclear Facilities						
SF Staff (HCF and IFTF)[c]	5	0.29	0.47	1.46	3.67	5.93
	5	0.05	0.06	0.24	0.24	0
WMA and CCSF Staff	4	0.12	0.29	0.46	0.47	0
Support Workgroups						
Radiation Protection Staff [d]	43	0.49	2.60	21.16	47.20	105.02
Trades Staff [e]	52	0.36	3.09	18.90	40.67	138.94
All Remaining Staff						
Other Staff [f]	491	0.02	0.48	7.39	7.87	23.72
WL Site[g]	600	0.08	3.09	49.61	100.12	273.61

a Includes photon and neutron; there were no tritium committed effective doses for 2019.
b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.
c HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.
d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.
e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL site in general.
f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.
g WL Site includes 411 CNL staff (WL and staff visiting from other CNL sites) and 189 contractors working at the WL site during 2019.

Table 13: WL External Whole-Body Dose Performance 2015 to 2019

Performance Metric	2019	2018	2017	2016	2015
Site Collective Worker Dose (p-mSv)	49.6	40.2	19.9	16.5	29.2
Max Individual Worker Dose (mSv)	3.09	1.65	1.41	0.36	0.42
Number of Workers > 0.2 mSv in a year	38	39	42	30	16
Number of Workers > 1 mSv in a year	14	12	1	0	0
PAD[a] – Maximum Daily Dose (mSv)	0.40	0.24	0.17	0.08	0.12
PAD – Maximum Dose Rate (mSv/h)	5.82	4.95	1.99	1.44	2.08

a Personal alarming dosimeter.

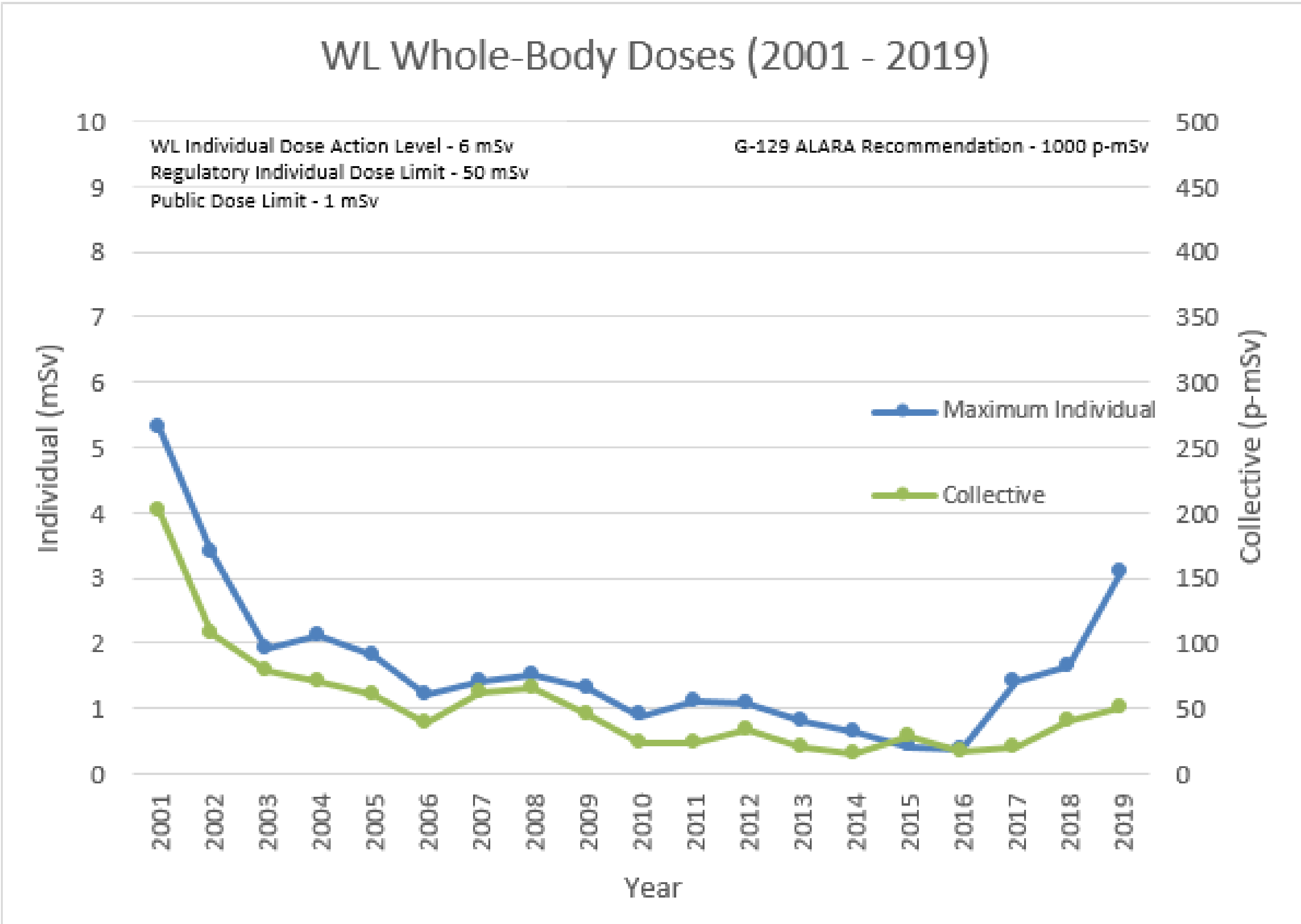

Figure 1: Whole-Body Effective Doses (2001 – 2019)

8. CONVENTIONAL HEALTH AND SAFETY

8.1 Conventional Health and Safety Program

Whiteshell Laboratories (WL) adheres to the Corporate Conventional Health and Safety Program. See Section 8 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

A number of Occupational Safety and Health (OSH) Program initiatives were undertaken in 2019, including:

- WL OSH specialists continued to work with the Health Centre on conducting the required audiology testing.
- OSH presence in the field continued at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to WL's internal safety success.
- Contractors continued to be "pre-qualified" prior to bidding on WL contracts. The pre-qualification process involves reviewing safety statistics and the safety programs of the potential bidders.
- WL continued to participate in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- There were 17 internal Safety Advisories sent to WL site employees in 2019. The bulletins are intended to inform WL employees about imminent issues that could impact their safety. Whiteshell Laboratories continued to be proactive in the approach to safety.

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives are continuing:

- Near Miss Reporting (a known industry best practice) with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 14). Near Miss reporting at WL always includes an investigation/fact finding session. The majority of Near Miss reports also generate an ImpAct. Whether an ImpAct is generated or not, the possibility of a human error trap being involved in the Near Miss incident is always considered, evaluated and followed up as appropriate.
- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.

Table 14: Summary of WL Near Miss Reporting

Year	2015	2016	2017	2018	2019
Near Miss Reported	90	79	60	53	46

Summary of changes to the OSH Program procedures/processes:

- A review / re-assessment of areas previously defined as Confined Space at the Whiteshell site was completed. Previously, confined spaces were identified based on a belief that only one of the Federal regulatory criteria needed to be met in order to be classified as such. The procedural/Regulatory review noted that all of the criteria needs to be met in order to declare an area a confined space. This resulted in a reduction of the number of currently identified confined spaces.

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis.

In 2019, the WL Site Safety and Health Committee received 17 inquiries out of which 1 remained open and in progress. Additionally there were 2 carried over from 2018. The Site Safety and Health Committee acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 54 site health and safety inspections completed in 2019.

8.1.3 Lost-Time Injuries

There were 0 lost time injuries reported to Employment and Social Development in 2019 at WL. There was one (1) Hazard Occurrence at WL that was reported to Employment and Social Development in 2019. CNSC staff CNSC staff were made aware of this occurrence.

A summary of injury rate data for 2019 and the previous four years is shown in Table 15 below.

Table 15: Summary of WL Injury Rate Data

	2015	2016	2017	2018	2019
Person Hours Worked	741,000	684,450	706,000	688,000	642,000*
Lost-Time Injuries	0	1	3	1	0
Working Days Lost	0	5	27	5	0
Frequency [a]	0	0.29	0.85	0.28	0
Severity [b]	0	1.46	7.76	1.45	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).
b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).
* Person Hours Worked calculation based on 321 Full Time Employees x 40 hrs/ week x 50 weeks / Year (321 employees x 2000 hrs)

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2019.

9. ENVIRONMENTAL PROTECTION

9.1 Environmental Protection Program

Whiteshell Laboratories (WL) adheres to the Corporate Environmental Protection (EnvP) Program. See Section 9 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Now and in the future, improvements in the WL Environmental Protection program will be gained through the implementation of:

- CSA N288.4-10, Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills [18],
- CSA N288.5-11, Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills [19],
- CSA N288.6-12, Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills [20]
- CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills [21],
- CSA N288.8-17, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities [22], and
- ISO 14001:2015, Environmental Management Systems [23].

In 2019, to align with the requirements of the above Canadian Standards Association (CSA) standards, CNL WL has been incorporating the requirements outlined in the standards into its environmental monitoring program documentation. The requirements of standards will be part of CNL WL's integrated environmental monitoring program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program and the Groundwater Monitoring Program. The integrated environmental monitoring program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

The WL site has maintained its ISO 14001 registration in 2019 with initial registration in 2010.

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control (QA/QC) programs as required by CSA N288.5 [19]. General quality assurance objectives for CNL's Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [24] for analytical laboratories.

Whiteshell Laboratories Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 2402 quality verification tests during 2019 on WL's radiochemical counting equipment. Of these tests, 97.5 % fully complied with acceptance criteria. The results of these tests are shown Table 16.

Table 16: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	479	5	98.9
Total Beta (Instrumentation)	493	11	97.8
Gamma (Instrumentation)	523	12	97.7
Tritium	1102	32	97.1
2019 Total	**2597**	**60**	**97.7**

In 2019, the WL Effluent verification program began performing regular field Quality Verification testing on the outfall, lagoon, and ditch effluent sampling (Table 17). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

Table 17: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	N/A	N/A	2	100%
Conductivity	2	< LMDL	2	100%
Phenols	2	< LMDL	2	100%
TSS	2	<LMDL	2	100%
Phosphorus	2	<LMDL	2	100%
Oil and Grease	2	< LMDL	2	100%
Mercury	2	<LMDL	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Chromium	2	< LMDL	2	100%
Copper	2	0.03 mg/L	2	100%
Iron	2	< LMDL	2	100%
Lead	2	0.0003 mg/L	2	100%
Nickel	2	< LMDL	2	100%
Zinc	2	< LMDL	2	100%
Radiological Parameters:				
Gross Alpha	N/A	N/A	2	100%
Gross Beta	N/A	N/A	2	100%
Cesium-137	N/A	N/A	2	100%
Americium-241	N/A	N/A	2	100%
Potassium-40	N/A	N/A	2	100%
Lead-214	N/A	N/A	2	100%
Beryllium-7	N/A	N/A	2	100%
Strontium-90	N/A	N/A	2	100%
Plutonium-238	N/A	N/A	1	100%
Plutonium-239/240	N/A	N/A	1	100%
Sewage Lagoon				
Non-Radiological Parameters:				
Phenols	1	< LMDL	N/A	N/A
TSS	1	<LMDL	N/A	N/A
Phosphorus	1	<LMDL	N/A	N/A
Oil and Grease	1	<LMDL	N/A	N/A
Mercury	1	<LMDL	N/A	N/A
Chromium	1	0.001 mg/L	N/A	N/A
Copper	1	0.03 mg/L	N/A	N/A
Iron	1	< LMDL	N/A	N/A
Lead	1	0.0003 mg/L	N/A	N/A
Nickel	1	0.001 mg/L	N/A	N/A
Zinc	1	< LMDL	N/A	N/A
Total Chlorine	1	< LMDL	N/A	N/A
Radiological Parameters:				
Tritium	1	< LMDL	N/A	N/A
Plutonium 238	1	< LMDL	N/A	N/A
Plutonium 239/240	1	< LMDL	N/A	N/A
Ditches				
Non-Radiological Parameters:				
pH	N/A	N/A	3	100%
Conductivity	2	< LMDL	3	100%
Phenols	2	< LMDL	3	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
TSS	2	< LMDL	3	100%
Phosphorus	2	0.0035 mg/L	3	100%
Oil and Grease	2	< LMDL	3	100%
Mercury	2	< LMDL	3	100%
Chromium	2	< LMDL	3	100%
Copper	2	0.02 mg/L	3	100%
Iron	2	< LMDL	3	100%
Lead	2	0.0002 mg/L	3	100%
Nickel	2	< LMDL	3	100%
Zinc	2	< LMDL	3	100%
Radiological Parameters:				
Gross Alpha	2	< LMDL	3	100%
Gross Beta	2	0.110 Bq/L	3	66%
Cesium-137	2	< LMDL	3	100%
Americium-241	2	< LMDL	3	100%
Cobalt-60	2	< LMDL	3	100%
Radium-228	2	< LMDL	3	100%
Europium-154	2	< LMDL	3	100%
Lead-210	2	< LMDL	3	100%
Thorium-228	2	< LMDL	3	100%
Thorium-230	2	< LMDL	3	100%
Thorium-234	2	< LMDL	3	100%
Uranium-235	2	< LMDL	3	100%
Radium-226	2	< LMDL	3	100%
Actinium-228	2	< LMDL	3	100%
Potassium -40	2	< LMDL	3	100%
2019 Total	**93**	**--**	**128**	**99%**

LMDL = Laboratory Method Detection Limit

Out of the 128 quality verification tests, 127 of these tests meet the acceptance criteria of the program, to yield a 99% pass rate.

In 2019, the WL Environmental Management group participated in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses were offered through the Canadian Association for Laboratory Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 18 and Table 19. There was one unacceptable test result out of thirty for the Environmental Research Associates inter-laboratory comparison studies, resulting in a 96.7% pass rate. For the Canadian Association for Laboratory Accreditation inter-laboratory comparison studies a 100% pass rate was achieved.

Table 18: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2019

MRAD Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-30	Air Filter Radionuclides	Americium-241	(pCi/Filter)	18.7	18.84	13.3 - 24.9	Acceptable
MRAD-30	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	721	554.87	468 - 884	Acceptable
MRAD-30	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	634	627.14	521 - 832	Acceptable
MRAD-30	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	93.8	95.08	79.7 - 119	Acceptable
MRAD-30	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	1380	1462.38	1130 - 2110	Acceptable
MRAD-30	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	50.3	55.27	26.3 - 82.9	Acceptable
MRAD-30	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	78.6	74.54	47.7 - 119	Acceptable
MRAD-30	Water Radionuclides	Americium-241	pCi/L	168	169.77	115 - 215	Acceptable
MRAD-30	Water Radionuclides	Cesium-134	pCi/L	123	100.61	92.9 - 135	Acceptable
MRAD-30	Water Radionuclides	Cesium-137	pCi/L	125	120.26	107 - 142	Acceptable
MRAD-30	Water Radionuclides	Cobalt-60	pCi/L	1100	1059.84	99 - 1260	Acceptable
MRAD-30	Water Radionuclides	Zinc-65	pCi/L	1780	1856.75	1580 - 2250	Acceptable
MRAD-30	Water Gross Alpha/Beta	Gross Alpha	pCi/L	68.5	46.19	25.0 – 94.5	Acceptable
MRAD-30	Water Gross Alpha/Beta	Gross Beta	pCi/L	151	178.96	75.5 – 208	Acceptable
MRAD-30	Water Tritium	Tritium	pCi/L	23700	24577	17900 - 28800	Acceptable
MRAD-31	Air Filter Radionuclides	Americium-241	(pCi/Filter)	32	30.13	22.8 - 42.7	Acceptable
MRAD-31	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	59	43.98	38.3 – 72.3	Acceptable
MRAD-31	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	437	427.40	359 - 573	Acceptable
MRAD-31	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	58.4	57.58	49.6 - 74.2	Acceptable
MRAD-31	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	364	391.91	298 – 556	Acceptable
MRAD-31	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	59.0	73.52	30.8 - 97.2	Acceptable
MRAD-31	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	57.6	55.53	34.9 - 87.0	Acceptable

MRAD Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-31	Water Radionuclides	Americium-241	pCi/L	64.2	42.34	44.1 – 82.1	Not Acceptable (Unknown Sample was near method detection limit)
MRAD-31	Water Radionuclides	Cesium-134	pCi/L	1960	1522.25	1480 – 2160	Acceptable
MRAD-31	Water Radionuclides	Cesium-137	pCi/L	1840	1772.34	1580 – 2090	Acceptable
MRAD-31	Water Radionuclides	Cobalt-60	pCi/L	1870	1718.04	1610 – 2150	Acceptable
MRAD-31	Water Radionuclides	Zinc-65	pCi/L	1370	1417.3	1220 – 1730	Acceptable
MRAD-31	Water Gross Alpha/Beta	Gross Alpha	pCi/L	124	98.81	45.3 – 171	Acceptable
MRAD-31	Water Gross Alpha/Beta	Gross Beta	pCi/L	68.0	102.62	34.0 - 93.6	Acceptable
MRAD-31	Water Tritium	Tritium	pCi/L	22300	22393.53	16800 – 27100	Acceptable

MRAD Multi-Media Radiochemistry

Table 19: Canadian Association for Laboratory Accreditation Inter-Laboratory Comparison Program CNL WL - 2019

CALA Study	Sample Id	Analyte	Units	CALA Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2019	CO1A-1	Conductivity	(µS/cm)	86	85	87	Acceptable
March -2019	CO1A-2	Conductivity	(µS/cm)	414	391		
March -2019	CO1A-3	Conductivity	(µS/cm)	1030	975		
March -2019	CO1A-4	Conductivity	(µS/cm)	663	626		
March -2019	CO4A-1	Total Suspended Solids	(mg/L)	7	6	96	Acceptable
March -2019	CO4A-2	Total Suspended Solids	(mg/L)	56	55		
March -2019	CO4A-3	Total Suspended Solids	(mg/L)	89	90		
March -2019	CO4A-4	Total Suspended Solids	(mg/L)	188	192		
March -2019	C15-1	pH	(pH units)	5.5	5.42	83	Acceptable
March -2019	C15-2	pH	(pH units)	6.92	6.97		
March -2019	C15-3	pH	(pH units)	9.21	9.36		

CALA Study	Sample Id	Analyte	Units	CALA Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2019	C15-4	pH	(pH units)	8.36	8.54		
October-2019	CO1A-1	Conductivity	(µS/cm)	79	79	94	Acceptable
October-2019	CO1A-2	Conductivity	(µS/cm)	663	644		
October-2019	CO1A-3	Conductivity	(µS/cm)	887	862		
October-2019	CO1A-4	Conductivity	(µS/cm)	751	729		
October-2019	CO4A-1	Total Suspended Solids	(mg/L)	17	14	79	Acceptable
October-2019	CO4A-2	Total Suspended Solids	(mg/L)	69	61		
October-2019	CO4A-3	Total Suspended Solids	(mg/L)	131	82		
October-2019	CO4A-4	Total Suspended Solids	(mg/L)	215	195		
October-2019	C15-1	pH	(pH units)	4.2	4.26	95	Acceptable
October-2019	C15-2	pH	(pH units)	7.74	7.75		
October-2019	C15-3	pH	(pH units)	9.31	9.36		
October-2019	C15-4	pH	(pH units)	8.74	8.75		

CALA Canadian Association for Laboratory Accreditation

9.3 Supplementary Studies

In 2019, the WL site, temporarily expanded the monitoring program to encompass additional parameters to be monitored for at the site's intake and outfall monitoring station for 6 months. This was done to verify and provide justification that the environmental monitoring program is properly identifying and analyzing for the appropriate contaminates of concern being released into the environment through the site's operations. This study will be discussed in more detail in Sections 9.5.1.4.4, and 9.5.1.4.5.2, and has led to an expansion of the parameters monitored for in 2020 at various monitoring locations around site.

9.4 Effluent Monitoring - Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [25] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, Environmental Monitoring in 2019 at Whiteshell Laboratories [26] and 2019 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories [27].

9.4.1 Airborne Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

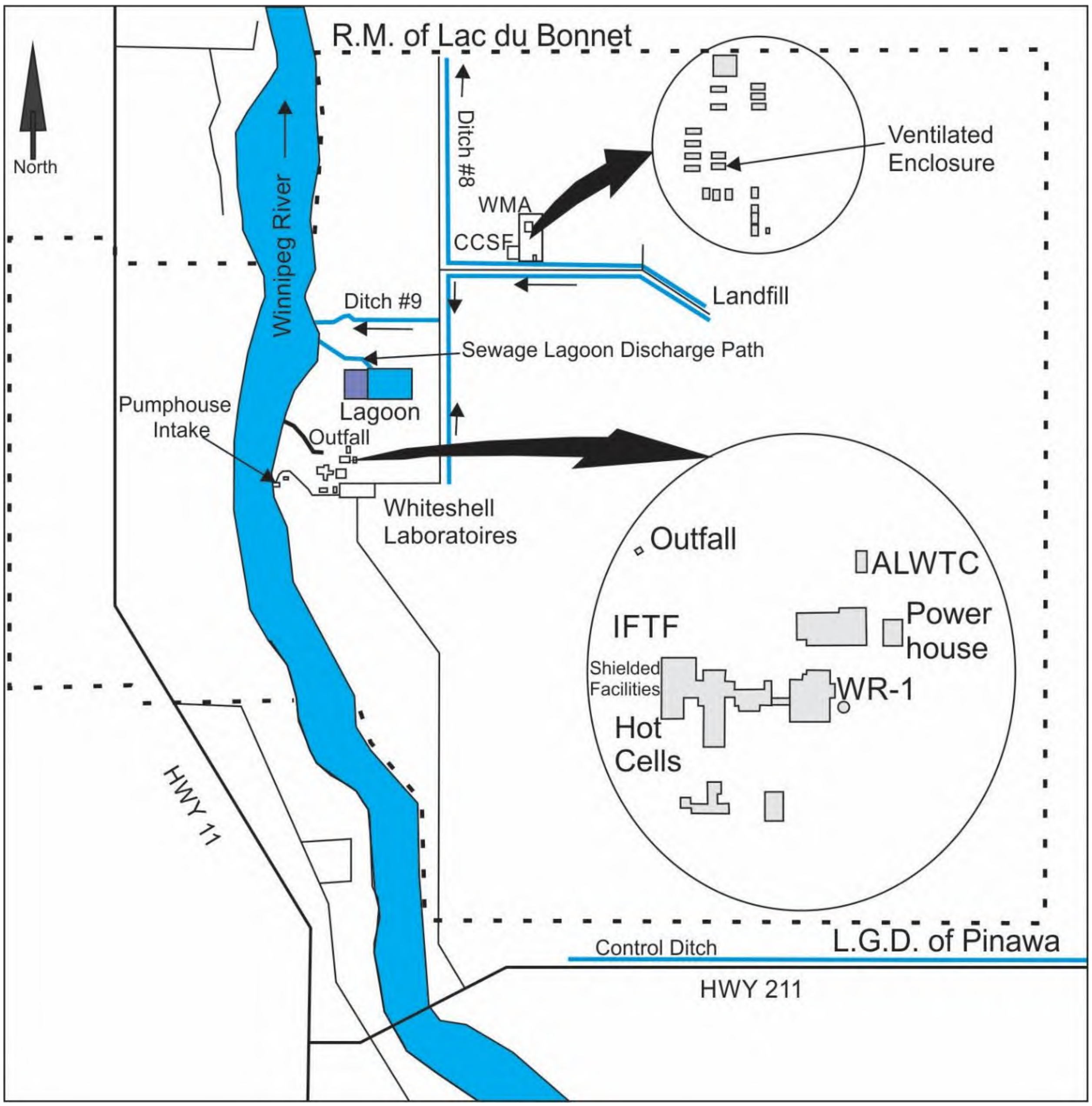

Figure 2: Effluent Monitoring Locations

Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable Derived Release Limits (DRLs) [28]. The DRLs now in use at WL came into effect on 2016 September 01. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta particulates) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction and analysis of individual beta emitting radionuclides, such as Sr-90, complemented by examination of historical data.

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in the CSA CAN/CSA-N.288.1-M87 [29]. The DRLs have been revised to meet the current CAN/CSA N288.1-08 [30], and these were accepted by the CNSC in 2016 August. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [31]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[5] that the annual dose limits are not exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3.2, the increase in 2019 liquid effluents is due to the higher detection limit values for Am-241 and Pu-239/240.

[5] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).

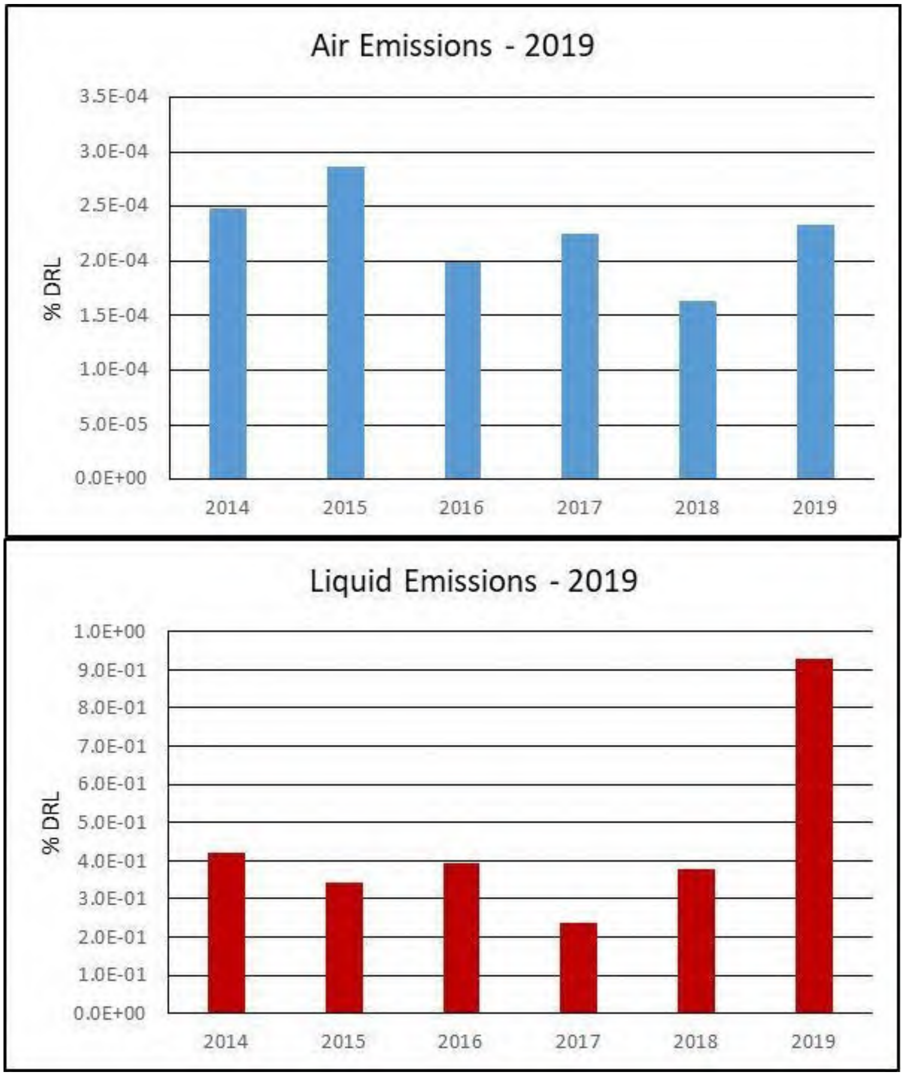

Figure 3: Trends for Airborne and Liquid Emissions form WL for 2014 to 2019

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Action Levels[6] derived from the DRLs as specified in Reference [28]. The Action levels were recalculated based on current CNSC guidance and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

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[6] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

9.4.1.2 Airborne Effluents Monitoring

9.4.1.2.1 Monitoring Points, Schedule and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. These activities include waste compaction in the Waste Handling Area, located in the Immobilized Fuel Testing Facility (IFTF), sampling and characterization activities within the WR-1 Reactor Building, and decommissioning activities in the ALWTC. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)
- Active Liquid Waste Treatment Centre (ALWTC) (Building 200)

Air effluents from Buildings 100, 200 and 300 are sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 20. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. Any proposals on modifications to the monitoring program will be communicated to CNSC staff.

Table 20: Radiological Air Effluent Monitoring Schedule – 2019

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
B100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
B200 V1F	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
B200 V2F	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
B300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
B300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured by passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water bubbler for tritium.
W Weekly
N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The stack flows and sampler flows at WL are measured and verified on an annual basis by WL Engineering. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [28]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (strontium-90 for gross beta and plutonium-239 and plutonium-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 21 and Figure 3 for the years 2014 to 2019. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also includes tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. Airborne emissions remain a small fraction of the release limit. The result for 2019 (0.00023% of the DRL) is greater than for 2018, and for the average for the last five years. Total site gross alpha in 2019 is similar to 2018 and the last five years average. It remains near detection limit values. The gross beta emissions are greater than in 2018 and the last five-year averages. During the week of April 16-23, the gross beta emissions for the DA-1 filter exceeded the Administrative Level for the Hot Cells facility. The subsequent evaluation of Hot Cells operations indicated no breach of the air filtration system. The likely cause of the abnormal exceedance was the dislodging of a hot particle from the historically contaminated Hot Cell stack.

Tritium emissions from the WR-1 stack were greater than 2018, but lower than the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative limit (1.52E10 Bq/week) for the facility and well below the Action Level (7.62E10 Bq/week) and DRL (1.65E15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence. Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Buildings 100 and 200, and work in the Shielded Facilities and Concrete Canister Storage Facility. Airborne dust monitoring was performed for building demolitions, demonstrating that in 2019 no radioactivity was released to the air from demolitions. The results of this monitoring are described in the 2019 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories [27].

Table 21: Radionuclides in Air Effluents from WL Facilities – 2014 to 2019

Location/Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2014 (Bq/wk)	2015 (Bq/wk)	2016 (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	Five-Year Average		2019		2019 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building													
Gross Alpha[b]	1.73E+09	1.71E+04	3.17E+02	3.61E+02	4.16E+02	3.82E+02	2.65E+02	3.48E+02	2.01E-05	2.89E+02	1.67E-05	5.09E+02	2.94E-05
Gross Beta[b]	6.92E+09	1.68E+05	3.17E+03	1.80E+03	1.91E+03	1.83E+03	1.07E+03	1.96E+03	2.83E-05	1.95E+03	2.81E-05	5.62E+03	8.12E-05
Tritium	1.65E+15	7.62E+10	6.69E+08	1.90E+09	6.24E+08	9.68E+08	2.51E+08	8.82E+08	5.35E-05	6.43E+08	3.90E-05	1.61E+09	9.76E-05
ALWTC													
Gross Alpha	1.73E+09	1.00E+04	2.01E+02	3.33E+02	2.25E+02	2.37E+02	3.13E+02	2.62E+02	1.51E-05	3.12E+02	1.80E-05	4.17E+02	2.41E-05
Gross Beta	6.92E+09	2.02E+04	2.19E+02	3.17E+02	2.33E+02	2.92E+02	3.24E+02	2.77E+02	4.00E-06	4.54E+02	6.57E-06	6.82E+02	9.86E-06
HCF													
Gross Alpha	1.73E+09	1.58E+04	6.00E+02	6.00E+02	6.00E+02	6.00E+02	6.00E+02	6.00E+02	3.47E-05	6.10E+02	3.53E-05	1.11E+03	6.42E-05
Gross Beta	6.92E+09	6.82E+04	8.20E+02	1.11E+03	1.05E+03	1.15E+03	1.04E+03	1.03E+03	1.49E-05	2.05E+03	2.65E-05	3.94E+04	5.69E-04
IFTF													
Gross Alpha	1.73E+09	1.48E+04	5.78E+02	5.88E+02	5.78E+02	5.78E+02	5.78E+02	5.80E+02	3.35E-05	5.78E+02	3.34E-05	5.78E+02	3.34E-05
Gross Beta	6.92E+09	3.76E+05	3.43E+03	1.12E+03	8.92E+02	1.04E+03	8.41E+02	1.46E+03	2.12E-06	1.84E+03	2.65E-06	7.04E+03	1.02E-04
Total Tritium (as %DRL)			4.05E-05	1.15E-04	3.78E-05	5.87E-05	1.52E-05	8.82E+08	5.35E-05	6.43E+08	3.90E-05	1.61E+09	9.76E-05
Total Alpha (as %DRL)			9.80E-05	1.09E-04	1.05E-04	1.04E-04	1.02E-04	1.79E+03	1.03E-04	1.79E+03	1.03E-04	2.61E+03	1.51E-04
Total Beta (as %DRL)			1.10E-04	6.28E-05	5.90E-05	6.23E-05	4.73E-05	4.73E+03	6.84E-05	6.29E+03	9.09E-05	5.27E+04	7.62E-04
Total (%DRL)			**2.49E-04**	**2.87E-04**	**2.02E-04**	**2.25E-04**	**1.64E-04**	**2.25E-04**		**2.33E-04**		**1.01E-03**	

a The DRLs shown are for members of the public at the WL boundary as described in reference [11].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A Not Applicable

Note that the 2016 values for Total Beta (as %DRL) and Total (%DRL) were reported incorrectly in the 2016 and 2017 annual reports.

9.4.1.3 Liquid Effluents Monitoring

9.4.1.3.1 Monitoring Points, Schedule and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the Outfall, the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the process water outflow (Outfall), which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways or around buildings, cooling water used in process and experimental facilities, and holding tank discharges including those from the new active liquid waste treatment system tanks based in Building 100 and Building 300. The ALWTC was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 22.

Table 22: Radiological Liquid Effluent Monitoring Schedule – 2019

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	Frequency	Method	Beta Screen	Gross Beta	Gross Alpha	Tritium	Gamma Spec (liquid)	Gamma Spec (ash)	Sr-90 (ash)	U-238 Pu-239/240 Pu-238	C-14
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wc[a]	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B 300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B 100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, twice a year for the Lagoon; as required for Building 200.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2018 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.
a Screening sample only.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2019 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers, which reduced the contribution from the washing of footwear in 2018. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is now directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 20 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (americium-241, cesium-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for plutonium-239/240, plutonium-238 and plutonium-241 isotopic analyses. In 2019 Outfall samples were analyzed for carbon-14 and tritium because they are known to exist in WR1 and decommissioning activities have a potential for releasing these isotopes. Carbon-14 and tritium analyses were initiated as a check on this possibility.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. Lagoon water residence time is more than three months, to allow for biodegradation and settling. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail later). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon's north side. In 2019 the lagoon was only discharged in the fall because an environmental risk assessment sample campaign was underway in the spring and there was enough freeboard that a spring discharge was not necessary.

The outflow of the Lagoon is continuously sampled during discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at the control point are also released to the Winnipeg River from the two ditches indicated in Figure 2. Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (646 mm) in 2019 was more than in 2018 (467 mm), and in 2017 (519 mm). The amount of precipitation in the spring and summer of 2019 was relatively low, but September experienced an unusually high amount of precipitation. Ditches were sampled 11 times during April to the end of June. During the summer they were sampled only 1 time in July. During September and October there were 6 ditch sampling events. As a result of low precipitation in the summer the amount of times ditches had running water was limited during the summer months of July and August.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[7] . The samples are analyzed for gross alpha, gross beta and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are submitted for gamma spectrometric and radio strontium analysis. If the alpha activity is above 0.5 Bq/L, the samples are submitted for gamma spectrometric and uranium analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [28]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cesium-137 for beta activity and plutonium-239 and plutonium-240 for alpha activity. With the introduction of total uranium and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

9.4.1.3.2 Monitoring Results

The liquid emission results are summarized in Table 24 and Figure 3 for the years 2014 to 2019. Average monthly emissions, in Becquerels, are shown for gross alpha, gross beta, total U (including uranium-234, uranium-235, and uranium-238), americium-241, strontium-90 and cesium-137 for the releases from the Outfall and the Lagoon. In addition, quarterly activities of plutonium-239/240 and plutonium-238 were reported for Outfall effluents. A plot of the monthly cesium-137 and strontium 90 releases as Bq from the Outfall in 2019 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of strontium-90 and cesium-137 from the tanks in 2019 were 2.79E06 Bq and 8.27E06 Bq, respectively. These releases were only a fraction of the total strontium-90 (3.73E07 Bq) and cesium-137 (1.37E07 Bq) releases from the Outfall. There was a slight correlation between the patterns of releases from the tanks with the pattern of releases from the Outfall. However, the fluctuations in releases from the tanks are too small to account for the magnitude of fluctuations of Outfall releases. The additional strontium-90 and cesium-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical site contamination events and historical radioactivity disposition in the storm drain line from B200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970's, although more likely from the Building 200 drain line. Strontium-90 and cesium-137 releases from the Outfall peaked in October. A possible reason was that the summer of 2019 was dry. Strong rain events occurred in September and October (as evidenced by the increase in ditch sampling), and these may have flushed contamination into the Outfall from storm drains and previously contaminated process piping. Note, all monthly releases from the Outfall were well below the administrative release level[8]. Releases of gross alpha were higher than the 2018 releases and the five year average. Gross

[7] The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

[8] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the As Low as Reasonably Achievable (ALARA) process.

beta releases in 2019 were slightly higher than the 2018 and five year average releases. Strontium-90 releases in 2019 were higher than in 2018, but less than the five year average. The cesium-137 releases were slightly below 2018 releases and the five year averages. Americium-241 and total uranium releases were higher than 2018 releases. The relatively constant emissions of gross alpha, gross beta, strontium-90 and cesium-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Plutonium-239/240 and plutonium-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.29). In 2019, Outfall water was also analyzed for the presence of Carbon-14, which could be introduced by the discharge tanks from Building 100. Carbon-14 was below detection levels (varying from 1.36 to 1.65 Bq/L) in Outfall samples. Given that the DRL for Carbon-14 is 1.06E+08 Bq/month, the detection limit of 1.65 Bq/L would correspond to a %DRL value of 0.23. Measurements of Carbon-14 in site intake water from Building 902 were also below detection values.

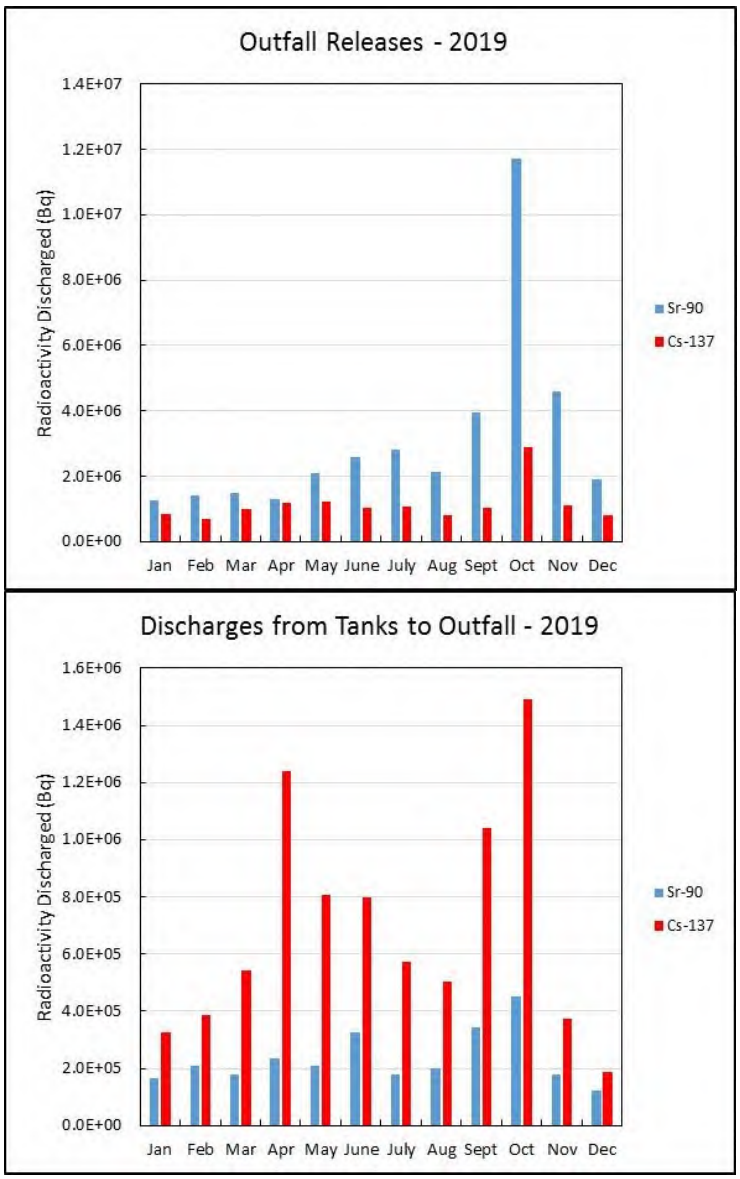

Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2019

The 2019 Lagoon discharge occurred only in the fall because an environmental risk assessment sample campaign was underway in the spring and there was enough freeboard that a spring discharge was not necessary. The Lagoon gross alpha releases were higher than 2018 values, and below the five year average (Table 24). Activities of total uranium (natural), americium-241 and plutonium-239/240 determined for lagoon samples were higher than in 2018. The uranium activity accounts for about a third of the gross alpha activity, and it was assumed that the remaining gross alpha activity could be accounted by the activity of americium- 241 and plutonium-239/240. It should be noted that the activities of these latter two elements are detection limit values and that their combined activities are greater than gross alpha by about a factor 2. Therefore, the actual releases of americium-241 and plutonium- 239/240 are actually less than reported here. The % DRL values of total uranium, americium-241 and plutonium-239/240 (which are reported instead of gross alpha) were very low (0.0015, 0.059 and 0.066 % DRL, respectively). The gross beta, strontium-90, and cesium-137 discharges were higher than in 2018. Releases of strontium 90 and cesium-137 were below 0.002% and 0.006% of their respective DRLs. All releases were well below administrative release levels.

The averaged results for the two drainage ditches and control sample are shown in Table 23.

Table 23: Annual mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2014 to 2019

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2014**	**2015**	**2016**	**2017**	**2018**	**Five-Year Average**	**2019[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.15	0.22	0.12	0.14	0.52	0.23	0.19±0.21
Gross Alpha	0.50	0.07	0.08	0.15	0.17	0.11	0.18	0.14	0.15±0.15
Tritium	7 000	3	4.6	< 4.2	4.4	4.8	5.3	4.8	5.5±4.3
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.18	0.15	0.09	0.13	0.32	0.17	0.20±0.16
Gross Alpha	0.50	0.07	0.06	0.09	0.09	0.09	0.16	0.10	0.20±0.36
Tritium	7 000	3.00	9.5	11.8	17.4	21.1	9	14	10±18
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.14	0.16	0.10	0.15	0.14	0.14	0.19±0.10
Gross Alpha	0.50	0.07	0.10	0.14	0.11	0.10	0.22	0.13	0.11±0.07
Tritium	7 000	3	< 4.5	< 4.4	4.8	4.67	<4	4.5	<4

a Compliance with Guidelines for Canadian Drinking Water [32] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. Lower Limit of Detection is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.
b LLD = Lower Limit of Detection.
c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2019 the gross beta activities in Ditches 8 and 9 were lower than in 2018. The 2019 gross alpha activities were lower in Ditch 8 and higher in Ditch 9 compared to 2018. The summer of 2019 was rather dry and was followed by a fall with many rain events. The gross beta values were similar to the control sample collected off of Highway 211. However, the gross alpha values were higher than the control ditch. The control sample is unaffected by CNL's operations. Compliance with the Guidelines for Canadian Drinking Water

Quality [32] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [33] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

The alpha and beta results remained below the trigger levels for gamma spectrometry, strontium-90 and uranium analysis mentioned in Section 9.4.1.3.1. As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amount measured in drainage Ditch 9 (10 ± 18 Bq/L) is above that noted at the control location (<4 Bq/L). This can be attributed to migration from the WMA. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [32].

Table 24 summarizes the data for releases of liquid effluents[9] for the years 2014 to 2019. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2019 was 0.93% of the DRL, which is higher than 2018 and the five-year average (0.36%). The main reason for the higher 2019 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release in 2019 was plutonium-238 from the Outfall at 0.83 % of the DRL.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 25) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

[9] The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [32] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 24: Radionuclides in Liquid Effluents from WL – 2014 to 2019

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2014 (Bq/mo)	2015 (Bq/mo)	2016 (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	Five-Year Average		2019		2019 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.43E+08	2.92E+06	2.43E+06	3.10E+06	2.20E+06	2.86E+06	2.7E+06	2.43E-01	4.23E+06	-	8.27E+06	-
Uranium-total	1.25E+10	N/A	N/A	N/A	N/A	1.24E+06	9.13E+05	NA		1.05E+06	8.39E-03	2.54E+06	2.03E-02
Plutonium-239/240	1.11E+09	N/A	N/A	N/A	N/A	5.76E+05	1.89E+06	NA		3.19E+06	2.87E-01	7.73E+06	6.96E-01
Plutonium-238	1.16E+09	N/A	N/A	N/A	N/A	7.24E+05	1.53E+06	NA		4.05E+06	3.49E-01	9.57E+06	8.25E-01
Americium-241	1.04E+09	N/A	N/A	N/A	N/A	1.49E+05	1.07E+05	NA		1.06E+06	1.02E-01	1.92E+06	1.85E-01
Gross Beta[b]	-	5.00E+08	2.20E+06	1.43E+07	1.78E+07	2.06E+07	1.36E+07	1.37E+07	-	2.06E+07	-	3.27E+07	-
Strontium-90	1.30E+10	N/A	4.42E+06	2.50E+06	3.91E+06	4.83E+06	2.39E+06	3.61E+06	2.78E-02	3.11E+06	2.39E-02	1.17E+07	9.02E-02
Cesium-137	1.16E+10	N/A	2.14E+06	1.31E+06	1.02E+06	1.51E+06	1.26E+06	1.45E+06	1.25E-02	1.14E+06	9.86-03	2.88E+06	2.84E-02
Tritium	6.80E+13									3.76E+08	5.53E-04	7.34E+08	1.08E-03
LAGOON													
Gross Alpha[a]	1.11E+09	5.84E+07	1.05E+06	9.70E+05	7.22E+05	1.03E+06	3.92E+05	8.33E+05	7.50E-02	6.17E+05	-	6.17E+05	
Uranium-total	1.25E+10	N/A	N/A	N/A	N/A	1.66E+05	5.49E+04	NA		1.92E+05	1.53E-03	1.92E+05	1.53E-03
Americium-241	1.04E+09	N/A	N/A	N/A	N/A	2.76E+05	2.44E+05	NA		6.17E+05	5.94E-02	6.17E+05	5.94E-02
Pu-239/240[a]	1.11E+09	N/A	N/A	N/A	N/A	4.22E+05	4.52E+04	NA		7.28E+05	6.56E-02	7.28E+05	6.56E-02
Gross Beta	-	1.50E+08	5.56E+06	4.30E+06	5.76E+06	4.14E+06	2.53E+06	4.46E+06	-	8.00E+06	-	8.00E+06	-
Strontium-90	1.30E+10	N/A	1.09E+06	7.98E+05	1.16E+06	7.26E+05	2.82E+05	8.11E+05	6.24E-03	1.85E+06	1.42E-02	1.85E+06	1.42E-02
Cesium-137	1.16E+10	N/A	7.53E+04	6.85E+04	5.05E+04	6.43E+04	2.44E+02	5.18E+04	4.46E-04	6.17E+05	5.32E-03	6.17E+05	5.32E-03
TOTAL as %DRL	**-**	**-**	**4.19E-01**	**3.44E-01**	**3.93E-01**	**2.61E-01**	**3.79E-01**	**-**	**3.59E-01**		**9.27E-01**	**-**	**9.27E-01**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 25: Effluents Monitoring Equipment Unavailability – 2019

	Unavailability Criteria [a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 25) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2019, there were no instances in which the unavailability criteria (Table 25) outlined above were exceeded. There were no instances of air monitoring unavailability. There were 4 instances of planned unavailability to Outfall monitoring were due to required maintenance that affected the electrical power supply 3 times and the water flow once. The total time of monitoring unavailability in 2019 was 9.3 h. In each instance an estimate of the release during unavailability was calculated as per procedure. Monitoring unavailability also occurred during the fall discharge of the Lagoon when the auto sampler failed due to frozen sample lines. Although the daily grab samples provided a reasonable substitute for auto sampling, strictly speaking there was a loss of monitoring for the remainder of the discharge. The total time for loss of unplanned monitoring, was 107 hours.

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 21 and Table 24 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2014 to 2019. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2019 were below CNL's Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [28]. During the week of April 16-23 the gross beta emissions for the DA-1 filter exceeded the Administrative Level for the Hot Cells facility. The subsequent evaluation of Hot Cells operations indicated no breach of the air filtration system. The likely cause of the abnormal exceedance was the dislodging of a hot particle from the historically contaminated Hot Cell stack. With this exception, all air emissions were below CNL's Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2019 continue to be very low, averaging 0.00023% of the DRL.

Radioactivity in the WL liquid releases for 2019 was 0.93% of the DRL which is higher than in 2018 and the last five-year average (0.36%). The main reason for the higher 2019 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Plutonium-238, at detection limit values, was the primary contributor to the Outfall, averaging 0.35% of the

DRL. The primary contributors for Lagoon emissions were plutonium-239/240 and americium-241, averaging 0.0.066% and 0.059% of the DRL, respectively. Both of these contributors had activities at detection level values. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2019 release results as well as the previous years' trends indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement regarding hazardous substances monitoring of liquid and airborne effluents for the WL site for 2019. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [25].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedule and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Sewage Lagoon (referred to as the Lagoon) at point of discharge to the Lagoon drainage ditch, the Process Outfall (referred to as the Outfall), the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are utilized as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial highway 211. More details for each monitoring area are provided in the sections to follow.

Referring back to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 26 lists the non-radiological parameters monitored at the inlet or effluent streams sampled, and the sampling schedule followed. The WL monitoring program follows the protocols from the Ontario Ministry of Environment [34] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups (ATGs). These are described in Table 27, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment (SRI). The LMDL and SRI were determined in accordance with protocol. The WL monitoring program also meets the regulations set out in the Federal Wastewater Systems Effluent Regulations [35], and the standards from CSA N288.4-10, *Environmental Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [18].

Table 26: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS TANKS	
						B300-LLLWTS	B100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	--	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.
b The Monthly = grab sample taken once within each month.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

Discharging the Lagoon in 2019 required 10 days between October 21st and October 31st in the fall, and there was no discharging of the Lagoon in the spring. The lagoon was not discharged during the spring, to enable sampling campaigns to be conducted on the lagoon cells and the discharge pathway. Prior to the fall discharge, grab samples of the lagoon effluent were collected for Carbonaceous Biochemical Oxygen Demand (CBOD), acute lethality test[10], and coliform[11] measurements. Remaining lagoon parameters were analyzed in samples that were collected daily and weekly during flow periods.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were eighteen events in 2019.

Whenever a tank was discharged at either of the LLLWTS's, the effluent was sampled.

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10 The acute lethality test is a pass/fail type of test that is required to be performed by the federal Wastewater Systems Effluent Regulations [35] that came into force 2015 January 01.

11 Coliform bacteria are a commonly used bacterial indicator of sanitary quality of foods and water.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [34]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system provides a defensible set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into ATGs, listed in Table 27. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses and result reporting.

Table 27: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.0010
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.010
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9	Nickel	ICP	mg/L	0.02	--	--	0.001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0020
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.
b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a very common estimate of bacterial counts, especially for sewage effluent.
c RMDL = Regulation Method Detection Limit
d The LMDL = Laboratory Method Detection Limit ("MDL" also used).
e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages or operator action requiring “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 25) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2019, there were no instances in which the unavailability criteria (Table 25) outlined above were exceeded. There were no instances of air monitoring unavailability. The 4 instances of planned unavailability to Outfall monitoring were due to required maintenance that affected the electrical power supply 3 times and the water flow once. The total time of monitoring unavailability in 2019 was 9.3 h. In each instance an estimate of the release during unavailability was calculated as per procedure.

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2019. These include an averages summary table and a comparison against the CNL’s Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2019 are presented in Table 28 through Table 32. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [34]. The next three give the CNL monthly guideline concentration, LMDL (Table 27) and units for each measurement. Generally, the next six columns provide for comparison, the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven columns contain a summary of the results for the 2019 monitoring period (explained further below).

CNL WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 27.

Within the 2019 results section, the number of samples included in the average (“# Spl.”) is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled “ND’s”) gives the number of samples in which the analyte was not detected and was therefore deemed a “zero” result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables located at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number permits some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 29 through Table 32, yearly average values for parameters marked with an asterisk indicate that a monthly guideline was exceeded for at least one month during the course of the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected together in Table 34, and compared to the previous five years).

Table 28: Averages Summary for Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2019							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2014	2015	2016	2017	2018	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)
3	pH	6 to 9	N/A	pH	7.23	7.30	7.03	7.42	7.41	7.28	12	0	6.93	7.84	7.432	3.35	N/A
6	Phosphorus	1.0	0.003	mg/L	0.108	0.111	0.040	0.026	0.020	0.610	12	0	0.013	0.026	0.017	19.2	0.017
7	Conductivity	N/A	2.0	µS/cm	102	103	104	93.0	107	102	12	0	95	135	107	9.91	N/A
8	TSS	25	1.0	mg/L	2.90	2.13	2.63	3.03	2.05	2.55	12	4	0	6..10	3.15	85.8	3032
9	Chromium	0.5	0.001	mg/L	0.0008	0.0017	0.0002	0	0.0001	0.0006	12	8	0	0.0018	0.0005	151	0.476
9	Copper	0.5	0.0005	mg/L	0.018	0.014	0.007	0.004	0.005	0.0096	12	0	0.004	0.012	0.007	34.8	6.77
9a	Iron	1.0	0.010	mg/L	1.77	0.405	0.32	0.310	0.233	0.6076	12	0	0.154	1.380	0.331	103	321
9	Lead	0.1	0.0002	mg/L	0.001	0.003	0.001	0.0002	0.0001	0.0011	12	8	0	0.0003	0.0001	150	0.099
9	Nickel	0.5	0.001	mg/L	0.0013	0.0018	0.0008	0	0	0.0008	12	11	0	0.0012	0.0001	346	0.109
9	Zinc	0.5	0.005	mg/L	0.0065	0.0025	0.0023	0	0	0.0023	12	12	0	0	0	N/A	0
12	Mercury	1.0	0.0020	µg/L	0.009	0.0087	0.0016	0	0.0002	0.0039	12	12	0	0	0	N/A	0
14	Phenolics	0.02	0.0010	mg/L	0.0009	0.0013	0.0014	0.0017	0.0002	0.0011	12	10	0	0.005	0.0007	236	0.001
25	Oil & Grease	15	1.0	mg/L	1.3	1.4	0.4	0.1	0.1	0.660	12	12	0	0	0	N/A	0
--	Estimated Flow (total volume for year)			m^3	1.48E+06	1.36E+06	1.30E+06	1.21E+06	1.18E+06	1.31E+06	1.01E+06						

a Averages were calculated by setting to zero results reported as "< DL".
b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.
c # Spl. is the number of samples analyzed and reported.
d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).
e RSTD = Relative Standard Deviation
N/A = not applicable.

Table 29: Averages Summary for Lagoon

					Monitoring Point: Lagoon													
					Averages from Previous Five Years						Results for Year 2019							
ATG	**Parameter**	**Monthly Guide[a]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl.[b]**	**NDs[c]**	**Min.**	**Max.**	**Vol. Wt. Avg.**	**RSTD[d] (%)**	**Load (kg)**
-	CBOD	25	2.0	mg/L	6.67	0.211	0	2.5	17.7	5.42	3	3	0	0	0	N/A	0
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.12	0.012	0.0099	0.010	0.0097	0.0323	2	0	0.001	0.0015	0.0011	28.3	0.042
-	Total residual Chlorine	0.02	0.010	mg/L	0.034*	0.023*	0.035*	0.017	0.018	0.025	2	0	0.020	0.030	0.022	28.3	0.831
--	Total Coliform	N/A	3	MPNU[e]/100 mL	309	10.04	35	534	330	244	3	0	200	200	200	0	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	4.21	1.33	5	40	5	11.1	3	0	15	43	13.5	129	N/A
3	pH	6 to 9	N/A	pH	7.96	8.41	7.01	8.59	8.68	8.13	10	0	6.07	7.36	6.66	6.69	N/A
6	Phosphorus	1.0	0.003	mg/L	0.273	0.171	0.083	0.069	0.131	0.145	2	0	0.037	0.052	0.049	23.8	1.90
7	Conductivity	N/A	2.0	µS/cm	261	363	279	223	229	271	2	0	347	353	348	4.37	N/A
8	TSS	25	1.0	mg/L	9.2	3.89	1.92	4.807	3.8	4.72	2	0	1.0	1.2	1.2	12.9	44.7
9	Chromium	0.5	0.001	mg/L	0.0006	0.0005	0	0	0	0.0002	2	2	0	0	0	N/A	0
9	Copper	0.5	0.0005	mg/L	0.0011	0.0010	0.0016	0.0021	0.0015	0.0015	2	0	0.6800	0.7700	0.0007	8.78	0.027
9a	Iron	1.0	0.010	mg/L	0.243	0.216	0.245	0.283	0.370	0.271	2	0	0.098	0.123	0.119	16.0	4.56
9	Lead	0.1	0.0002	mg/L	0	0	0	0.0001	0	0.0000	2	2	0	0	0	N/A	0
9	Nickel	0.5	0.001	mg/L	0	0.0004	0.0005	0.0015	0.0015	0.0008	2	0	0.0011	0.0011	0.0011	0	0.042
9	Zinc	0.5	0.005	mg/L	0.0011	0.0005	0.0003	0	0	0.0004	2	2	0	0	0	N/A	0
12	Mercury	1.0	0.0020	µg/L	0.077	0.003	0.0006	0	0	0.0161	2	2	0	0	0	N/A	0

					Monitoring Point: Lagoon													
					Averages from Previous Five Years						Results for Year 2019							
ATG	**Parameter**	**Monthly Guide[a]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl.[b]**	**NDs[c]**	**Min.**	**Max.**	**Vol. Wt. Avg.**	**RSTD[d] (%)**	**Load (kg)**
4	Phenolics	0.02	0.0010	mg/L	0.0007	0.0015	0.0017	0.0033	0	0.0008	2	2	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	2.53	0.45	0.78	0.856	0	1.21	2	2	0	0	0	N/A	0
--	Estimated Flow (total volume for year)[f]			m^3	8.35E+04	5.26E+04	7.46E+04	4.72E+04	1.22E+04	5.40E+04	3.83E+04						
--	Number of Batches Discharged			--	2	2	2	2	1	2	1						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e. Code = "< DL", result = 0).
d RSTD = Relative Standard Deviation
e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.
f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: The 2019 Spring Discharge = 0 L; 2018 Fall discharge = 3.83E+07 L.

Notes: Any averages with an asterisk indicate that a monthly guideline was exceeded in one or more months for the given parameter in the year.
N/A = not applicable.
Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 30: Averages Summary for Outfall

					Monitoring Point: Process Outfall[a]													
					Averages from Previous Five Years[b]						Results for Year 2019							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2014	2015	2016	2017	2018	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.	RSTD[e] (%)	Load (kg)
3	pH	6 to 9	N/A	pH	7.57	7.54	7.50	7.81	7.76	7.64	53	0	6.70	8.62	7.67	4.20	0
6	Phosphorus	1.0	0.003	mg/L	0.119	0.120	0.040	0.035	0.030	0.069	53	2	0	0.079	0.022	64.8	27.74
7	Conductivity	N/A	2.0	µS/cm	115	118	130	139	131	127	53	0	110	1400	164	107	0
8	TSS	25	1.0	mg/L	2.11	7.60	2.35	2.97	1.5	3.31	53	15	0	24	4.2	102	5764
9	Chromium	0.5	0.001	mg/L	0.0010	0.0024	0.0001	0	0.0001	0.0007	53	30	0	0.1183	0.0006	118	0.818
9	Copper	0.5	0.0005	mg/L	0.009	0.010	0.006	0.006	0.005	0.007	53	0	0.002	0.020	0.005	79.8	7.03
9a	Iron	1.0	0.010	mg/L	0.29	0.36	0.316	0.262	0.186	0.283	53	0	0.078	0.573	0.218	54.74	296
9	Lead	0.1	0.0002	mg/L	0.0005	0.0023	0.0004	0.0003	0.0002	0.0007	53	28	0	0.0006	0.0002	117	0.220
9	Nickel	0.5	0.001	mg/L	0.0013	0.0027	0.0009	0.0020	0.0006	0.0015	53	33	0	0.0022	0.0005	137	0.742
9	Zinc	0.5	0.005	mg/L	0.025	0.004	0.003	0.001	0.001	0.007	53	25	0	0.022	0.004	112.89	6.13
12	Mercury	1.0	0.0020	µg/L	0.019	0.012	0.001	0	0.0006	0.007	53	47	0	0.0274	0.0009	455	0.001
14	Phenolics	0.02	0.0010	mg/L	0.0008	0.0011	0.0017	0.004	0.0001	0.0015	53	45	0	0.0029	0.0003	251	0.0003
25	Oil & Grease	15	1.0	mg/L	1.47	2.40	0.82	0.19	0.1	1.00	53	52	0	1.0	0.02	728	19.1
--	Estimated Flow (total volume for year)			m^3	1.38E+06	1.33E+06	1.41E+06	1.13E+06	1.16E+06	1.28E+06	1.25E+06						

a All results below the LMDL, originally flagged as “< DL” when reported, are only estimates.
b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.
c # Spl. is the number of samples analyzed and reported.
d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).
e RSTD = Relative Standard Deviation
N/A = Not Applicable.

Note: There were no monthly guideline exceeds for any monitored parameter.

Table 31: Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2019					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.24	7.46	7.50	7.88	7.81	7.58	18	0	7.39	8.3	7.73	3.10
6	Phosphorus	1.0	0.003	mg/L	0.168	0.116	0.049	0.071	0.045	0.090	18	0	0.015	0.12	0.043	64.88
7	Conductivity	N/A	2.0	µS/cm	348	554	571	445	690	522	18	0	120	930	586	39.5
8	TSS	25	1.0	mg/L	1.5	2.4	2.3	1.4	1.65	1.85	18	6	0	6.0	1.92	91.2
9	Chromium	0.5	0.001	mg/L	0.0008	0.0012	0.0004	0	0	0.0005	18	11	0	0.0017	0.0005	132
9	Copper	0.5	0.0005	mg/L	0.002	0.003	0.002	0.0015	0.0015	0.002	18	2	0	0.0025	0.0013	50.9
9a	Iron	1.0	0.010	mg/L	0.256	0.191	0.208	0.192	0.083	0.186	18	0	0.032	0.345	0.147	63.2
9	Lead	0.1	0.0002	mg/L	0.0004	0.0009	0.0002	0	0	0.0003	18	18	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.0022	0.0035	0.0052	0.0037	0.0026	0.0034	18	1	0	0.0046	0.0030	34.9
9	Zinc	0.5	0.005	mg/L	0.007	0.004	0.004	0.0023	0.0014	0.0037	18	15	0	0.0094	0.0012	236
12	Mercury	1.0	0.0020	µg/L	0.1647	0.0061	0.0055	0	0.0020	0.0357	18	13	0	0.0046	0.0009	172
14	Phenolics	0.02	0.0010	mg/L	0.0016	0.0006	0.0022	0.0070	0.0002	0.0023	18	14	0	0.0069	0.0006	275
25	Oil & Grease	15	1.0	mg/L	1.9	1.4	0.85	0.4	0.13	0.94	18	16	0	1.6	0.17	291

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					Monitoring Point: DITCH 9 (Westbound)[a]											
					Averages from Previous Years[b]						Results for Year 2019					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**#Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	6.93	7.14	7.05	7.67	7.69	7.30	18	0	7.21	8.11	7.58	3.68
6	Phosphorus	1.0	0.003	mg/L	0.181	0.136	0.053	0.045	0.042	0.091	18	3	0	0.12	0.035	95.7
7	Conductivity	N/A	2.0	µS/cm	195	216	193	214	538	271	18	0	150	1300	400	84.9
8	TSS	25	1.0	mg/L	4.5	1.5	2.4	2.1	2.08	2.5	18	3	0	14.1	2.69	115
9	Chromium	0.5	0.001	mg/L	0.0006	0.0018	0.0003	0	0	0.0005	18	11	0	0.0016	0.0005	131
9	Copper	0.5	0.0005	mg/L	0.0016	0.0027	0.0008	0.0013	0.0021	0.0017	18	0	0.0011	0.0024	0.0018	21.8
9a	Iron	1.0	0.010	mg/L	0.522	0.446	0.575	0.326	0.315	0.437	18	0	0.080	0.471	0.250	53.4
9	Lead	0.1	0.0002	mg/L	0.0001	0.0009	0	0	0	0.0002	18	18	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.0018	0.0027	0.0030	0.0022	0.0027	0.0025	18	0	0.0011	0.0062	0.0030	39.2
9	Zinc	0.5	0.005	mg/L	0.010	0.005	0.006	0.0022	0.0040	0.0054	18	12	0	0.0093	0.0025	150
12	Mercury	1.0	0.0020	µg/L	0.0343	0.0078	0.0087	0	0.0021	0.0106	18	10	0	0.0052	0.0016	124
14	Phenolics	0.02	0.0010	mg/L	0.0023	0.0009	0.0021	0.0086	0	0.0028	18	15	0	0.0058	0.0005	305
25	Oil & Grease	15	1.0	mg/L	0.9	1.6	1.1	0	0	0.72	18	18	0	0	0	N/A

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					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						**Results for Year 2019**					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	6.98	7.27	7.22	7.76	7.83	7.41	17	0	7.35	8.05	7.72	2.17
6	Phosphorus	1.0	0.003	mg/L	0.192	0.182	0.148	0.083	0.065	0.134	17	1	0	0.38	0.104	95.5
7	Conductivity	N/A	2.0	µS/cm	398	465	347	380	939	506	17	0	310	1000	579	36.2
8	TSS	25	1.0	mg/L	1.92	3.44	3.28	6.2	2.9	3.5	17	0	1.3	53	7.0	175
9	Chromium	0.5	0.001	mg/L	0.0006	0.0013	0.0003	0	0	0.0004	17	11	0	0.0069	0.0008	218
9	Copper	0.5	0.0005	mg/L	0.0007	0.0025	0.0005	0.0010	0.0015	0.0012	17	0	0.0008	0.0094	0.0018	112
9a	Iron	1.0	0.010	mg/L	0.45	0.416	0.714	0.594	0.674	0.570	17	0	0.246	4.830	0.762	144
9	Lead	0.1	0.0002	mg/L	0.0002	0.0036	0.0005	0.0002	0	0.0009	17	13	0	0.0032	0.0002	353
9	Nickel	0.5	0.001	mg/L	0.0016	0.0026	0.0029	0.0021	0.0047	0.0028	17	0	0.0013	0.0069	0.0033	45.4
9	Zinc	0.5	0.005	mg/L	0.012	0.0047	0.0029	0	0.0126	0.0064	17	8	0	0.0666	0.0111	169
12	Mercury	1.0	0.0020	µg/L	0.0517	0.0082	0.0127	0	0.0004	0.0146	17	13	0	0.0041	0.0007	193
14	Phenolics	0.02	0.0010	mg/L	0.0016	0.0006	0.0022	0.0074	0.0001	0.0024	17	12	0	0.0069	0.0007	221
25	Oil & Grease	15	1.0	mg/L	0.8	1.1	1.1	0	0.3	0.7	17	17	0	0	0	N/A

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< W."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< W", result = 0).
f RSTD = Relative Standard Deviation
N/A = not applicable

Table 32: Averages Summary for the Low Level Liquid Waste Treatment Systems

					Monitoring Point: B100 & B300 LLLW Treatment Systems[a]													
					Averages from Previous Five Years[b]						Results for Year 2019							
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**	**Load (kg)**	
3	pH	6 to 9	N/A	pH	7.43	7.97	7.50	7.52	7.39	7.56	68	0	6.74	8.33	7.54	3.84	N/A	
6	Phosphorus	1.0	0.003	mg/L	0.334	0.270	0.145	0.370	0.327	0.289	68	1	0	3.500	0.554*	119	0.104	
7	Conductivity	N/A	2.0	µS/cm	653	518	326	267	348.84	423	68	0	184	631	352	30	N/A	
8	TSS	25	1.0	mg/L	17.79*	12.73*	4.38	14.67*	16.28*	13.2	68	2	0	24	8.25	52.3	1.52	
9	Chromium	0.5	0.001	mg/L	0.0038	0.0032	0.0016	0.0007	0.0006	0.0020	68	28	0	0.0033	0.0009	91.6	0.0002	
9	Copper	0.5	0.0005	mg/L	0.285*	0.301*	0.128	0.509*	0.516*	0.347	68	0	0.134	1.650	0.512*	47.0	0.097	
9a	Iron	1.0	0.010	mg/L	1.73*	2.22*	9.37*	3.39*	1.660*	3.67	68	0	0.096	2.140	0.465*	81.0	0.088	
9	Lead	0.1	0.0002	mg/L	0.007	0.006	0.006	0.014	0.0112	0.009	68	1	0	0.0313	0.0057	71.3	0.001	
9	Nickel	0.5	0.001	mg/L	0.0071	0.0097	0.0180	0.0066	0.0055	0.0094	68	1	0	0.0357	0.003	127	0.001	
9	Zinc	0.5	0.005	mg/L	0.100	0.089	0.096	0.180	0.272	0.1474	68	0	0.031	0.443	0.152	63	0.029	
12	Mercury	1.0	0.0020	µg/L	0.339*	0.147	0.161	0.130	0.060	0.1674	68	6	0	0.300	0.03	149	0.00000	
14	Phenolics	0.02	0.0010	mg/L	0.005	0.002	0.007	0.007	0.01*	0.0062	68	4	0	0.011	0.005	50.2	0.0009	
25	Oil & Grease	15	1.0	mg/L	6.83	4.35	0.60	0.73	0.88	2.68	68	51	0	5.2	0.59	208	0.111	
--	Estimated Flow (total volume for year)			m^3	1.51E+03	5.12E+02	2.30E+02	1.72E+02	1.32E+02	5.11E+02	1.89E+02							
--	Number of batches discharged			--	82	34	14	24	50	41	68							

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< DL."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).
f RSTD = Relative Standard Deviation
N/A = not applicable

Notes: Any averages with an asterisk indicate that a monthly guideline was exceeded in one or more months for the given parameter in the year.
Discharges of effluent coming from the new low level liquid waste treatment systems are being combined together, as it allows for comparisons to the data collected over the previous 5 years.

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. The CNL guideline limits are derived from the most recent legislation available. They are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 33 provides a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2019 or at any time during the previous five years.

As with the average summary table provided for each monitoring point, the first two columns in the table identify the Ministry of Environment ATG and parameter names. The next three give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns indicate the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

In order to assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 33: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2019		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	100	100	100	100	12	2	83
LLLWTS /ALWTC	8	TSS	25	1.0	mg/L	92	92	100	78	92	90.8	12	0	100
LLLWTS /ALWTC	9	Copper	0.5	0.0005	mg/L	75	67	100	67	33	68.4	12	7	42
LLLWTS /ALWTC	9a	Iron	1.0	0.010	mg/L	83	75	67	44	50	63.8	12	2	83
LLLWTS /ALWTC	12	Mercury	1.0	0.0020	µg/L	92	100	100	100	100	98.4	12	0	100
LLLWTS /ALWTC	14	Phenolics	0.02	0.0010	mg/L	100	100	100	100	92	98.4	12	0	100
Outfall	8	TSS	25	1.0	mg/L	100	83	100	100	100	96.6	12	0	100

- Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table.
- Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that particular parameter at the monitoring point. This year there were eleven occurrences when one of three parameters (Copper, Iron, and Phosphorus) from the LLLWTS had monthly values higher than CNL monthly guidelines. Figure 5, show the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, and Figure 8 for each parameter, and the explanations for the observed high values can be found in Section 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is indicated by a broken red line in the corresponding figures.

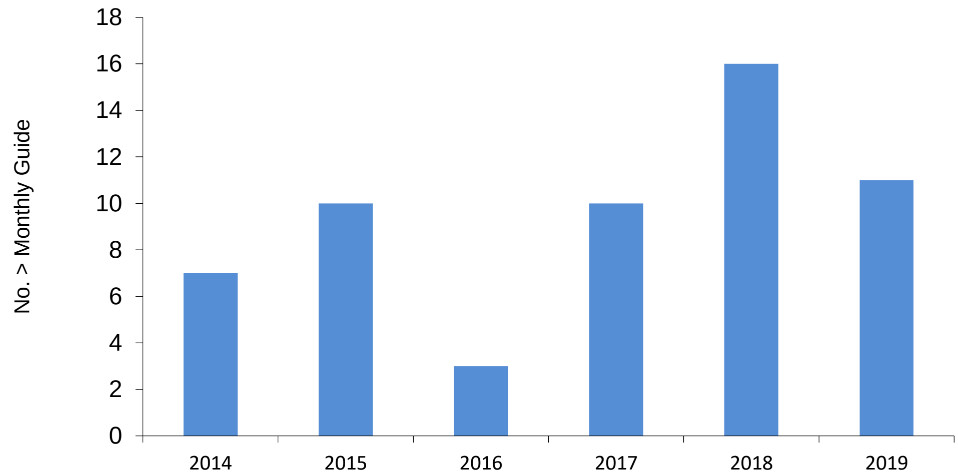

Figure 5: Non-Radiological Monitored Effluent Parameters above Monthly Guidelines

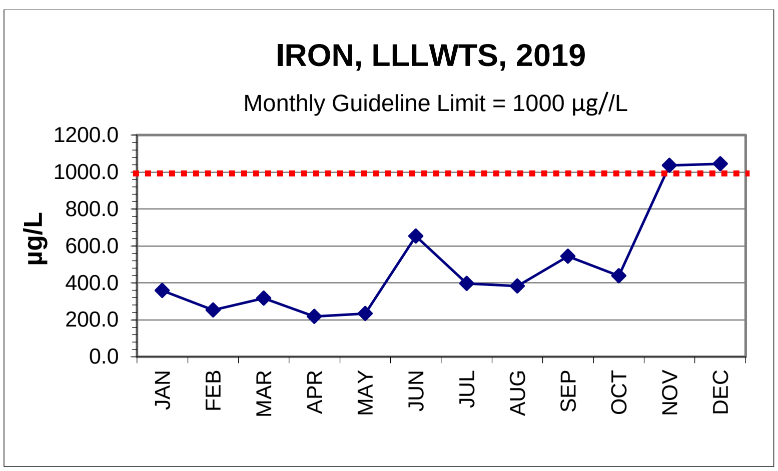

Figure 6: Monthly Average Iron Concentrations of Effluents from the Low Level Liquid Waste Treatment System for 2019

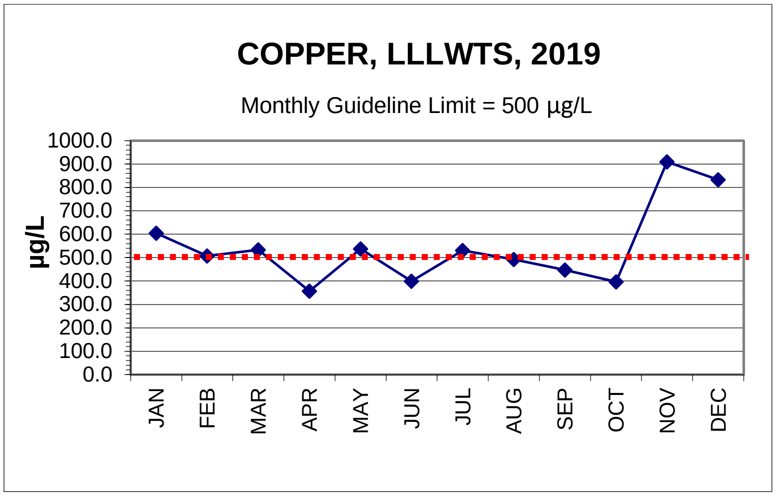

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low Level Liquid Waste Treatment System for 2019

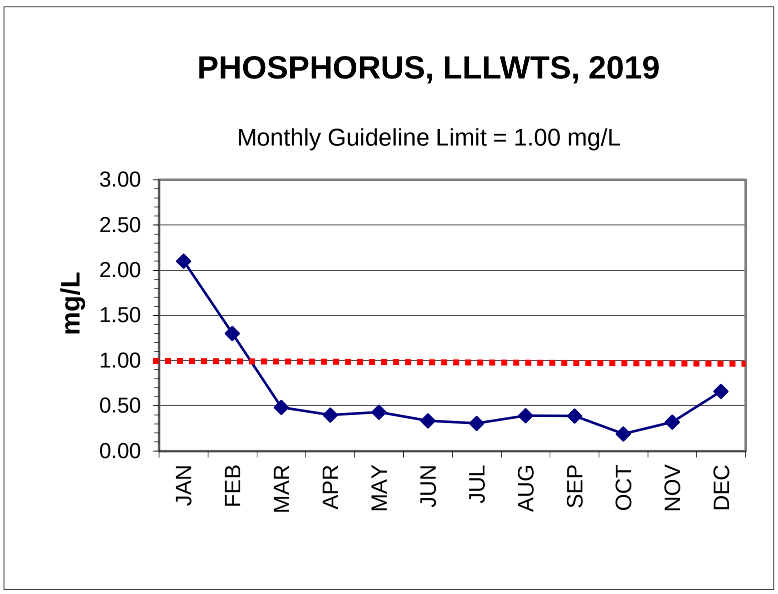

Figure 8: Monthly Average Phosphorus Concentration of Effluents from the low Level Liquid Waste Treatment Systems for 2019

9.5.1.4.4 Monitoring of Intake Water from the Winnipeg River

Except for bottled drinking water, all of the water required to operate the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 28, where they are compared to available data for the previous five years. Figure 9 shows the estimated amount of water used monthly for 2019.

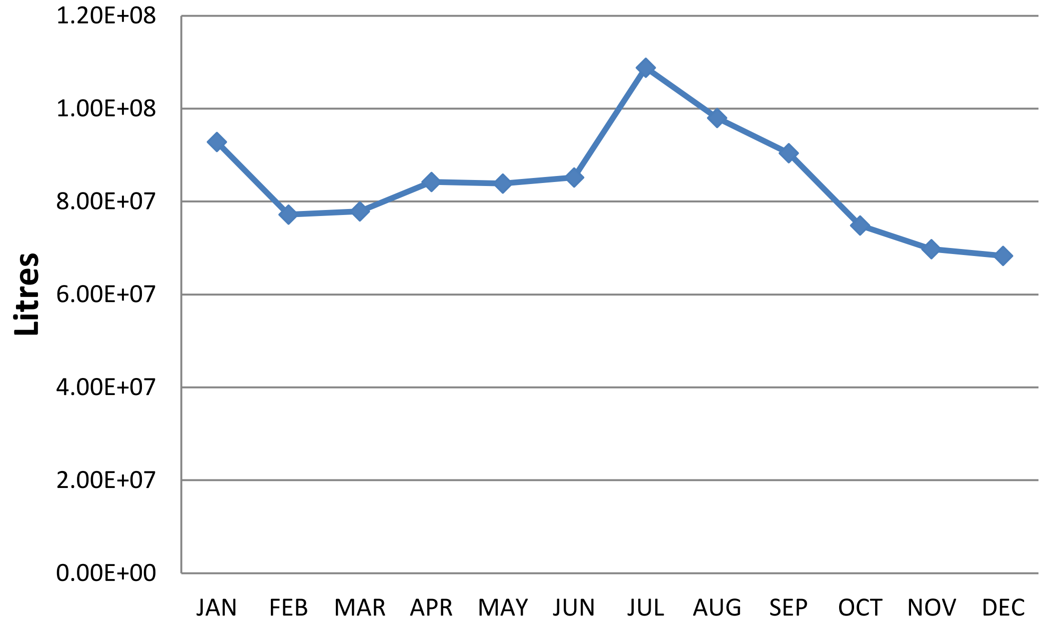

Figure 9: Monthly 2019 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2019 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 1.01E+06 m^3 of water was pumped from the river over the year.
- Compared to the five-year average, increased concentrations (> 10%) were only observed for Total Suspended Solids.
- Parameters that had their concentrations improve (> 10% decrease) this year compared to the average observed for the last five years are Phosphorus, Chromium, Copper, Iron, Lead, Nickel, Zinc, Mercury, Phenolics and Oil & Grease.
- Water consumption for the site increases during the summer months as the chillers and air compressors that are operated in the summer are cooled by the river water.

Intake water results can have a significant impact on the apparent environmental performance of the WL site and they will continue to be monitored closely. In 2019, the WL site temporarily expanded the monitoring program to encompass additional parameters at the site's intake and outfall monitoring station for 6 months. This was done to verify and provide justification that the environmental monitoring program is properly identifying and analyzing for the appropriate contaminant of concern being released into the environment through the site's operations.

The concentrations observed at the intake are used as the base line to determine if measured concentrations at the outfall are a result of site operations. The additional parameters that were looked at were the following:

Neutral Extractables, Chlorinated Extractables, Chemical Oxygen Demand, Dissolved Nitrate, Dissolved Organic Carbon, Total Organic Carbon, Chloride, Aluminium, Antimony, Arsenic, Barium, Beryllium, Bismuth, Boron, Cadmium, Cobalt, Lithium, Manganese, Molybdenum, Selenium, Silicon, Strontium, Thallium, Tin, Titanium, Uranium, Vanadium, Zirconium, Calcium, Magnesium, Potassium, Sodium, and Volatiles.

The results of this study will be summarized in more detail in the Outfall Section 9.5.1.4.5.2.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell had only one period of discharge during the 2019 calendar year. This period of discharge occurred in the fall between October 21st and October 31st. There was no discharge in the spring as various sampling campaigns for the environmental assessment follow-up report and the environmental risk assessment for the lagoon were being conducted during this time period. The total amount of effluent discharged from the Lagoon in 2019 was 38,300 m^3.

Prior to discharging, the Lagoon was tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the cell occurs. During fall discharge, grab-samples were collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters are collected on a weekly basis during the course of the discharge.

The vertical scale from which surface height is determined was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

$$\begin{aligned}\text{Volume (in L)} &= \text{Height x [Width\_Bottom x Length\_Bottom} \\ &+ 0.5\text{(Width-Width\_Bottom) Length\_Bottom} \\ &+ 0.5\text{(Length-Length\_Bottom) Width\_Bottom} \\ &+ (1/3)\text{ (Width-Width\_Bottom) (Length-Length\_Bottom)]}\end{aligned}$$

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

$$\text{Volume (in L)} = 636\,655{*}d + 206.886{*}d^2 + 0.02133{*}d^3 \text{ for depth “d” (in cm)}$$

The position of the Lagoon’s water surface was recorded once or twice daily while emptying. The daily flow was calculated from changes in the contained volume. This permitted calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of nearly fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in determining meaningful average concentrations.

The fall discharge of the secondary cell was allowed to proceed after initial testing. Once discharging begins, the pH is monitored daily throughout the discharge period.

Table 29 summarizes the results of the fall discharge. Some notable points are:

- Compared to the five-year average, there was an increase in concentrations (> 10%) for fecal coliforms, Conductivity and Nickel. For the metal parameter concentrations a noticeable increase was observed, although all increases are still well below the guideline limits and measured at such low concentrations that a small increase in concentration leads to a large percentage increase.
- Compared to the five-year averages, CBOD, Unionized Ammonia, Total Residual Chlorine, Phosphorus, Total Suspended Solid (TSS, Chromium, Copper, Iron, Lead, Mercury, Zinc, Phenolics, and Oil & Grease were all substantially lower (> 10% decrease).
- No trout mortality was observed in the spring lagoon effluent sample that underwent acute lethality testing.
- The Total Residual Chlorine concentrations was at the proposed Wastewater System Effluent Regulations limit for 2019. The cloudy and wet fall contributed to the high levels of chlorine being observed, as there would be limited chlorine breakdown occurring in this weather.

The WL Lagoon discharge was compared against the limits set by the federal government in the Wastewater Systems Effluent Regulations in The Canadian Gazette [35]. The limits in force were met in all cases.

The results of the federally regulated parameters are indicated below:

- Carbonaceous Biochemical Oxygen Demand - annual volume weighted average was 0 mg/L, which is less than the 25 mg/L limit.
- TSS - annual volume weighted average was 1 mg/L which is less than the 25 mg/L limit.
- Un-ionized Ammonia - the maximum concentration was 0.0011 mg/L which is less than 1.25 mg/L limit.
- Total Residual Chlorine - annual volume weighted average was 0.02 mg/L which is at the 0.02 mg/L limit (limit not in force until 2021).

9.5.1.4.5.2 Process Outfall

The Outfall monitoring station functioned as expected during 2019. The total discharge volume was 1.25 GL. This volume is lower than the previous five-year average of 1.28 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 53 samples of each parameter for the year.

Table 30 summarizes the results obtained, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were no instances of CNL’s monthly guidelines being exceeded at the Outfall monitoring station.
- The only parameters that had a significant increase (> 10%) compared to the 5 year average were TSS and conductivity.
- Compared to the five year average, Phosphorus, Chromium, Copper, Iron, Lead, Nickel, Mercury, Zinc, Phenolics and Oil and Grease concentration levels significantly decreased (>10%) .

Overall, the Process Outfall and sampling station operated successfully during 2019.

As indicated in Section 9.5.1.4.4, in 2019 the WL site temporarily expanded the monitoring program to encompass additional parameters at the site's intake and outfall monitoring station. The results of this study indicated that there were significant increases (>20 %) observed in the following parameter concentrations when compared to the intake concentrations.

Dissolved Nitrate, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene. Currently, CNL is able to identify that the source of the Potassium and Sodium being introduced to the outfall is a result from the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products result from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL will be expanding the monitoring program to include looking for these parameters at upstream monitoring locations in hopes of being able to identify a source for them.

Going forward the environmental monitoring program will continue to monitor for the parameters mentioned above in the intake and the outfall, and will begin reporting on them in this annual report.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were eighteen events from 2019 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparison is made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines this year. The measurement data are summarized in Table 31. The following are notable points for the 2019 ditches results:

- The rain event that occurred on September 3rd did not have a sample collected from the control ditch, due to a beaver dam obstructing the ditch flow.
- Conductivity was the only parameters that had a higher concentration than the previous five-year average for Ditch 8. The only parameters that had a higher concentration than the previous five-year average for Ditch 9 were Conductivity and Nickel. The control ditch also had readings higher than the previous five-year average for Conductivity, Copper, Iron, Nickel, and Zinc.
- All metal concentrations detected are so close to the detection limit, a small increase observed in the concentrations is having a large percentage increase being observed in Ditch 9 and the Control Ditch.
- The majority of the remaining parameters improved by more than 10% or stayed relatively the same for Ditch 8 and Ditch 9 when compared to the previous five years.
- All concentrations still remain well below the CNL's monthly guideline limit and pose no concern.

- All parameters measured in Ditch 8 and Ditch 9 were below or comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.

It should be noted that sediment control measures were put in place for projects in the WMA in 2019, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When nearly full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria does not include all parameters listed in CNL's non radiological guideline limit values, however the post-discharge analysis includes all of these parameters. CNL staff have determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the previous system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging generally requires a day or less to complete, and can be more gradual if required.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to determine pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the R&D Complex in Building 300 and Building 100 should still be similar enough that a comparison is worthwhile.

In 2019, 0.19 ML was discharged from the LLLWTS.

The weighted averages of the combined releases from the LLLWTS are presented in Table 32 and monthly plots for the parameters that exceed the monthly guidelines are in Figure 6, Figure 7, and Figure 8.

The following are notable results for 2019:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being observed at the Outfall monitoring location downstream in the process.
- There were increases (> 10%) in the annual average concentrations of Phosphorus and Copper, compared to the previous five year average results.

- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines two times (November, December). The overall Iron concentration observed for the year is lower than the previous years. The elevated levels observed in the LLLWTS align with some work that required manholes on site to be dewatered to permit employee access. This water was pumped into totes, and was relocated to the LLLWTS for treatment and disposal.
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines seven times in 2019 (April, June, August, September, and October did not have an exceedance). Frequent exceedances are being observed in relation to the new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon as the new tanks were commissioned and utilized, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration observed at the Outfall remains well below the monthly guideline limits.

  In November and December, the copper concentrations observed in these two months approximately doubled, as a result of the water relocations that enabled the manhole work.
- The Phosphorus concentration coming from the LLLWTS exceeded the CNL monthly guidelines two times (January, February). The elevated levels observed in the in the LLLWTS align with some work that was being performed for Building 200 on site. At this time pipe removal of the old active liquid waste treatment center was underway. Residual liquid or materials left in the pipe are suspected to be the source of the phosphorus, as it known that the decontamination center used high phosphorus containing compounds for decontamination of tools and equipment.

9.5.1.5 Loading Calculations

For the Lagoon and Outfall, volume-weighted loads were calculated (explained below), expressed in kilograms. All analytical data used previously in calculating averages are represented in the load.

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 34 contains the results of calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- TSS was the only parameter that had a load increase greater than 10% when compared to its previous five-year average. This increase in overall load is similar to the percentage increased observed at the intake over the same 5 year period, and as a result the percentage observed at the outfall.
- All other parameters had a significant decrease of 10% or more in their loads.

The sum of all parameter loads (6174 kg) has increased compared to last year (2735 kg) and is lower than the five-year average (7027 kg).

Table 34: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2019		
			2014	**2015**	**2016**	**2017**	**2018**	**Average**	**# Spl. [b]**	**NDs[c]**	**Load (kg)**
-	CBOD	Lagoon	557	21.5	0	132	216	185	3	3	0
		Site Total	**557**	**21.5**	**0**	**132**	**216**	**185**	**3**	**3**	**0**
-	Un-ionized Ammonia	Lagoon	10.04	0.61	0.74	0.46	0.118	2.39	2	0	0.042
		Site Total	**10.04**	**0.61**	**0.74**	**0.46**	**0.118**	**2.39**	**2**	**0**	**0.042**
-	Total residual Chlorine	Lagoon	2.81	1.23	2.6	0.808	0.220	1.53	2	0	0.831
		Site Total	**2.81**	**1.23**	**2.6**	**0.808**	**0.220**	**1.53**	**2**	**0**	**0.831**
6	Phosphorus	Lagoon	22.79	8.98	6.2	3.29	1.59	8.57	2	0	1.90
		Outfall	168	152	55.4	38.0	42.6	91.2	53	2	27.7
		Site Total	**191**	**161**	**61.6**	**41.3**	**44.2**	**99.8**	**55**	**2**	**28.6**
8	TSS	Lagoon	769	205	143	227	46.4	278	2	0	44.7
		Outfall	3110	11440	3504	3142	2031	4645	53	15	5764
		Site Total	**3879**	**11650**	**3647**	**3369**	**2077**	**4924**	**55**	**15**	**5809**
9	Chromium	Lagoon	0.05	0.02	0	0	0	0.014	2	2	0
		Outfall	1.45	3.08	0.35	0	0.06	0.988	53	30	0.818
		Site Total	**1.50**	**3.10**	**0.35**	**0**	**0.06**	**1.002**	**55**	**32**	**0.818**
9	Copper	Lagoon	0.09	0.05	0.12	0.10	0.018	0.0756	2	0	0.027
		Outfall	12.40	12.95	9.5	6.61	7.63	9.81	53	0	7.03
		Site Total	**12.49**	**13.00**	**9.6**	**6.71**	**7.65**	**9.89**	**55**	**0**	**7.06**
9a	Iron	Lagoon	20.31	11.37	18.3	13.34	4.52	13.6	2	0	4.56
		Outfall	449.6	501	417	291.1	258	383	53	0	296
		Site Total	**469.91**	**512**	**435**	**304**	**263**	**397**	**55**	**0**	**301**
9	Lead	Lagoon	0	0	0	0.003	0	0.0006	2	2	0
		Outfall	0.77	2.70	0.55	0.312	0.23	0.912	53	28	0.220
		Site Total	**0.77**	**2.70**	**0.55**	**0.32**	**0.23**	**0.913**	**55**	**30**	**0.220**
9	Nickel	Lagoon	0	0.02	0.035	0.069	0.019	0.0286	2	0	0.042
		Outfall	1.93	3.29	1.4	1.349	0.836	1.761	53	33	0.742
		Site Total	**1.93**	**3.31**	**1.4**	**1.42**	**0.855**	**1.783**	**55**	**33**	**0.784**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2019		
			2014	2015	2016	2017	2018	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0.09	0.02	0.024	0	0	0.027	2	2	0
		Outfall	47.91	5.89	6.3	1.167	1.77	12.6	53	25	6.13
		Site Total	**48.00**	**5.91**	**6.4**	**1.17**	**1.77**	**12.7**	**55**	**27**	**6.13**
12	Mercury	Lagoon	0.006	0.0002	0	0	0	0.00124	2	2	0
		Outfall	0.027	0.016	0.005	0	0.001	0.0098	53	47	0.001
		Site Total	**0.033**	**0.016**	**0.005**	**0**	**0.001**	**0.011**	**55**	**49**	**0.001**
14	Phenolics	Lagoon	0.06	0.08	0.13	0.155	0	0.085	2	2	0
		Outfall	1.36	1.44	2.1	4.024	0.0001	1.78	53	45	0.0003
		Site Total	**1.42**	**1.52**	**2.2**	**4.18**	**0.0001**	**1.86**	**55**	**47**	**0.0003**
25	Oil & Grease	Lagoon	211	23.5	59	40.40	0	66.8	2	2	0
		Outfall	2090	3086	1147	163.5	124	1322	53	52	19.1
		Site Total	**2301**	**3109**	**1206**	**204**	**124**	**1389**	**55**	**54**	**19.1**

a Averages were calculated by setting to zero results reported as “< DL.”
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

9.5.2 Airborne Effluents

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013 May, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen in the amount of cleaner burning propane used on site. Table 35 presents WL heating fuel consumption from 2014 to 2019. Generally, fuel consumption continues to trend downward (see Section 9.7.2 and Figure 10).

Table 35: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2019
Parameter	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	448 261	419 020	361 110	287 982	209 158	345 106	243,268
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	11.35	11.39	9.815	7.827	5.685	9.2134	6.612
Total	**TJ**	**11.35**	**11.39**	**9.815**	7.827	**5.685**	**9.2134**	**6.612**
Heating Demand								
Heating Degree Days	HDD	5548	4942	5573	5403	5855	5464	6079

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.
b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

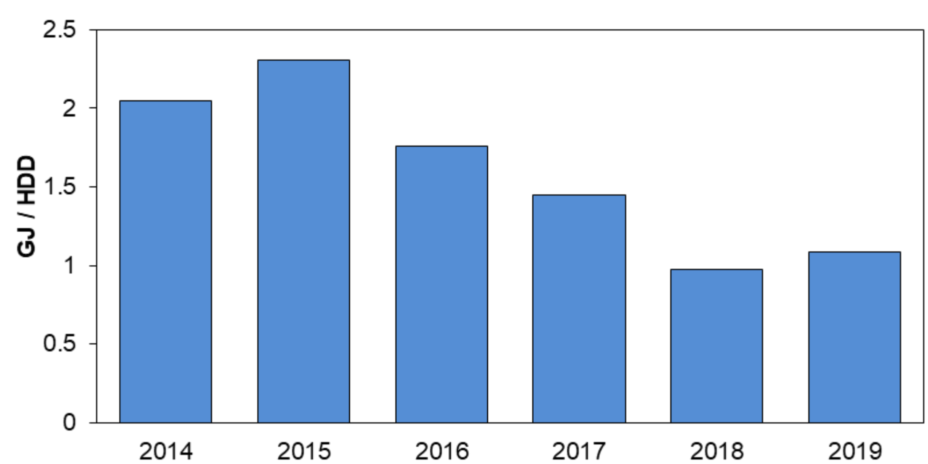

Figure 10: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory (NPRI)

Under the authority of the *Canadian Environmental Protection Act*, 1999 [36], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [38]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CSDs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2019 will be captured in the 2019 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories [27].

Table 36 outlines the annual Criteria Air Contaminants (CACs) generated from site activities. Prior to 2012, annual reports provided CACs for burning of fuels for heating only. However, to remain consistent with government reporting under the NPRI, the full suite of calculated CAC emissions were reported in 2012 and will continue to be reported as such.

Table 36 shows a small increase in emissions observed in 2019 compared to the 5-year average for the values for total particulate matter, PM_{10}, and $PM_{2.5}$. These values all met the NPRI reporting threshold this year, and are reported to Environment and Climate Change Canada. Road dust emissions were the major contributor to meeting these reporting thresholds. This year small segments of unpaved roads on the main campus were included for the road dust calculations that were not applied previously in the previous years. Estimated vehicle travel on the unpaved road to the landfill and all main campus unpaved road travel was added to the estimate this year. Although these segments of road have less vehicle traffic, they were added into the calculations for inclusiveness.

Table 36: Stationary Combustion Data and Emissions from WL

		Data for Previous Five Years						Data for 2019	NPRI Reporting Threshold
Parameter	**Unit**	**2014**	**2015**	**2016**	**2017**	**2018**	**Average**		
Airborne Emissions									
NO_x (as NO_2)	Mg	1.030	1.044	0.908	0.753	0.536	0.8542	0.621	20
SO_2	Mg	0.022	0.026	0.023	0.020	0.014	0.021	0.016	20
CO	Mg	0.475	0.461	0.399	0.348	0.233	0.383	0.271	20
TPM	Mg	19.57	16.36	15.022	13.651	14.562	15.833	10.574	20
PM_{10}	Mg	5.011	4.199	3.853	3.499	3.726	4.058	2.712	0.5
$PM_{2.5}$	Mg	0.532	0.454	0.415	0.376	0.391	0.434	0.292	0.3
Volatile Organic Compounds	Mg	0.081	0.082	0.071	0.059	0.042	0.067	0.049	10

9.5.2.3 Greenhouse Gas Reporting

Under the authority of the *Canadian Environmental Protection Act*, 1999 [36] WL is required to calculate releases under the GHGs emissions notice [37] providing the facility emits over 50,000 tonnes of carbon dioxide equivalent or more within the 2019 calendar-year.

GHG emissions from WL include carbon dioxide, methane and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

Table 37 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have increased slightly from 2018. This small increase can be attributed to the increase in propane required to heat the site in 2019 as shown in Table 35. There was an increase in the number of heating degree days (i.e. increased demand for building heat based on temperature) in 2019. Overall greenhouse gases are 6% less than the average for the last 5 years.

Table 37: Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2019 Releases
	2014	2015	2016	2017	2018	5-yr. Avg.	
GHG CO_2e tonnes	1940	1957	1883	1873	1678	1866	1756

Notes: GHG CO_2e tonnes - A unit of measure used to compare between gases that have different Global Warming Potentials (GWP). For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, pursuant to the Federal Halocarbon Regulations [39]. All releases greater than 10 kg are considered reportable.

As seen in Table 38, there were no reportable releases of halocarbons in 2019.

Table 38: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2019	
Type	**Global Warming Potential[b]**	**Ozone Depleting Potential[c]**	**2014**	**2015**	**2016**	**2017**	**2018**	**Number of Losses**	**Annual Loss (kg)**
Refrigerants[a]									
CFC (R-11)	4 600	1	0	0	0	0	0	0	0
CFC (R-12)	10 600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1 700	0	26.39	0	0	0	0	0	0
HFC (R-134a)	1 300	0	0	0	0	12.47	0	0	0
Fire Suppressants									
Halon (R-1301)	6 900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b Global Warming Potential per unit mass, relative to CO2 = 1.00
c Ozone Depleting Potential per unit mass, relative to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [39]

9.5.3 Overall Performance

The non-radiological effluent monitoring program established by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were zero discharges from the Outfall and Lagoon which exceeded the current monthly guideline limits placed on CNL.

The fall discharge of the Lagoon this year was at the proposed Total Residual Chlorine limit. The overcast rainy fall contributed to CNL being at the limit, but the reduction in Chlorine use and changes to operation of the lagoon allowed CNL to meet the Total residual Chlorine limit despite not having the favourable weather which would have further reduced the Total Residual Chlorine concentrations in the water. This limit comes into force in 2021 as per the “Wastewater Systems Effluent Regulations” in *The Canadian Gazette* [35]. The site’s chlorination practices that have been adjusted over the last few years continued to prove successful in 2019, and will be applied in the future.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances to report in 2019. However, CNL did have two reportable contamination incidents to the Winnipeg River (see Table 39). Both of these incidents were reported to Manitoba Sustainable development, and are related to a fuel leakage from the motor of the environmental field boat. The second incident was connected to the initial incident as it was caused by the misdiagnosis of the problem afflicting the motor during the initial repair.

Table 39: Reportable Events (Environmental Protection) at WL in 2019

Event No.	Title	Reportable Agency
ERM-19-3292	WL - Small fuel (gasoline) leak from boat motor into Winnipeg River - small volume approximately 30 ml.	Manitoba Sustainable Development
ERM-19-3460	WL EnvP: WL - Small fuel (gasoline) leak from boat motor into Winnipeg River - small volume < 500 ml	Manitoba Sustainable Development

9.7 Discussion of Improvement Initiatives

The following sections describe some efforts made during 2019 to identify, understand and/or remove sources of some monitored substances.

9.7.1 Monitoring Site Intake Water

Monthly samples of Intake water (from the Pump House wet well) were collected and measured for the usual effluent parameters.

In past years, monitoring of Intake water provided useful insights into apparent increases that could not be explained by internal events, allowing attention to be focused on those issues that can be influenced to improve. Monthly sampling will continue and will include an expansion for parameters being analyzed in 2020. This includes the addition of the following parameters: Dissolved Nitrate, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, Chloroform and Toluene.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, in order to heat the site buildings. Starting in 2013 May, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 10 shows the annual fossil energy consumption since 2014, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 10, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2019 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [27] (to be issued to the CNSC by 2020 June 30).

10. EMERGENCY MANAGEMENT AND FIRE PROTECTION

10.1 Emergency Preparedness Program

Whiteshell Laboratories (WL) adheres to the Corporate Emergency Preparedness (EmP) Program. See Section 10.1 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

As buildings are vacated at WL, the Building Emergency Teams are either dissolved or incorporated into the building to which they have moved. All occupied buildings at WL maintain adequate Building Emergency Teams.

10.1.1 Drills, Training, and Exercises

Two new Emergency Operations Center (EOC) staff members were oriented to the WL EOC and incorporated into the team in 2019. There was no change to the EOC staff structure, only personnel changes.

An aggressive drill and exercise schedule was planned for WL in 2019. However, operational changes were made on 2019 June 14th to comply with the CNSC Security Order (#9336) that resulted in a significant shift in the program's focus for the last half of the year. This resulted in many of the scheduled exercises being postponed or cancelled. In an effort to support the creation of the Tiered Response Force (TRF) at WL, EmP created and delivered multiple courses for the Force. EmP also assisted with field level training drills, and conducted a week of mini scenarios in preparation for the CNSC required force on force exercise, verifying the capability of the new TRF.

In 2019, a total of 218 exercises and drills were delivered at WL. This is a marginal increase over the 184 drills/exercises delivered in 2018.

The evaluations conducted through these exercises and drills generated 70 opportunities for improvement across the site and the EmP program. Table 40 provides details on the number and type of the exercises and drills conducted in 2019.

Table 40: WL Emergency Preparedness Exercises – 2019

Type of Drill or Exercise	Number Completed in 2019
Fire Drills	11
Site-wide Specialty Drills	160
Table Tops[a]	6
Targeted Communication Exercise	17
Site-wide Communication Exercise	12
Field Exercises (Functional)	12

a Table Tops include specific EOC Skill workshops as well. Each workshop focuses on a unique aspect of the EOC and includes a small practice scenario to conclude the workshop.

10.1.2 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains emergency facilities and resources, including the following.

10.1.2.1 Emergency Operation Center (EOC)

As part of WL's EOC framework there are two teams of EOC staff, and a backup team of alternates that can be engaged to cover for members of the two teams. These two teams operate on a two week on-call rotation.

All EOC technical equipment is checked monthly, with repairs, improvements and updates being installed as required and when identified. The system that enables the EOC to see a single camera view in the EOC was upgraded to enable multiple views.

All perishable EOC goods and supplies are checked annually and replaced as required.

There were no emergency events requiring activation of the EOC in 2019.

10.1.2.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories still maintains the Mobile Nuclear Laboratory (MNL) for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the MNL in 2019.

10.1.2.3 Equipment Checks

Respirators make up the majority of the equipment in the emergency cabinets. Due to the ongoing decommissioning activities, the number of respirators required in each location was assessed by EmP and RP staff in 2019. As a result, some inventories were reduced to reflect the new realities of the site, others were removed completely. The emergency-related equipment in most facilities is stored in strategically placed emergency cabinets. These cabinets are opened and inspected monthly. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2019.

There were no emergency events requiring the use of this equipment in 2019.

10.1.2.4 Public Address System

The Public Address (PA) system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2019.

10.1.2.5 Secondary Emergency Signals

The WL site still employs an exterior siren as a redundant form of emergency alerting. The system is no longer required and was replaced by the PA system as the primary alerting system. This system will continue to be used as a redundant alerting system until either the equipment fails completely (there have previously been some issues with the equipment) or the building it is mounted to is decommissioned and demolished.

10.1.2.6 EOC Notification System

2019 was the first full calendar year that WL used the Everbridge Mass Notification system. There was a 100% response rate to all monthly communication tests (see Table 41) in 2019. This demonstrates the effectiveness of the notification system. The system has increased the effectiveness of the notification process while simultaneously reducing the burden of activation on the operator.

Table 41: WL Emergency Operations Center Communication Tests: 2019

	January	February	March	April	May	June	July	August	September	October	November	December
EOC Commander	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liaison Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Env. Protection Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safety Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Planning Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Logistics Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Operations Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nuclear Facilities Representative	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Y= Yes
N= No

In addition to these regularly scheduled monthly drills, a random quarterly drill is conducted. These drills are scheduled for random times and dates, including weekends, evenings and work hours. These random drills include the expanded EOC team and all the alternates. Table 42 identifies the response rates of the 2019 WL EOC Staff to the Quarterly Random EOC call out drills.

Table 42: WL Emergency Operations Center Random Quarterly Communication Tests: 2019

	Q1	Q2[a]	Q3	Q4[b]
# of Participants	32	16	33	30
# who Responded	32	16	32	30
Response Percentage	100%	100%	97%	100%

a Only the Core EOC team was used for this test, which is the reason for the lower numbers.
b The Q4 drill was delivered early in Q1 of 2020, but is being counted as part of 2019. A second drill will be run in Q1 of 2020 that will be counted as part of the 2020 exercises.

10.1.3 External Collaborations

Contact is maintained with a variety of other emergency response/management organizations and interested public groups.

10.1.3.1 Local Agencies

A joint exercise was conducted with the Regional Health Authority, Emergency Medical Services in 2019. WL continues to maintain a working relationship with the Local Government District (LGD) of Pinawa. Scheduling conflicts prevented a joint exercise between the WL site and the Pinawa Fire Department in 2019, but another exercise will be scheduled in 2020.

10.1.3.2 Federal Interactions

The EmP Program Manager continues to maintain membership with the Manitoba Section of the Federal Coordination Working Group. The Federal Coordination Working group helps WL maintain ties with representatives from multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police (RCMP), Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada, in order to bolster organizational resilience. The relationship with the RCMP continues to be heavily invested in, with several joint training exercises being delivered in 2019. WL continues to offer up decommissioned buildings to the RCMP for training prior to demolition. This ongoing training continues to increase their knowledge and comfort with the WL site and site operations. The various teams have also participated in joint exercises with WL staff, enhancing realism for staff and providing opportunities to practice integration.

10.1.4 Unplanned Emergency Events

No incidents requiring initiation of the WL Site Emergency Plan occurred during 2019.

10.2 Fire Protection Program

Whiteshell Laboratories (WL) adheres to the Corporate Fire Protection Program. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In 2018, the Fire Protection Program completed a gap analysis and implementation plan to enable the transition to CSA standard N393 *Fire Protection for Facilities that Process Handle, or Store Nuclear Substances* [40]. The following improvements were implemented in 2019:

- Fire Response Needs Analysis was completed.

There were no reportable fire events at WL in 2019.

10.2.1 Fire Response Drills

Fire drills are conducted annually in accordance with NFPA 801 [41], the National Fire Code of Canada [42] and CSA standard N393-13 *Fire Protection for Facilities that Process Handle, or Store Nuclear Substances* [40].

All fire response drills for the facilities at the Whiteshell site were completed in 2019.

10.2.2 External Collaborations

Whiteshell Laboratories and the Town of Pinawa signed a Fire Protection Service Agreement to improve Mutual Aid support capabilities.

Firefighters engage in training programs to improve response operations throughout the year. Significant aspects of response-based training included the following:

- 32 personnel are qualified to awareness training in confined space rescue.
- 16 personnel are qualified in NFPA 1006 rope rescue operations.
- 21 personnel are qualified to emergency medical responder level.
- 14 personnel are qualified to NFPA 472 Hazmat operations level.

10.2.3 Third Party Audits & Inspections

A third party Fire Protection Audit was conducted in 2018 February. The next audit, as per the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [40], is scheduled for 2021.

10.2.4 Fire Hazard Analysis

All fire hazard analysis documentation for buildings requiring a fire hazard analysis have been reviewed and are being evaluated against the decommissioning schedule. Any Fire Hazard Analysis documentation requiring revisions will be updated in 2020.

11. WASTE MANAGEMENT

11.1 Waste Management Program

Whiteshell Laboratories (WL) adheres to the Corporate Waste Management Program. See Section 11.1 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program include:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL Programs to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Closure Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for three of the waste receiving facilities on-site (including the Waste Clearance Facility, Waste Handling Area and the WMA storage facilities) remained unchanged for 2019. It should be noted the Waste Clearance Facility was taken out of service late 2019 to support its demolition in 2020. It was determined by management no replacement facility was required as materials can be radiological released in-situ.

11.1.1 Waste Management Operations

Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for interim storage.

Demolition of the Large Scale Vented Combustion Test Facility (LSCVTF) consisting of Buildings 308, 309, 310 and 311 (B308, B309, B310 and B311) located in the outer area of the WL site was decommissioned. A total of 962 m^3 clearable waste was generated from the demolition; 702 m^3, consisting of metal and concrete, was recycled while 260 m^3, consisting of asphalt shingles and asbestos-containing tiles, was dispositioned to an off-site waste receiver.

Building 414, used as the controlled access/exit point to and from the Controlled Area 2 on the north end of the site was demolished. A total of 2.2 m^3 of clearable was generated; 0.1 m^3 of metal was sent to an off-site metal recycler while 2.1 m^3 of waste was dispositioned to an off-site waste receiver.

Stage 6 of B300 Research and Development Complex, also known as RD-14M, was demolished. A total of 780 m^3 of clearable was generated; 310 m^3 of construction and demolition debris was dispositioned to an off-site waste receiver, 270 m^3 of metal was sent to an off-site metal recycler and 200 m^3 of concrete was processed (rubblized and separated of rebar) for re-use by the WL site.

The Soil Storage Compound (SSC) was de-inventoried in 2019. The contaminated material, consisting of soil and gravel, was packaged at the WMA in certified transportation packages. A total of 201 m^3 of low-level waste (LLW) was generated and dispositioned to CRL.

Decommissioning of Building 200 Active Liquid Waste Treatment Centre continues, generating 186.8 m^3 of LLW in 2019, which is packaged in certified transportation packages and staged at the WMA. Disposition of waste to CRL is scheduled for 2020.

Operational clean-out of the Low-Level Bunker 6 was completed in 2019, which produced 406 m^3 of LLW. Drummed soil, palletized concrete, compacted bales and other miscellaneous waste items were safely packaged in certified transportation packages in the WMA and are staged in the Waste Transshipment Area. Disposition to CRL will be in 2020.

De-inventorying efforts of legacy waste stored in SMAGS continued in 2019. A total of 834 m^3 of LLW and 28 m^3 of intermediate-level[12] waste (ILW) was transported to CRL. Thirty-one bins remain, undergoing additional qualification and inspection of waste contents to ensure transportation and waste criteria compliance are met, and will be shipped to CRL in 2020.

Table 43 summarizes the quantities of radioactive waste generated in 2019 that was sent to each storage location. Table 44 summarizes the volumes of solid low-level radioactive waste originating from each facility in 2019. Table 45 summarizes the volumes of solid intermediate-level radioactive waste originating from facility in 2019. Table 46 summarizes the volumes of solid low-level and intermediate-level radioactive waste transported to Chalk River Laboratories for disposition.

Table 43: Radioactive Waste by Storage Location

Storage Facility	Volume (m^3)	
	2018	2019
Low-Level Quonsets (B431, B432, B433)	21.9	59.6
Intermediate-Level Waste Bunkers	0.0	0
SMAGS[a]	35.0	46.0
Soil Storage Compound	0.0	0.0

a Shield Modular Above Ground Storage

[12] In this context, ILW refers to any waste that does not meet the proposed Near Surface Disposal Facility (NSDF) Waste Acceptance Criteria (WAC) and requires storage in ILW facilities at CRL.

Table 44: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2018		2019	
	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)
Building 100	4.5	0.0	4.8	0.0
Building 200	35.9	77.9	19.1	167.7
Building 300	2.6	0.5	0.0	0.4
Building 303	0.0	0.0	0.0	0.0
Building 304	0.0	0.0	0.0	0.0
Building 309 (LSVCTF) [a]	0.0	0.0	0.0	0.2
Building 402	0.5	0.5	0.7	0.0
Building 411 [a]	7.4	0.2	0.2	0.0
Building 421	0.7	2.5	0.2	0.0
Building 511	0.0	0.0	0.0	0.0
Building 514 [a]	3.5	114.0	0.0	0.0
Concrete Canister Storage Facility	0.0	0.0	0.0	0.0
Shielded Facilities (HCF & IFTF) [b]	64.3	9.0	101.4	0.0
Waste Handling Area	18.2	0.0	0.0	0.0
Waste Management Area	25.6	0.0	6.9	0.0
LLW Bunker 6	0.4	0.0	13.6	406
Affected Lands	2.5	1.0	0.1	1.7
Soil Storage Compound [c]	0.0	0.0	0.0	201.0
Total	**166.1 (25.0)**[13]	**205.6**	**162.0 (15.0)** [14]	**766.8**
Total after Compaction	**230.6**		**781.8**	

a Building demolished.
b Operational compactable waste volumes were generated as a result of the refurbishment of the hot cell manipulators.
c The soil storage compound was de-inventoried in 2019.

Table 45: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m^3)	
	2018	2019
Affected Lands	0.72	0.0
Building 200	0.96	0.0
Total	1.68	0.0

13 This volume of compactable waste was reduced to 25.0 m^3. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

14 This volume of compactable waste was reduced to 15.0 m^3. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

Table 46: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2018		2019	
	LLW Volume (m^3)	ILW Volume (m^3)	LLW Volume (m^3)	ILW Volume (m^3)
Building 411	84.0	0.0	168.0	0.0
Building 514	0.0	0.0	252.0	0.0
WMA (Cesium Pond Soil)	826.0	0.0	28.0	0.0
WMA (Legacy Sources)	0.0	3.1	0.0	0.0
Soil Storage Compound	0.0	0.0	201.0	0.0
SMAGS[a]	344.0	0.0	834.0	28.0
Total	1,254.0	3.1	1,483.0	28.0

a Shield Modular Above Ground Storage – legacy waste generated from various decommissioning projects

Likely clean waste from Controlled Areas was monitored in-situ or at the Waste Clearance Facility (WCF). Clean bagged waste was monitored using the bag monitor located in the IFTF facility where WL's laundry facility is now stationed; all bagged waste met the unconditional clearance criteria and was deemed to be clean and suitable for unrestricted release in 2019.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable; this includes both recyclable material sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

Table 47 summarizes the disposition pathway of non-active waste.

Table 48 summarizes the amount, by material type, of recyclable waste shipped off-site.

Table 47: Non-Active Waste Disposition Pathways

Disposition Location	Volume (m^3)	
	2018	2019
WL Asbestos Disposal Site	0	0
WL Burn Pit	84 [a]	0
WL Inactive Landfill	367	543
Recycling [b] Sent Off-Site	262	410
Off-Site Landfill [c]	0	777
Total	**713**	**1,730**

a Increased volume of vegetation sent to the Burn Pit due to the expansion of the Protected Area in the WMA.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted a municipal recycling facilities

c WL's Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

Table 48: Recycled Waste Shipped Off-Site

Material[a]	Weight (kg)	
	2018	**2019**
Aluminum	0	0
Batteries Shipped	196	1,708
Batteries Recycled	533	882
Cardboard [b]	544	0
Copper and Brass	0	0
E-Waste Shipped	876	0
E-Waste Sold	0	0
Ferrous Metals	269,788	798,574
Glass	0	0
Lumber	0	0
Plastic Shipped	0	0
Plastic Sold	0	0
Stainless Steel	0	0
Lead	857	3006
Total	**272,261**	**804,170**

a This recycling waste pertains to material that is sold or charged to be taken to a material specific recycling facility.
b Cardboard is sent to a municipal recycling facility and inclusive in Table 47.

Improvements were made in preventing waste accumulation inside of buildings and transferring the waste to appropriate waste facilities immediately after generation. Improvements continue to be addressed in reference to the lack of processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes radioactive wastes generated from decommissioning activities. Mitigation measures that will be put in place in 2020 include developing an Independent Safety Assessment (ISA) for the interim storage of cargo containers containing radioactive wastes in the WMA while transportation documentation and acceptance from off-site waste receivers are pending.

Following each inspection, the findings were communicated to the identified waste owners for remedial or corrective actions.

11.1.1.1 Liquid Waste Generation

During 2019, 186.5 m^3 of low-level liquid was processed in the B300 LLLWTS and 2.8 m^3 in the B100 LLLWTS, for a total of 189.1 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Several buildings and structures were decommissioned in 2019, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition.

The Stage 6 of B300 Research and Development Complex, also known as RD-14M, structure and services were completely removed within 1 m of the building footprint, excluding the radiologically cleared concrete foundation and footings below 1.5 m below grade. Final clearance of soils beneath the building and remaining building foundation was completed before the excavated area was backfilled and restored to match the surrounding grade.

The Large-Scale Vented Combustion Test Facility (LSVCTF), consisting of four buildings in the outer area of the WL site and surrounding security control fence, was completed removed within 1 m of the building footprints. The site was backfilled and landscaped to grade.

The B414 Controlled Area 2 Entrance was demolished to grade. The concrete pad and subsequent clearance of soils will be performed at a later date in conjunction with affected lands work.

B200 decommissioning activities involved the continued removal of process systems and equipment to reduce source term hazards. The focus of work involved radiological and waste characterization of tanks, application of fixatives to prepare tanks for future size reduction, and removal and packaging of processing piping, gloveboxes and sample stations.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

Table 49 lists the WL Detailed Decommissioning Plans (DDPs) and their status as of 2019.

Table 49: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
Whiteshell Laboratories	The Whiteshell Laboratories Detailed Decommissioning Plan: Volume 1 - Program Overview	WLDP-02000-DDP-001 (RC-2143-1, Rev. 4), January 2002	To be Cancelled and Superseded by WLDP-02000-DDP-001, Rev.0.
	The Whiteshell Laboratories Detailed Decommissioning Plan: Volume 1 - Program Overview	WLDP-02000-DDP-001, Revision 0, 2019	Current version of DDP Volume 1 submitted to CNSC for acceptance.
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned.
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility is being decommissioned. DDP Volume is available for use.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach) WLDP-26400-DDP-001, Revision 4, 2017 (In Situ Decommissioning Approach)	Facility has been shut down and currently under M&S. Complete Dismantlement and Removal approach has been approved by the CNSC. EA process for ISD is in progress, Revision 4 to be revised with final EA submission. DDP Volume (Revision 3) is available for use.
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC for information and comments received (to be dispositioned).

Facility	DDP Document Title	Document #	Status
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001, Revision 0, 2016	Facility is operational DDP under development.
	Volume 8 - WMA Part 2: Intermediate Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001, Revision 1, 2017	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 4, 2019	Facility is operational. DDP was sent to the CNSC for acceptance and comments received (to be dispositioned)
Research and Development Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use.
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001	Facility has been shut down and currently under M&S. DDP under development.
DDP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use. Note: This DDP is “Part 2” of Volume 12.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer Area Buildings and Facilities	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

12. SECURITY

12.1 Security Program

Whiteshell Laboratories (WL) adheres to the Corporate Security Program. See Section 12 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The *Whiteshell Site Security Report* [43] outlines the security arrangements that are in place at the WL site. The Security program consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Program and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in the Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness document [44].

A CNSC Type II Compliance Inspection was conducted 2019 August 26-28, resulting in one Directive. A response letter, addressing the Directive, is due to the CNSC by 2020 February 19.

CNL-WL has one open enforcement item (Order). An implementation plan to address the Order has been submitted and accepted by the CNSC. All actions identified in the implementation plan are to be completed by 2020 May 01, the main action being the standing up of a Tiered Response Force (TRF).

The CNSC 2019 biennial security exercise was successfully conducted on 2019 November 28, which included testing the capabilities of the first groups of TRF trainees. The exercise report is being completed and is due to the CNSC by 2020 February 14. Any improvements or actions identified in the exercise report will be tracked via the corrective action program.

12.1.1 Security Events

In 2019, there was one low safety-significant security event at WL, reported to CNSC (see Section 3.2.1).

13. SAFEGUARDS AND NON-PROLIFERATION

13.1 Safeguards Program

Whiteshell Laboratories (WL) adheres to the Corporate Nuclear Materials and Safeguards Management (NM&SM) Program. See Section 13 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

13.1.1 IAEA Activities

A Design Information Verification inspection was carried out by the IAEA on 2019 September 06.

The activities associated with the Design Information Verification included:

- Verification of the DIQ;
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

The IAEA requested that the DIQ be updated to reflect the changes to the WMA fence line and new buildings.

A discussion of IAEA inspections conducted at WL can be found in Section 1.2.2.2. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2.2, Management System of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4].

14. PACKAGING AND TRANSPORT

14.1 Packaging and Transport Program

Whiteshell Laboratories (WL) adheres to the Corporate Transportation of Dangerous Goods Program, which includes the requirements of the Packaging and Transport SCA. See Section 14 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances and radiation devices. The TDG Program applies to any activities involving the transportation of dangerous goods to or from CNL sites. The TDG Program provides an operational framework for the safe off-site transport of dangerous goods by conforming to all applicable laws and regulations, as well as company policies and procedures.

The Waste Certification & Transportation branch is a centralized organizational department responsible for planning, coordinating and executing radioactive waste shipments from the WL site to the off-site disposal or storage facilities in a safe and compliant manner, including having fully trained Radioactive Material (RAM) Shippers as authorized under the CNL TDG Program.

Significant activities in 2019 included:

- Transportation of 1,483 m^3 of low-level waste and 28 m^3 intermediate-level waste sent off-site and safely delivered to CRL;
- Throughout 2019, additional technical assessments and studies on the WL used fuel inventory were completed in support of the licensing application of the Used Fuel Transportation Package (UFTP). The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations starting in 2020. There is a two-step licensing strategy for the UFTP, with the first phase focusing on licensing the UFTP for non-enriched CANDU fuels and the second phase focusing on WL's inventory of enriched and experimental fuels, including Uranium Carbide and Uranium Metal fuel types. The phase one UFTP Safety Analysis Report (SAR) Addendum was submitted to the CNSC in 2019 May. The UFTP SAR for Mixed Fuel Types (representing phase two) is under development, with an expected submission to the CNSC in 2020.

14.1.1 Shipments

At WL, 382 radioactive transport packages making up 63 loads were safely and successfully sent off-site in 2019. Whiteshell Laboratories complied with the Packaging and Transport of Nuclear Substances Regulations [45] and IAEA Safe Transport of Radioactive Material [46].

15. OTHER MATTERS OF REGULATORY INTEREST

15.1 Public Information and Disclosure Program

Whiteshell Laboratories (WL) adheres to the Corporate Public Information Program. See Section 15 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Public Information Program document [47] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document Public Information and Disclosure [48].

15.1.1 Outreach and Stakeholder Engagement

WL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events. Employees are CNL's greatest ambassadors and they are kept informed of developments so that they can also share information with their relatives, friends, and neighbours. The Whiteshell Laboratories site engages with the public at a number of activities. For 2019, these activities are listed in Table 50.

Table 50: Whiteshell Laboratories Engagement Activities in 2019

Date	Activity
January 3	Springwell School Tour
February 5	North Forge East funding announcement
March 3	WR-1 website updated
April 3	Filming of "Still Standing" on the Whiteshell Site
April 11	Site tour and meeting with Red River College
Spring	*CONTACT* newsletter distributed to approximately 8,000 homes
May 21	Public Liaison Committee meeting
May 24	Lac du Bonnet Trade Fair
May 31	SunRise School Division School Board tour and meeting
June 8	Whiteshell Laboratories Open House
June 18	Public tour
July 16	WR-1 Update to the LGD of Pinawa
August 6	Public Tour
September 16	Public Tour
November 6	Take Your Kids to Work day including tour of WR-1
November 12	WR-1 Breakfast Session: Reactor Characterization
November 14	Public Liaison Committee meeting
December	*CONTACT* newsletter distributed to approximately 8,000 homes

15.1.2 Public Consultation

WL actively works to engage local stakeholders on matters related to CNL activities. In 2019 a number of methods were deployed to gain feedback from and create discussion with interested parties including: feedback forms being made available online and at external events, technical meetings and focus groups being held and responses to inquiries being answered. WL strives to create open and transparent communication with all identified stakeholders.

Throughout 2019 CNL received 49 community inquiries related to WL. CNL works to address and respond to all inquiries.

Table 51: Whiteshell Laboratories Closure Project Public Inquiries

Nature of Enquiry	Number
In situ decommissioning of WR-1	33
Media	3
General Information and Tours	8
Asset Donation	5

15.1.3 Traditional and Online Communications

See Section 15 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

15.1.3.1 Website

See Section 15 of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

CNL's Whiteshell Decommissioning web page had 2,891 page views in 2019.

15.1.3.2 Newsletters

CONTACT is an external newsletter distributed to community stakeholders and to residences and businesses in communities surrounding WL, and is available on www.cnl.ca. This publication informs the reader on activities undertaken at CNL's Whiteshell Laboratories and profiles CNL's community activities. Approximately 8,000 homes in the region receive this bilingual newsletter. A spring and winter edition of *CONTACT* was issued in 2019. Since November 2017, four newsletters have been released with topics including the following:

- WL Closure Project and WR-1 Updates
- Highlights of public and Indigenous engagement activities
- Community initiatives demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- Employee Profiles
- Environmental Stewardship including steps to reduce greenhouse gas emissions, wildlife protection and waste minimization

15.1.3.3 Media Releases

There is regular local and provincial media coverage regarding CNL's Whiteshell Laboratories and included 20 articles during the 2019 calendar year. See Table 52.

Table 52: Whiteshell Laboratories Closure Project Media Coverage for 2019

Date	Article	Title of Publication
January 3	Modular Reactor momentum building	The Clipper
January 9	CNL employees support local communities	The Clipper
February 20	North Forge East receives funding	The Clipper
March 14	SNC-Lavalin controversy reaches into Manitoba	Winnipeg Free Press
May 21	A Magical Machine	Discover Magazine
August 22	CNL to renew decommissioning licence	The Clipper
August 23	CNL applies to renew Whiteshell Laboratories Decommissioning Licence	Winnipeg River Advocate
September 26	Ceremony for CNL decommissioning	The Clipper
October 3	Modular Reactor momentum building	The Clipper
October 4	Indigenous knowledge keepers host ceremony at Pinawa Nuclear site	Winnipeg River Advocate
October 9	National Commission holds hearing for CNL renewal	The Clipper
October 9	CNL employees support local communities	The Clipper
November 7	CNL Breakfast Session to discuss decommissioning	The Clipper
November 9	Pinawa’s toxic predicament hurts Lake Winnipeg	Winnipeg Free Press
November 19	Nuclear Power vs Fossil Fuels	Winnipeg Free Press
December 4	Pallister Unaware of Nuclear Energy Pact	Winnipeg Free Press
December 6	Nuclear Option	Winnipeg Free Press
December 20	Small Nuclear Reactors no solution to Climate Change	Winnipeg Free Press
December 20	On Site Disposal of Nuclear Reactors is not acceptable	Sierra Club Foundation website
December 24	CN Nuclear Option	Winnipeg Free Press

15.1.4 Whiteshell Public Liaison Committee

Completing its sixteenth consecutive year of operation, the independently facilitated Whiteshell Public Liaison Committee continued to meet in 2019. Meeting minutes are recorded and actions are tracked and filed for reference. Over the year, two meetings were held: May 21 and November 14. Both meetings were held onsite, with a tour of the site provided to interested attendees after the May 21 meeting. Below are some highlights of the presentations from the meetings held in 2019:

- WL Closure Project Progress Update and Look Ahead,
- End State process and engagement
- WR-1 Environmental Assessment Update,
- WL Site Licence Update,
- Update from the Community Regeneration Partnership Committee.

The committee is comprised of community and stakeholder representatives (as given below), consisting of elected officials and community interest groups. Its mandate is to provide an opportunity for open dialogue between community stakeholders and WL senior management on WL's various environmental and decommissioning projects.

The Whiteshell Public Liaison Committee is represented by:

- Local Government District Pinawa,
- Rural Municipality (RM) of Lac du Bonnet,
- Town of Lac du Bonnet,
- Town of Powerview Pine Falls,
- Town of Beausejour,
- RM of Brokenhead,
- RM of Whitemouth,
- RM of Alexander, and
- Manitoba Sustainable Development.

15.1.5 Ongoing Projects

15.1.5.1 WR-1 In Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning (also referred to as in situ disposal) Environmental Assessment (EA) is a key project identified by CNL as part of the overall integrated approach to safely manage and reduce Canada's legacy liabilities. It is a requirement in support of the EA process that the WR 1 project information be made available to CNL neighbouring communities and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Engagement activities were conducted in support of this requirement through a variety of methods including social media and website content, WR-1 in situ decommissioning Presentations, Meetings, Site Tours and Information Sharing with Stakeholders.

Project specific webpages and content were produced for the WR-1 In Situ Disposal Project. Content included: fact sheets, info graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages. See www.cnl.ca/wr-1.

15.2 Indigenous Engagement

WL's Public Information Program, which seeks to build awareness and understanding for the work that CNL carries out on behalf of Canadians, is an established platform to sustain open and honest communications. CNL also follows CNSC RegDoc-3.2.2 Public and Indigenous Engagement: Indigenous Engagement which sets out requirements and guidance for licensees on Indigenous engagement. CNL recognizes and values the ongoing engagement with Indigenous communities. Through its engagement activities, CNL seeks to inform Indigenous groups of ongoing activities at the WL site and the possible effects of these activities to members of communities and the environment, and to seek feedback from the communities regarding traditional and current uses in the vicinity of the WL site.

Through its engagement activities, WL has been able to solicit and respond to First Nations and Métis community input. First Nations and Métis communities have sought more information and engagement on jobs, contracting opportunities, and environmental protection. CNL has supported the completion of traditional knowledge and land use studies for Indigenous communities in order to further learn what is important to local communities in terms of land use and value components and how CNL may impact that. CNL has been working with local First Nations and Métis communities to provide reasonable capacity, and at the same time has engaged communities with opportunities to better understand concerns and build positive relationships. Table 52 lists the engagement activities from 2019. Further details on Indigenous Engagements are available through the Indigenous Engagement Report.

Table 53: First Nations and Métis Engagement Activities in 2019

Date	Event / Activity	Attendance / Correspondence
January 08	Preparatory meeting for Sagkeeng First Nation Alternative Means Workshop	• 1 representative of Sagkeeng First Nation • 2 representatives of CNL
January 10	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
January 18	Preparatory meeting for Sagkeeng First Nation Alternative Means Workshop	• 1 representative of Sagkeeng First Nation • 2 representatives of CNL
February 06	South East Regional Development Council (SERDC) visit to the Whiteshell Site	• 2 Representatives of SERDC • 2 Representatives of CNL
February 13 -15	Sagkeeng First Nation Alternative Means Workshop	• 7 Sagkeeng community members • 5 CNL • 3 AECL • 4 CNSC
February 15	Meeting and site tour with Black River First Nation Councillor	• 1 Representative of Black River First Nation • 1 Representative of CNL
February 26	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
March 03	Trip with Black River First Nation to Waste Management Symposia	• 1 Representative of Black River First Nation
March 14	Meeting in Winnipeg with Manitoba Metis Federation of Traditional Knowledge and Land Use Occupancy study actions	• 4 representative of Manitoba Metis Federation • 4 representatives of CNL • CNSC on the phone
March 18	Sagkeeng First Nation Turtle Lodge Ceremony	• 7 Sagkeeng community members • 2 CNL • 2 AECL • 2 CNSC
April 26	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
May 14 - 16	Vision Quest Conference and Trade Show	• 1 Representative from CNL • 1 Representative from North Forge East

Date	Event / Activity	Attendance / Correspondence
May 28	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
June 03	Traditional knowledge study WL site tour	• 22 representative of Black River, Brokenhead, Hollow Water First Nations • 3 representatives of CNL • 3 representative of HTFC Planning & Design
June 04	Traditional knowledge study workshop	• 22 representative of Black River, Brokenhead, Hollow Water First Nations • 3 representatives of CNL • 3 representative of HTFC • 2 representatives of CNSC
June 08	WL site public open house and tour	• ~300 registrants
July 04	Meeting to discuss Traditional Ceremony on WL site and tour	• 3 representatives from Turtle Lodge • 2 representatives from CNL • 1 representative from AECL
July 31	Manitoba Metis Federation (MMF) Meeting with Procurement re Opportunities	• 2 representatives from MMF • 2 representatives from CNL
August 01	Manitoba Metis Federation Observation of CNL's Environmental Monitoring Program	• 1 representative of Manitoba Metis Federation • 3 representatives from CNL
August 15	Manitoba Metis Federation Observation of CNL's Environmental Monitoring Program	• 1 representative of Manitoba Metis Federation • 3 representatives from CNL
September 10	Update meeting with Sagkeeng First Nation and CNSC	• 1 representative from Sagkeeng (OKT Law firm) • 1 representative from CNL • Up to 6 representatives from CNSC
September 13	Traditional Indigenous Ceremony with Sagkeeng First Nation and Turtle Lodge	• 7 representatives from Sagkeeng • 10 representatives from Turtle Lodge • 2 representatives from Hollow Water • 2 representatives from CNSC • 2 representatives from AECL • 3 representatives from CNL plus staff
September 18	Community Meeting with Sagkeeng First Nation	• 7 representatives from Sagkeeng • 6 representatives from CNSC • 4 representatives from CNL
September 20 - 22	Manitoba Metis Federation Annual General Assembly	• 4 representatives from CNL

Date	Event / Activity	Attendance / Correspondence
September 25	Update on Traditional Knowledge Study with Black River, Brokenhead and Hollow Water	• 1 representative from Black River • 2 representatives from Brokenhead • 1 representative from Hollow Water • 2 representatives from HTFC Planning & Design • 1 representative from CNSC • 1 representative from CNL
September 26	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
October 04	Manitoba Metis Federation Observation of CNL's Environmental Monitoring Program and check-in on MMF satisfaction with the process	• 1 representative of Manitoba Metis Federation • 5 representatives from CNL
October 10	Manitoba Metis Federation Observation of CNL's Environmental Monitoring Program	• 1 representative of Manitoba Metis Federation • 3 representatives from CNL
October 22	Manitoba Metis Federation Celebration of the 175th anniversary of Louis Riel's birthday	• 3 representatives from CNL for the dinner
November 01	Manitoba Metis Federation meeting with AECL and CNL re post site closure Environmental Monitoring	• 3 representatives from MMF • 2 representatives from AECL • 2 representatives from CNL
November 25	Regular Update meeting with Sagkeeng and CNSC	• 2 representatives from Sagkeeng • 7 representatives from CNSC • 2 representatives from CNL
November 26	Recurring monthly meeting with Manitoba Metis Federation, CNL, CNSC	• 3 representative of Manitoba Metis Federation • 3 representatives of CNL • 3 representatives of CNSC
December 03	Meeting with MMF re topics arising from monthly meeting actions as well as Intervention	• 5 representatives from MMF • 4 representatives from CNL
December 05	Meeting with Black River, Brokenhead and Hollow Water regarding roll-out of Traditional Knowledge Study	• 21 representatives from Black River and Brokenhead • 2 representatives from HTFC • 3 representatives from CNSC • 3 representatives from CNL • 2 representatives from AECL
December 11	Long-term relationship workshop with Sagkeeng Anicinabe	• 8 representatives from Sagkeeng First Nation • 6 representatives from CNL

16. ACRONYMS

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable (economic and social factors being taken into account)
ALWTC	Active Liquid Waste Treatment Center
ATG	Analytical Test Group
CAP	Corrective Action Plan
CBOD	Carbonaceous Biochemical Oxygen Demand
CCSF	Concrete Canister Storage Facility
CED	Committed Effective Dose
CFC	Chlorofluorocarbons
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSD	Criticality Safety Document
DCP	Dose Control Point
DDP	Detailed Decommissioning Plan
DIQ	Design Information Questionnaire
DL	Detection Limit
DRL	Derived Release Limits
EA	Environmental Assessment
EmP	Emergency Preparedness
EnvP	Environmental Protection
EOC	Emergency Operations Center
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCF	Hot Cell Facility
HCFC	Hydrochlorofluorocarbons
HEPA	High Efficiency Particulate Air (Filter)
HU	Human Performance

IAEA	International Atomic Energy Alliance
IFTF	Immobilized Fuel Test Facility
ILLW	Intermediate – Level Liquid Waste
ILW	Intermediate – Level Waste
ImpAct	Improvement Actions
LGD	Local Government District
LLD	Lower Level of Detection
LLW	Low – Level Waste
LLLW	Low – Level Liquid Waste
LLLWTS	Low – Level Liquid Waste Treatment Center
LMDL	Laboratory Method Detection Limit
LSVCTF	Large Scale Vented Combustion Test Facility
MPNU	Most Probable Number of Units
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
NPRI	National Pollutant Release Inventory
OSH	Occupational Safety and Health
PAD	Personal Alarming Dosimeters
PIP	Periodic Inspection Plan
PM	Particulate Matter
R&D	Research and Development
RAM	Radioactive Material
RCMP	Royal Canadian Mounted Police
RM	Rural Municipality
RMDL	Regulatory Method Detection Limit
RP	Radiation Protection
RSTD	Relative Standard Deviation
SAR	Safety Analysis Report
SCA	Safety Control Area
SF	Shielded Facilities
SMAGS	Shielded Modular Above Ground Storage

SRI	Smallest Reporting Increment
TDG	Transportation of Dangerous Goods
TLD	Thermoluminescent Dosimeters
TSS	Total Suspended Solids
UFTP	Used Fuel Transportation Package
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactore 1

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APPENDIX A CONCRETE CANISTER STORAGE FACILITY

A.1 FACILITY OPERATION

The Concrete Canister Storage Facility (CCSF) is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [49]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2019, staff of the Site and Nuclear Operations Branch monitored the operation of the CCSF.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2019.

Routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

A.1.1 RADIATION EXPOSURE

Waste Management Area facility staff from the Site and Nuclear Operations Branch operated the CCSF. Radiation exposures received by the staff are listed under the Waste Management Area (see Section D), since measured doses are attributed to waste management operations in that facility.

Staff operating the CCSF participated in routine bioassay testing which involved a semi-annual or annual whole-body count and/or gross beta of urine samples every 60 days. There was no indication of any internal radiation exposures to facility personnel.

There were no doses exceeding CNL's Action Levels or CNSC regulatory limits to personnel as a result of operating the CCSF during 2019.

A.1.2 COMPLIANCE MONITORING

A.1.2.1.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in October.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters.

There was no visible moisture detected from the internal canister space during 2019 monitoring, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.1.2.1.2 Monitoring of Ground and Surface Water

Figure 11 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, compliance results for the CCSF are described below.

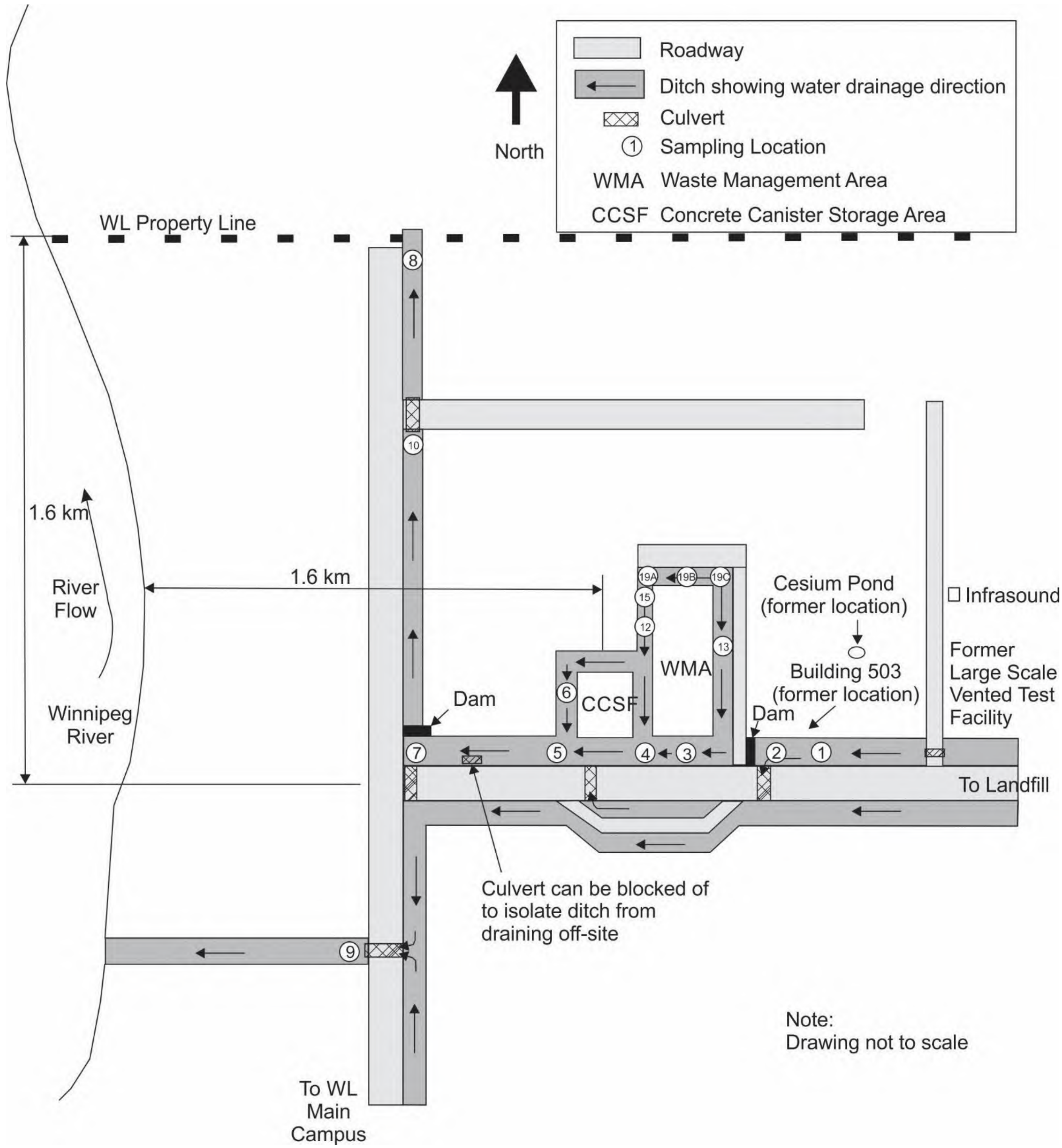

Figure 11: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Section D.1.5.1.3 of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Sr-90. Gamma spectrometry analysis provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147 and Am-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [32]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Note that in some occasions locations were sampled on a two day period due to rain conditions on those periods. Ditch Location 5 and Ditch Location 6 samples (see Figure 11 for sampling locations) could contain surface drainage from the CCSF. The gross beta level in Ditch Location 5 and Ditch Location 6 did not reach the trigger level (10 Bq/L) for gamma spectrometry and strontium analysis this year. The highest value noted (2.22 Bq/L) was in Ditch 5 on October 22. Half of this activity would be attributable to Sr-90 (assuming secular equilibrium with Y-90) at the applicable Maximum Acceptable Concentration of 5.0 Bq/L, and the remaining activity is below the Maximum Acceptable Concentration for Y-90 (30 Bq/L).

The alpha activities were below the trigger level of 0.5 Bq/L, except for three samples; on May 02 Ditch Location 5 and Ditch Location 6, and on October 22 and 24 combined sample date one sample from Ditch Location 19B, reached the gross alpha trigger level for gamma spectrometry and uranium analysis. Location 5 had a value of 26 ppb uranium, Location 6 had a value of 22 ppb on May 02 and Location 19B had a value of 16 ppb on the September 30-October 01 combined sampling date. Location 5 had a value of 26 ppb uranium, Location 6 had a value of 22 ppb on May 02 and Location 4 had a value of 18 ppb on the October 22 and 24 combined sampling date.

Ditch samples collected immediately downstream from the WMA (Locations 5, 6 and 7) contained elevated levels of tritium[15] (see Table 53). None of these samples exceeded the associated Maximum Acceptable Concentration of 7,000 Bq/L [32]. The activity seen is likely from the WMA as discussed in Section D.1.5.1.1.

There is no evidence to indicate that any activity has been released to the ground or surface water as a result of operations within the CCSF in 2019.

Table 54, Table 55, Table 56 and Table 57 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2019. Operational control-monitoring data from previous years has been included for completeness.

[15] Tritium analysis of samples from Ditch Locations 5 and 6 was previously discontinued due to the higher levels of tritium (~ 4000 Bq/L) noted at upstream locations associated with the WMA.

Table 54: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Total Beta [a]Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	0.13	0.05	0.20	0.21	0.19	0.18	0.13
2	IF	0.26	0.20	0.44	0.23	0.26	0.21	0.10
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	2.22
5	0.35	1.09	0.67	IF	0.80	0.54	IF	IF
6	IF	0.64	0.85	IF	0.51	0.32	IF	IF
7	0.78	1.08	1.34	0.97	1.24	0.69	1.11	0.87
19 A	IF	IF	IF	IF	IF	0.44	IF	IF
19 B	IF	IF	IF	IF	IF	0.43	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.23	0.21	0.14	IF	0.17	0.09	0.19	0.07

IF insufficient flow, water was stagnant in the ditch

Historical Beta Data (Average [b]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
5	1.05	1.63	0.56	1.02	2.37	0.69

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.

Table 55: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Total Alpha [a]Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	0.12	0.10	0.05	0.20	0.24	0.10	0.09
2	IF	0.21	0.15	0.27	0.23	0.05	0.16	0.21
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	0.41
5	0.15	0.60	0.40	IF	0.06	0.19	0.25	IF
6	IF	0.70	0.40	IF	0.12	0.11	IF	IF
7	0.17	0.22	0.22	0.40	0.31	0.30	IF	IF
19 A	IF	IF	IF	IF	IF	0.26	IF	IF
19 B	IF	IF	IF	IF	IF	0.51	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.05	0.10	0.11	IF	0.11	0.05	0.17	0.05

IF insufficient flow, water was stagnant in the ditch
NA sample not available for analysis

Historical Alpha Data (Average [b]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
5	0.17	0.23	0.25	0.24	0.29	0.27

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.

Table 56: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Total Tritium [a]Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	2.5	4.1	3.5	3.8	4.2	4.6	5.4
2	IF	2.3	4.3	3.7	3.6	4.0	4.2	5.0
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	415
5	13.3	339	50	IF	106.8	73	IF	IF
6	IF	749	773	IF	69.9	136	IF	IF
7	IF	146	231	145	165.1	219	400	217
19 A	IF	IF	IF	IF	IF	543	IF	IF
19 B	IF	IF	IF	IF	IF	777	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	2.5	2.3	4.0	3.5	3.8	4.8	5.3	5.7

IF insufficient flow, water was stagnant in the ditch
NA sample not available for analysis

Historical Tritium Data (Average [a]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
5	348	309	706	699	111	117

a Arithmetic average of samples collected.

Table 57: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Uranium ppb) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	1.96	2.25	3.04	2.90	2.39	3.74	1.25
2	IF	3.52	3.67	4.79	8.10	3.00	4.69	2.26
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	18
5	3.85	26.40	24.20	16.30	4.05	10.40	12.60	IF
6	IF	21.60	26.10	IF	2.61	4.54	IF	IF
7	IF	13.80	22.20	IF	11.10	8.67	IF	10.3
19 A	IF	IF	IF	IF	IF	12.50	IF	IF
19 B	IF	IF	IF	IF	IF	15.80	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.66	0.59	0.78	NA	2.67	1.17	0.56	0.45

ND not detected
NA Not available
IF Insufficient flow

Historical Uranium Data [a](Uranium ppb)						
Sample Point	2014	2015	2016	2017	2018	2019
5	NR	NR	NR	NR	24.70[b]	13.8

a Arithmetic average of samples collected.
b Single value

A.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing or organization for the operating staff responsible for the CCSF in 2019.

No program changes were made for the CCSF in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

In 2019, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [49]. Staffing was maintained at levels to provide the needed operational and safety support.

A.3 FACILITY CHANGES

All facility changes were performed as per the approved Engineering Change Control procedure [11]. There were no major facility changes made in 2019.

A.4 FACILITY EQUIPMENT PERFORMANCE

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2019. None of the canisters had a deviation greater than 1°. In 2019, Canister C5 had a deviation of 0.7° to the west compared to 2018 when it displayed a deviation of 0.8° to the east. This deviation and those seen on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2019.

A.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

As required by Section 8 of the Facility Authorization [49], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2019. The general appearance and fencing were found to be satisfactory on each inspection. Minor infilling was done along the base of the fence to meet security requirements.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes. Only minor patching was conducted in 2019. No increased radiation field was noted from the canisters. There was no degradation of the exposed metallic portions of the canisters. One of the wood poster boxes containing zone information was replaced due to environment-related degradation.

A.5.1 CANISTER SITE MONITORING AND SURVEILLANCE

A.5.1.1.1 Gamma Field Surveys

Gamma exposure rates from the canisters were measured quarterly in 2019. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No field anomalies were found during 2019, and there was no change in results as compared with previous surveys.

Table 58 shows the averaged gamma near contact exposure rates measured during 2019, and for the previous four years.

Table 58: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.11	0.08	0.10	0.12	2019	C13	0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
	0.08	0.08	0.09	0.08	2017		0.18	0.25	0.15	0.18	2017
	0.07	0.08	0.11	0.09	2016		0.17	0.20	0.16	0.14	2016
	0.07	0.07	0.06	0.08	2015		0.15	0.19	0.14	0.15	2015
C6	0.09	0.11	0.10	0.08	2019	C14	0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
	0.08	0.10	0.08	0.06	2017		0.11	0.18	0.17	0.13	2017
	0.09	0.12	0.08	0.07	2016		0.09	0.17	0.14	0.13	2016
	0.08	0.09	0.08	0.08	2015		0.13	0.13	0.14	0.14	2015
C7	0.18	0.16	0.14	0.16	2019	C15	0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
	0.20	0.16	0.14	0.14	2017		0.33	0.39	0.31	0.30	2017
	0.18	0.12	0.17	0.14	2016		0.24	0.31	0.31	0.29	2016
	0.13	0.16	0.08	0.13	2015		0.25	0.33	0.31	0.32	2015
C8	0.11	0.13	0.11	0.11	2019	C16	0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
	0.10	0.10	0.10	0.09	2017		0.18	0.29	0.13	0.17	2017
	0.10	0.12	0.11	0.12	2016		0.15	0.22	0.12	0.16	2016
	0.11	0.12	0.08	0.08	2015		0.19	0.23	0.17	0.13	2015
C9	0.26	0.23	0.17	0.21	2019	C17	0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
	0.25	0.19	0.20	0.22	2017		0.20	0.15	0.23	0.24	2017
	0.23	0.17	0.23	0.23	2016		0.13	0.15	0.24	0.23	2016
	0.16	0.14	0.11	0.15	2015		0.16	0.10	0.19	0.21	2015
C10	0.24	0.28	0.22	0.21	2019	C18	0.69	0.76	1.25	0.62	2019
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018
	0.24	0.30	0.21	0.22	2017		0.70	0.70	1.22	0.70	2017
	0.21	0.27	0.19	0.22	2016		0.73	0.70	1.25	0.64	2016
	0.18	0.27	0.20	0.17	2015		0.59	0.72	1.08	0.41	2015
C11	0.25	0.24	0.29	0.29	2019	C19	0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
	0.26	0.26	0.30	0.30	2017		0.18	0.18	0.25	0.22	2017
	0.19	0.18	0.30	0.32	2016		0.14	0.15	0.19	0.18	2016
	0.25	0.21	0.20	0.22	2015		0.14	0.16	0.16	0.19	2015
C12	0.19	0.21	0.13	0.13	2019	C20	0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018
	0.22	0.25	0.15	0.13	2017		0.16	0.11	0.18	0.18	2017
	0.18	0.18	0.12	0.17	2016		0.15	0.11	0.17	0.20	2016
	0.16	0.18	0.11	0.11	2015		0.12	0.12	0.14	0.12	2015

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h = 1 mrem/h

A.5.1.1.2 Air Monitoring

Air monitoring was conducted on each of the canisters in the CCSF in 2019. This involves an air pump that circulates air from and outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero.

No anomalies were found during 2019, and there was no change in results as compared with previous surveys.

Table 59 shows the averaged beta on each filter measured during 2019, and for the previous four years.

Table 59: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	6	<0.02	2019	C13	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	0.02	2017
	6	0.02	2016		6	0.02	2016
	6	<0.02	2015		6	0.02	2015
C6	6	<0.02	2019	C14	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	<0.02	2017
	6	0.02	2016		6	<0.02	2016
	6	0.02	2015		6	0.02	2015
C7	6	<0.02	2019	C15	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	<0.02	2016		6	0.02	2016
	6	0.03	2015		6	<0.02	2015
C8	6	<0.02	2019	C16	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	0.02	2016		6	<0.02	2016
	6	0.02	2015		6	<0.02	2015
C9	6	<0.02	2019	C17	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	<0.02	2016		6	0.02	2016
	6	<0.02	2015		6	0.02	2015
C10	6	<0.02	2019	C18	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	<0.02	2017
	6	<0.02	2016		6	<0.02	2016
	6	<0.02	2015		6	0.02	2015
C11	6	<0.02	2019	C19	6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
	6	<0.02	2017		6	0.03	2017
	6	0.02	2016		6	0.02	2016
	6	<0.02	2015		6	<0.02	2015
C12	6	<0.02	2019	C20	6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.03	2017
	6	<0.02	2016		6	<0.02	2016
	6	0.02	2015		6	<0.02	2015

A.6 WASTES GENERATED

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

A.6.1 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of solid radioactive and /or hazardous waste generated in the CCSF in 2019.

A.6.2 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of liquid radioactive and / or hazardous waste generated in the CCSF in 2019.

A.7 EFFLUENTS RELEASED

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the CCSF as part of routine operations.

A.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

A.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX B ACTIVE LIQUID WASTE TREATMENT CENTER

B.1 FACILITY OPERATION

The Active Liquid Waste Treatment Center (ALWTC) in Building 200 (B200) is operated under the WL Site Licence [1], in accordance with the requirements of the ALWTC Facility Authorization [50] while facilitating and harmonizing the decommissioning activities as prescribed in the established work plan. During 2019, the ALWTC was monitored and operated by Site and Nuclear Operations Branch personnel.

The facility was operated on an 8-hour, five-day per week basis, Monday to Friday, with on-call emergency response outside of normal working hours Saturdays, Sundays, and Holidays during 2019.

In 2017 August, new LLLWTS began operation in B100 and B300. All of the B100 low level liquid waste is now being tested, treated and controlled release to the river in the B100 LLLWTS and likewise in B300. All of the collection tanks in B200 were then isolated and taken out of service. The B200 sumps have also been taken out of service and any water collected from the sumps and associated piping is put into drums for processing. Decommissioning of the Low-Level Liquid Waste (LLLW) and Intermediate-Level Liquid Waste (ILLW) systems in B200 are underway.

Passive evaporation from Tank 807 ILLW is no longer conducted, nor is any ILLW stored in B200. The contents of Tank 807 was pumped into road-transportable containers in 2013, and the first shipment of this liquid was sent to an offsite processing facility for volume reduction. The remaining liquid is stored in road-transportable containers (5,400 L) in a Quonset in the WMA. Plans are underway to purchase and install a LLLW and ILLW waste processing facility in LLW Bunker 6 at the WMA, and then process the stored liquid waste onsite.

Routine operations in the ALWTC were carried out by four operating staff and one trainee from the Site and Nuclear Operations Branch.

B.1.1 RADIATION EXPOSURES

The operation of the ALWTC was carried out by the Site and Nuclear Operations Branch who also provide shut-down and surveillance activities for the WR-1 reactor. Radiation exposures received by staff are listed under WR-1 Reactor (see Appendix F), since they were not recorded separately from B100 operations

The ALWTC operations staff participated in routine bioassay testing which involved an annual whole-body count and/or gross beta of urine samples every 60 days. There was no indication of any internal radiation exposures to facility personnel.

There were no doses exceeding CNSC regulatory limits or CNL’s Action Levels to personnel as a result of ALWTC operations during 2019.

B.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing or organization for the operating staff responsible for the ALWTC in 2019.

No program changes were made for the ALWTC in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

In 2019, the facility continued to maintain the minimum staffing requirements outlined in the ALWTC Facility Authorization [50]. Staffing was maintained at levels to provide the needed operational and safety support.

B.3 FACILITY CHANGES

All facility changes were performed as per the approved *Engineering Change Control* procedure [11]. Building 200 was turned over to decommissioning near the end of 2017 to begin the decommissioning of the building. Decommissioning of the LLLW systems was completed in 2019. All of the laundry, decontamination, WR-1 and Building 300 LLLW collection systems in B200 have been removed except for the collection tanks. The removal of the ILLW system is well under way in 2019.

B.4 FACILITY EQUIPMENT PERFORMANCE

The Facility operated satisfactorily in 2019.

B.4.1 LOW-LEVEL LIQUID WASTE SYSTEM

The low-level liquid waste system is shut down and being decommissioned.

B.4.2 MEDIUM-LEVEL LIQUID WASTE SYSTEM

The medium-level liquid waste (intermediate-level liquid waste) system is no longer in use and is being decommissioned.

B.4.3 VENTILATION SYSTEM

Routine Poly-Alpha-Olefin testing of the exhaust High Efficiency Particulate Air (HEPA) filter was carried out satisfactorily in 2019 May and November. All filters had acceptable penetrations of less than 0.03% in both tests.

B.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

As required by Section 8 of the Facility Authorization [50], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests and inspections were completed. Monthly housekeeping and fire prevention inspections were completed.

B.6 WASTES GENERATED AND EFFLUENTS RELEASED

There were no radioactive and/or hazardous wastes generated in the ALWTC as part of routine operations.

B.6.1 WASTES GENERATED

B.6.2 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of solid radioactive and/or hazardous waste generated in the facility in 2019.

During 2019, 161 m^3 of low-level solid radioactive waste and 6.7 m^3 of intermediate-level solid radioactive waste was generated from ALWTC decommissioning activities.

B.6.3 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

There were no liquid radioactive and / or hazardous waste generated in the facility as part of routine operations.

Decommissioning of low-level and intermediate-level liquid systems generated 0 m^3 of liquid waste for 2019.

B.7 EFFLUENTS RELEASED

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the ALWTC as part of routine operations.

B.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

There was no liquid effluent released to the Outfall from the ALWTC in 2019.

Non-radiological liquid releases from this facility are discussed in Section 9.5 of this report. There were no hazardous liquid wastes released from this facility.

B.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Radioactive air emissions form the facility are included in Section 9.4 of this report. There were no hazardous gaseous wastes released from this facility.

APPENDIX C SHIELDED FACILITIES

C.1 FACILITY OPERATION

The WL Shielded Facilities (SF) operates under the WL site licence [1], in accordance with the requirements of the Facility Authorization [51]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shutdown and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of HEPA filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

C.1.1 RADIATION EXPOSURE

The average and maximum whole-body effective dose received by SF staff for 2019 were 0.29 mSv and 0.47 mSv respectively. The average and maximum individual equivalent dose to the skin were 0.73 mSv and 1.39 mSv respectively. The whole body effective collective dose was 1.46 person·mSv for SF staff. The average extremity dose was 1.19 mSv and the maximum dose was 1.62 mSv.

There was no need for tritium monitoring in the SF during 2019.

The SF staff participated in routine bioassay testing, which involved a bi-annual whole-body count, and gross beta of urine samples every 60 days. There was no indication of any internal radiation exposures to facility personnel.

There were no doses exceeding CNSC regulatory limits or CNL’s Action Levels to personnel as a result of SF operation during 2019.

C.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing for the operating staff responsible for the SF in 2019. There were no organizational changes.

No program changes were made for the SF in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

In 2019, the SF continued to maintain the minimum staffing requirements outlined in the Facility Authorization [51]. Staffing was maintained at levels to provide the needed operational and safety support.

C.3 FACILITY CHANGES

All facility changes were performed as per the approved Engineering Change Control procedure [11]. The high temperature heat detectors in Hot Cells 1-5 and Cell 13 that alarmed locally, were added to the WL site Fire Alarm system in 2019 as part of the Hot Cells Restoration project.

C.4 FACILITY EQUIPMENT PERFORMANCE

The Facility operated satisfactorily in 2019 with the exception of the Hot Cell alarm panel as listed in C.4.2. Also the Hot Cells Manipulator electronic controls were upgraded to improve efficiencies and reliability as part of the Hot Cells Restoration project.

C.4.1 VENTILATION SYSTEM

The ventilation system was rebalanced in 2019 to improve air efficiencies as part of the Hot Cells Restoration project. Planned project and maintenance activities requiring part of the ventilation system to be taken down occurred without incident.

C.4.1.1.1 High Efficiency Particulate Air Filter Performance

The annual routine Poly-Alpha-Olefin testing of the HCF and IFTF HEPA filters were conducted and all filters passed.

C.4.2 ALARM TESTING

An alarm-testing program has been in place in the SF throughout its operational history. In 2019 the SF alarms were fully operational with the exception of 2019 September 17-30, where there was a Hot Cells alarm panel electronic board failure resulting in an impairment of the Hot Cell facility. Compensatory measures were put in place to provide alarm coverage during this time.

C.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

As required by Section 8 of the Facility Authorization [51], all routine maintenance for safety related systems was carried out as per the facility maintenance plan, and all equipment tests and inspections were complete.

C.6 WASTES GENERATED

C.6.1 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

C.6.1.1.1 Low-Level Solid Waste

In 2019, the SF generated 101.4 m^3 of compactable low-level radioactive solid waste and 0 m^3 of non-compactable waste.

The Waste Handling Area processed 162.0 m^3 of low-level radioactive solid waste which was reduced to 15 m^3. A portion of this waste was generated in the SF, and the remainder came from all of the nuclear facilities and decommissioning projects at WL where waste is being generated.

Table 60 lists the annual low-level solid waste generated in the SF for 2019 and the previous four years.

Table 60: Solid Wastes Generated

Total Volume	2015	2016	2017	2018	2019
Low-Level Solid Waste (m^3)	25.0	47.7	0.4	73.3	101.4
Medium-Level Solid Waste (m^3)	0	0	0	0	0

C.6.1.1.2 Medium-Level Solid Waste

In 2019, the SF generated no medium-level (intermediate-level) radioactive solid waste. Table 60 lists the annual medium-level solid waste generated for 2019 and the previous four years.

C.6.2 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of liquid radioactive and/or hazardous waste generated in the SF on 2019.

C.6.2.1.1 Low-Level Liquid Waste System

In 2019, 186.5 m^3 of low-level liquid waste was processed through the B300 low-level liquid waste system (see Appendix E).

C.6.2.1.2 Medium-Level Liquid Waste System

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2019, there was one transfer of 1.2 m^3 medium-level liquid waste to transportable totes that is being stored for future disposition.

Table 61 lists the annual aqueous waste generated for 2019 and also for the previous four years.

Table 61: Building 300 Liquid Waste Volumes Transferred to the ALWTC

Year	Low-Level Waste System[a]		Medium-Level Waste System[b]
	Total Volume (m^3)	Activity	Total Volume (m^3)
2015	74.5	0.045GBq β 0.002GBq γ 0.001GBq α	0
2016	195.4	0.039GBq β 0.006GBq γ 0.004GBq α	0
2017	164.0	0.073GBq β 0.007GBq γ 0.003GBq α	0

2018	123.0	0.016GBq β 0.006GBq γ 0.003GBq α	0
2019	186.5	1.35E+07GBq β 8.23E+06GBq γ 2.66E+06 GBq α	1.2

a Total volume for Building 300 (Sumps).
b Total volume can be attributed to the SF.

C.7 EFFLUENTS RELEASED

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

C.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Liquid radioactive and/or hazardous effluents were discharged from the SF as part of routine operations.

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

C.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX D WASTE MANAGEMENT AREA

D.1 FACILITY OPERATION

The Waste Management Area (WMA) operated under the WL site licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [52]. Limiting Condition of Operation #9 was modified in 2019 to permit excavations deeper than 4.5 m under a set of controlled circumstances. This change was necessary in order to prepare for decommissioning activities. The change was reviewed and approved by the CNSC. During 2019, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2019, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, WMA Operator and two WMA based utility workers, with support from other Site and Nuclear Operations personnel as required.

D.1.1 RADIATION EXPOSURES

Staff from the Site and Nuclear Operations Branch operated the WMA. The average and maximum individual whole-body effective dose received by WMA facility staff for 2019 were 0.12 mSv and 0.29 mSv respectively. The average and maximum individual equivalent dose to the skin were 0.12 mSv and 0.30 mSv respectively. The collective effective dose was 0.46 person·mSv. There were no extremity doses in 2019.

Waste Management Area staff participated in routine bioassay testing which involved bi-annual whole-body counts and gross beta of urine samples every 60 days. There was no indication of any internal radiation exposures to facility personnel.

There were no doses exceeding CNSC regulatory limits or CNL's Action Levels to personnel as a result of WMA operations during 2019.

D.1.2 INVENTORY ADDITIONS AND DELETIONS

Changes in inventory are reported in Table 62 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.3 LOW-LEVEL SOLID WASTE

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. Some of the inventory of stored waste in WMA was sent to CRL for storage pending future disposal. The stored volume of waste is listed in Table 62.

D.1.4 INDUSTRIAL WASTE

There were no additions of industrial chemical waste during 2019.

Table 62: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2018 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433, and Building 923	21,034.86	2,501.88	330.6
Additions for 2019	Building 923, SSC, B431 to B433	106	1.35	0.00
Removals for 2019	Building 923 SSC LLW Bunker 6 B411 B514	862 201 406 126 252	345.98 2.93 0.04 6.27 0.14	0.00 0.00 0.00 0.00 0.00
Total Accumulation as of 2019 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433, Building 923 and SSC	19,293.86	2,147.87	330.6

D.1.5 COMPLIANCE MONITORING

D.1.5.1 Monitoring and Surface Water

D.1.5.1.1 Surface Water

Figure 11 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

A recorded amount of precipitation of 646 mm occurred in 2019, which was more than the 467 mm recorded in 2018. A period of high rainfall occurred in the fall of 2019 (>200 mm in September).

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

- If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.
- If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, this year all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [32]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration (MAC) for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity near detection limits were noted for Ditch sample Locations 1 to 7 (Table 63). Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. Most beta activity levels in the ditch water remained below the drinking water screening level of 1 Bq/L and well below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137. Compliance with Guidelines for Canadian Drinking Water [32] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively.

The alpha activity levels in the surface water are presented in Table 64, and were below the trigger level of 0.5 Bq/L, except for three samples; on May 02 Ditch Location 5 and Ditch Location 6, and on October 23 and 24 combined sample date one sample from Ditch Location 19B, reached the gross alpha trigger level for gamma spectrometry and uranium analysis. Location 5 had a value of 26 ppb uranium, Location 6 had a value of 22 ppb on May 02. Location 5, 6, and 7 had values of 24, 26, and 22 respectively on samples taken May 06 and 07. Location 19B had a value of 16 ppb on September 30-October 01 combined sampling date. The values at Locations 5, 6 and 7 slightly exceeded the MAC in May, but returned below this level in samples taken later in the year. Uranium results are presented in Table 65.

The uranium values recorded at locations 19 A and B are believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation. This rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018 and is currently stored east of the WMA at the former Cesium Pond location. The Lac du Bonnet Batholith granite is noted to have naturally occurring uranium. Uranium sample results were only available for the September 30 to October 01 sampling at Locations 19 A and B. There was no flow this year at Location 19C.

As shown in Table 66, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [32] at all locations. The elevated readings that existed in this area in previous years likely resulted from migration of tritium in the clay columns from WR-1 stored in Trench 23. Trench 23 is nearest Location 19C, with flow towards 19B and 19A along the drainage direction of the ditch towards the west. The summer was dry likely limiting migration to the ditch from Trench 23. At Locations 1 to 7, downstream of Locations 19 A, B and C, the highest reading was 773 Bq/L. Locations 8 and 9 had average tritium values of 6 Bq/L and 10 Bq/L respectively. Tritium detected at Locations 3 and 19 A, B and C would contribute to that seen in Locations 4, 5 and 7. Location 3 is believed to also have contributions of tritium from Location 19 C. Locations 19 A, B and C were originally chosen for sampling for the potential migration of cesium-137 due to the presence of the Cesium Pond soil pile. Although the Cesium Pond soil has been removed, CNL will continue to monitor locations 19 A, B and C due to the elevated levels of tritium.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [53], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is elevated immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 10 Bq/L in 2019). Although the amount measured in Locations 1 to 7 are above that noted at the Control location, the levels are much lower than the Maximum Acceptable Concentration in drinking water for tritium (7000 Bq/L).

Carbon 14 was noted with a value of 3.1 Bq/L in the east ditch of the WMA (Location 13), which is several orders of magnitude less than the Canadian Drinking Water Guideline of 200 Bq/L [32]. A potential source for the C-14 may be from residue from barrels previously held in the area of Trench 1 and 2 while awaiting incineration in the now decommissioned Building 514 incinerator on the east side of the WMA. It may also relate to potential surface clay fissuring from the dry summer in 2019 followed by a high rainfall period in September allowing migration of contaminants from adjacent trenches through the clay fissures prior to the clay self-sealing with expansion from water uptake. Further measurements will be taken in 2020 as ditch water flows permit.

Table 63, Table 64, and Table 65 present the WMA surface-water sampling data. The data represents continuing documentation of a spill incident that occurred in 1979 near Intermediate-Level Waste (ILW) Bunker 3, at the reference sample point (Location 3) in the southeast section of the WMA, as shown in Figure 11 and Figure 12. In 2017, sampling Location 3 had been reconfigured to allow preparations for future bunker and standpipe remediation, but the location was dry this year due to dry summer. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. While it has been confirmed that there is water in the bunkers, there is no indication of contaminant movement at levels of concern. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater is below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of 1.27×10^{7} Bq/L [54]. These tables, and Table 66, have been expanded to include the historical monitoring at Ditch Locations 19 A, B and C.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. Water tested at Locations 19 A, B and C along the north perimeter ditch of the WMA (Figure 12) has given no indication of Cesium-137 migration to the ditches (Table 67).

Table 63: Gross Beta Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	**Sampling Data (Total Beta [a]Bq/L) in 2019**							
Locations	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	0.13	0.05	0.20	0.21	0.19	0.18	0.13
2	IF	0.26	0.20	0.44	0.23	0.26	0.21	0.10
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	2.22
5	0.35	1.09	0.67	IF	0.80	0.54	IF	IF
6	IF	0.64	0.85	IF	0.51	0.32	IF	IF
7	0.78	1.08	1.34	0.97	1.24	0.69	1.11	0.87
19 A	IF	IF	IF	IF	IF	0.44	IF	IF
19 B	IF	IF	IF	IF	IF	0.43	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.23	0.21	0.14	IF	0.17	0.09	0.19	0.07

IF insufficient flow, water was stagnant in the ditch

Historical Beta Data (Average [b]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
3	10.9	2.13	1.23	1.62	1.24	IF
19 A	0.76	0.53	0.40	0.69	0.36	0.44[c]
19 B	0.67	0.63	0.52	0.72	0.24	0.43[c]
19 C	0.69	0.70	0.39	0.58	0.38	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF insufficient flow
NA Not available

Table 64: Gross Alpha Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Total Alpha [a]Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	0.12	0.10	0.05	0.20	0.24	0.10	0.09
2	IF	0.21	0.15	0.27	0.23	0.05	0.16	0.21
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	0.41
5	0.15	0.60	0.40	IF	0.06	0.19	0.25	IF
6	IF	0.70	0.40	IF	0.12	0.11	IF	IF
7	0.17	0.22	0.22	0.40	0.31	0.30	IF	IF
19 A	IF	IF	IF	IF	IF	0.26	IF	IF
19 B	IF	IF	IF	IF	IF	0.51	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.05	0.10	0.11	IF	0.11	0.05	0.17	0.05

IF insufficient flow, water was stagnant in the ditch
NA not available

Historical Alpha Data (Average [b]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
3	0.21	0.25	0.64	0.28	0.31	IF
19 A	0.31	0.23	0.34	0.53	0.92	0.26[c]
19 B	0.29	0.39	0.36	0.74	0.24	0.51[c]
19 C	0.48	0.41	0.40	1.05	0.39	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF insufficient flow
NA Not available

Table 65: Uranium of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample Locations	**Sampling Data (Uranium ppb) in 2019**							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	1.96	2.25	3.04	2.90	2.39	3.74	1.25
2	IF	3.52	3.67	4.79	8.10	3.00	4.69	2.26
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	18
5	3.85	26.40	24.20	16.30	4.05	10.40	12.60	IF
6	IF	21.60	26.10	IF	2.61	4.54	IF	IF
7	IF	13.80	22.20	IF	11.10	8.67	IF	10.3
19 A	IF	IF	IF	IF	IF	12.50	IF	IF
19 B	IF	IF	IF	IF	IF	15.80	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.66	0.59	0.78	NA	2.67	1.17	0.56	0.45

NR Analyses not required
IF insufficient flow

Historical Uranium Data (Average [b]ppb)						
Sample Point	2014	2015	2016	2017	2018	2019
3	NR	NR	ND	NR	21	IF
19 A	NR	NR	NR	24	52 [a]	13[a]
19 B	NR	NR	NR	39	NR	16[a]
19 C	NR	NR	NR	67	47 [a]	IF

a Based on single sample analyses
b Arithmetic average of samples collected.
NR Analyses not required.
IF insufficient flow
ND Not detected
NA Not available

Table 66: Tritium Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample Locations	Sampling Data (Total Tritium Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
1	IF	2.5	4.1	3.5	3.8	4.2	4.6	5.4
2	IF	2.3	4.3	3.7	3.6	4.0	4.2	5.0
3	IF	IF	IF	IF	IF	IF	IF	IF
4	IF	IF	IF	IF	IF	IF	IF	415
5	13.3	339	50	IF	106.8	73	IF	IF
6	IF	749	773	IF	69.9	136	IF	IF
7	IF	146	231	145	165.1	219	400	217
19 A	IF	IF	IF	IF	IF	543	IF	IF
19 B	IF	IF	IF	IF	IF	777	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	2.5	2.3	4.0	3.5	3.8	4.8	5.3	5.7

NR Analyses not required
IF insufficient flow

Historical Tritium Data (Average [a]Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
3	937	751	228	1335[b]	178	IF
19 A	1396	1025	2324	5535	459	543[b]
19 B	1481	1206	4001	8123	325[b]	777[b]
19 C	1731	1216	4203	9610	405	IF

a Arithmetic average of samples collected
b Single data point
IF insufficient flow
NA Not available

Table 67: Sample Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample Locations	Sampling Data (Total Cesium-137 Bq/L) in 2019							
	10 and 11 Apr	02 May	06 and 07 May	13 and 14 May	23 and 24 Sep	30 Sep and 01 Oct	07 and 09 Oct	22 and 24 Oct
19 A	IF	IF	IF	IF	IF	<1	IF	IF
19 B	IF	IF	IF	IF	IF	<1	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF
Background	<1	<1	<1	<1	<1	<1	<1	<1

IF Insufficient Flow
ND Not detected

Historical Cs-137 Data (Average[b] Bq/L)						
Sample Point	2014	2015	2016	2017	2018	2019
19 A	ND	ND	ND	ND	ND	<1[a]
19 B	ND	ND	ND	ND	ND	<1[a]
19 C	ND	ND	ND	ND	ND	IF

a Single data point
b Arithmetic average of samples collected.
IF insufficient flow
ND Not detected

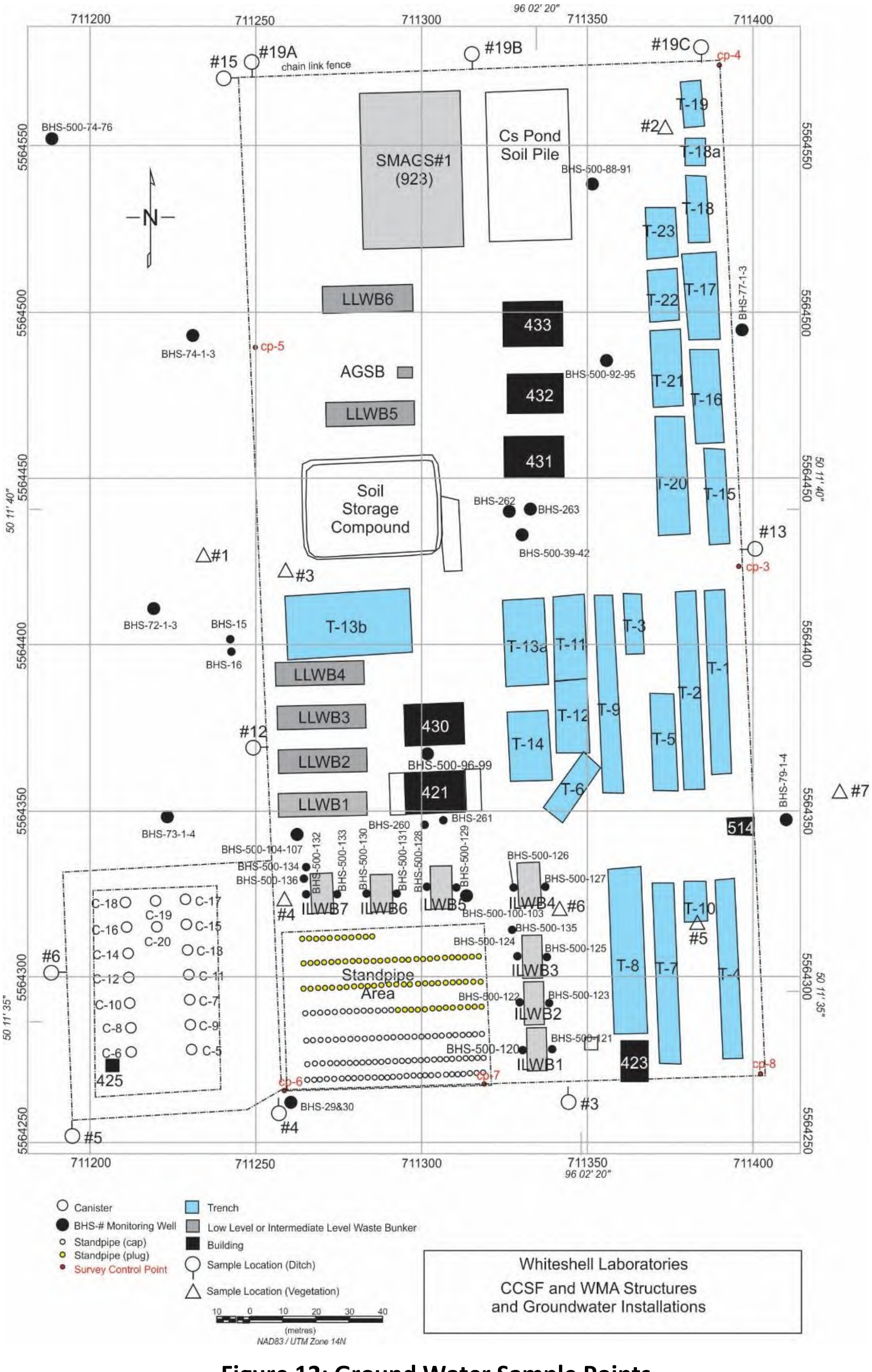

Figure 12: Ground Water Sample Points

D.1.5.1.2 Intermediate Level Waste Bunkers Near Field Wells

A series of shallow near field wells were installed adjacent to the Intermediate Level Waste bunkers in the WMA in 2015 (Figure 11). Groundwater samples were taken from the wells and from water in the Intermediate Level Waste Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile and will bond with sand, and tritium the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2019, Sr-90 was noted to be a maximum of 22 Bq/L adjacent to ILW Bunker 1, and < 7 Bq/L adjacent to ILW Bunker 3. For all other locations the Sr-90 and Cs-137 levels were negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 68) from the Intermediate Level Waste Bunkers, and Sr-90 (Table 69) and tritium levels (Table 70) that are orders of magnitude below the levels observed in the water in the adjacent Intermediate Level Waste Bunkers. The tritium levels immediately adjacent to the west side of ILW Bunker 3 and the east side of ILW Bunker 5 that were showing upward trends, are within the range of previous results. Tritium adjacent to ILW Bunker 2 has shown an increase in 2019 (4274 Bq/L).

Table 68: Cesium 137 Activity of Near Field Wells Adjacent to Intermediate Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values Bq/L				
	Bq/L	2015	2016	2017	2018	2019
ILW Bunker 1	31762					
BHS 500-120	-	ND	ND	<1	<1	<1
BHS 500-121	-	ND	0.03	<1	<1	<1
ILW Bunker 2	1170					
BHS 500-122	-	ND	0.02	<1	<1	<1
BHS 500-123	-	ND	0.04	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	ND	0.33	<1	<1	<1
BHS 500-125	-	ND	0.05	<1	<1	<1
BHS 500-135	-	[(b)]	ND	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	ND	0.05	<1	<1	<1
BHS 500-127	-	ND	0.04	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	ND	0.07	<1	<1	<1
BHS 500-129	-	ND	0.10	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	ND	0.08	<1	<1	<1
BHS 500-131	-	ND	0.90	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	ND	0.07	<1	<1	<1
BHS 500-133	-	ND	0.08	<1	<1	<1
BHS 500-136	-	[(b)]	0.07	<1	<1	<1

[(a)] bunker values from 2015 samples
[(b)] well installed in early 2016
ND Not Detected

Table 69: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values Bq/L				
	Bq/L	2015	2016	2017	2018	2019
ILW Bunker 1	98300					
BHS 500-120	-	10.8	1.60	32	15.30	22.10
BHS 500-121	-	<1.1	0.30	1.31	4.44	2.92
ILW Bunker 2	865					
BHS 500-122	-	<0.80	0.50	0.25	0.21	0.14
BHS 500-123	-	<0.83	0.70	1.27	2.55	1.59
ILW Bunker 3	26950					
BHS 500-124	-	<1.1	0.60	5.70	11.3	6.58
BHS 500-125	-	<1.0	0.70	<0.20	<0.10	<0.10
BHS 500-135	-	(b)	0.50	0.72	0.74	1.32
ILW Bunker 4	2485					
BHS 500-126	-	<1.2	0.60	0.33	0.24	0.30
BHS 500-127	-	2.9	0.80	<0.20	0.28	0.35
ILW Bunker 5	3850					
BHS 500-128	-	<0.78	1.47	<0.20	<0.10	<0.10
BHS 500-129	-	3	1.50	<0.20	<0.10	<0.10
ILW Bunker 6	157500					
BHS 500-130	-	<0.64	0.48	<0.20	<0.10	<0.10
BHS 500-131	-	2.7	0.54	<0.20	<0.10	<0.10
ILW Bunker 7	3335					
BHS 500-132	-	<0.64	0.50	<0.20	<0.10	<0.10
BHS 500-133	-	<0.58	0.53	<0.20	<0.10	<0.10
BHS 500-136	-	(b)	0.60	<0.20	<0.10	<0.10

(a) bunker values from 2015 samples
(b) well installed in early 2016

Table 70: Tritium Activity of Near Field Wells Adjacent to Intermediate Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values Bq/L				
	Bq/L	2015	2016	2017	2018	2019
ILW Bunker 1	42000					
BHS 500-120	-	3093	16	70	279	258
BHS 500-121	-	1747	1097	765	2788	2355
ILW Bunker 2	6100					
BHS 500-122	-	738	836	1877	475	4274
BHS 500-123	-	3752	2974	1876	2554	2834
ILW Bunker 3	4600000					
BHS 500-124	-	76077	97567	158564	83604	128534
BHS 500-125	-	4360	3299	2956	2512	39
BHS 500-135	-	[(b)]	3532	2404	3536	47
ILW Bunker 4	41000					
BHS 500-126	-	52	49	69	24	39
BHS 500-127	-	46	21	76	< 4	47
ILW Bunker 5	5500000					
BHS 500-128	-	2210	2785	2981	2674	2655
BHS 500-129	-	6378	11364	10700	9100	9633
ILW Bunker 6	210000					
BHS 500-130	-	30	32	310	29	5
BHS 500-131	-	13	12	22	19	5
ILW Bunker 7	970000					
BHS 500-132	-	112	40	49	131	100
BHS 500-133	-	46	11	16	<4	6
BHS 500-136	-	[(b)]	28	36	78	72

(a) bunker values from 2015 samples
(b) well installed in early 2016

D.1.5.1.3 Water Table Wells and Deep Wells

Water samples were collected from wells in and around the WMA (Figure 12) in the spring and fall of 2019. The gross alpha and gross beta results are summarized in Table 71. The beta activity levels in the clay, clay till and basal zone wells remained below the drinking water screening level of 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs 137 (10 Bq/L) [32]. The average alpha activity in the samples collected from the Basal zone wells was below the screening level.

Uranium concentrations in the basal zone wells ranged from 0 to 0.19 Bq/L. The concentrations in the Clay zone wells ranged from 0.33 to 3.40 Bq/L, and in the clay till from 0 to 1.88 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [55], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (8.07 Bq/L) and clay-till (14.07 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA.

Table 71: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2015 Avg. (Bq/L)	2016 Avg. (Bq/L)	2017 Avg. (Bq/L)	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2019 Avg. Range (Bq/L)
Total Beta [a]						
Clay	1.21	0.67	0.35	0.29	0.42	0.05 to 1.80
Clay Till	0.86	0.54	0.36	0.25	0.26	0.05 to 1.20
Basal	0.67	0.39	0.16	0.13	0.34	0.05 to 7.00
Total Alpha [b]						
Clay	0.54	1.05	1.01	1.03	0.87	0.05 to 4.20
Clay Till	0.36	0.60	0.77	0.72	0.75	0.10 to 3.20
Basal	0.21	0.18	0.10	0.12	0.22	0.05 to 4.20
Total Uranium [c]						
Clay	0.01	0.86	0.90	0.88	0.86	0.33 to 3.40
Clay Till	0.54	0.55	0.52	0.62	0.60	0.00 to 1.88
Basal	0.03	0.01	0.01	0.04	0.01	0.00 to 0.19
Total Tritium						
Clay	12.4	11.86	11.60	11.36	8.07	3.42 to 39.18
Clay Till	12.3	12.04	13.36	13.51	14.07	3.42 to 83.29
Basal	< 4[d]	5.32	4.08	4.63	5.66	3.38 to 72.85

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value is calculated from the concentration of uranium in the water samples
d Well BHS 500-101 had tritium (15.8 Bq/L)

D.1.5.1.4 High-Level Liquid Waste Tray Water

Quarterly monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. The sample results indicated no leakage has occurred from the tanks. The data are summarized in Table 72. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 72: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2015 Avg (Bq/L)	2016 Avg (Bq/L)	2017 Avg (Bq/L)	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2019 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	12.8	11.9	13.8	13.8	12.1	9 to 14
Total Alpha[b]						
Tank Tray Water	< 0.6	< 0.6	0.65	0.69	1.5	1.5 to 2.0

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13 Bq/L of the gross beta activity is due to K-40.
b The reference nuclide for total alpha is Pu-239

D.1.5.2 Radiation Field Measurements

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2019 radiation field measurements were similar to those in 2018. The data are summarized in Table 73.

Table 73: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2015 Avg	**2016 Avg**	**2017 Avg**	**2018 Avg**	**2019 Avg**	**2019 Range**
Spring Survey						
South Fence	0.33	0.3	0.2	0.2	0.2	0.2
West Fence	0.48	0.5	0.4	0.4	0.4	0.2-0.7
North Fence	0.33	0.4	0.2	0.2	0.2	0.2-0.3
East Fence	0.34	0.3	0.3	0.3	0.3	0.2-0.5
Fall Survey						
South Fence	0.23	0.2	0.2	0.2	0.2	0.1-0.3
West Fence	0.42	0.4	0.4	0.4	0.5	0.3-0.8
North Fence	0.43	0.2	0.2	0.2	0.2	0.1-0.4
East Fence	0.39	0.3	0.3	0.3	0.4	0.1-0.8

D.1.5.3 Vegetation

In 2019, vegetation samples were collected at monitoring locations within the WMA (Figure 12), and at a control location unaffected by WL operations. The gross beta results are summarized in Table 74. In 2019, as since 2017, the samples were only collected in the late summer-fall as it was determined that the uptake occurs over the summer, so the fall measurements presented in since 2017 are more conservative than previous years. As was the case last year, K-40 still represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. For 2019, the average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90). Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 74: Waste Management Area Vegetation Monitoring Data

WMASample Locations	Average Gross Beta[a] (Bq/kg)				
	2015 Avg	**2016 Avg**	**2017 Avg**	**2018 Avg**	**2019 Avg**
North-East Area[d]	488	488	NA	672	450
Mid-West Area	477	578	1619	411	155
South-West Area	707	575	275	414	NA
South-East Area	538	751	460	409	441
Control Sample[b]	397	632	379	187	210
Background Sample[c]	519	592	419	324	317
East of ILW Bunkers 3 and 4	488	488	NA	672	450

a The reference nuclide for beta is Sr-90

b Adjacent to the WMA outside of fence boundary

c Ambient Radiation Monitor Stations Background Samples

d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area.
Only a single set of vegetation samples was taken as of 2017 as uptake occurs over the summer. Range is no longer included because of this change.

D.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing or organization for the operating staff responsible for the WMA in 2019.

No program changes were made for the WMA in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

In 2019, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [52]. Staffing was maintained at levels to provide the needed operational and safety support.

D.3 FACILITY CHANGES

All facility changes are performed as per the approved Engineering Change Control procedure [11].

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2019. This included testing and activation of the expanded Protected Area that encompasses the Standpipes and Intermediate Level Bunkers. The old Protected Area fence that enclosed the standpipes area alone was removed along with the old poles for security lighting.

The WR-1 Phase 1 decommissioning waste material was stored in Buildings 432 and 433 in the WMA. Approximately 96% of the WR-1 Phase 1 decommissioning waste stored in B432 and B433 was processed by the end of 2016. Nine oversized crates remain in B433, and five asbestos containing crates that moved to B430 were returned to B433 and remained there as of the end of 2019.

The Soil Storage Compound has been emptied of stored soil bags, with the waste packaged and shipped off site.

The marine container used for storing sealed sources that was transferred from Building 430 in the WMA to the standpipes Protected Area to meet revised security regulations from the CNSC in 2015, remained in place through 2019, with a number of sources having been transferred for offsite storage - the remainder are still held pending future dispositioning.

Building 923 (SMAGS) waste is being transferred to CRL. This process began in 2018 and continued in 2019. This will allow the building to be re-purposed for loading of intermediate level waste shipping casks.

Low Level Waste Bunker #6 has largely been emptied of waste, with most being packaged for offsite shipment. Some waste was removed and returned to the bunker pending completion of characterization work and shipping plans.

Construction began on an access structure on the east side of Low Level Waste Bunker #5 to facilitate waste retrieval operations planned in 2020.

A Waste Transshipment Area was established outside the northern perimeter to allow for shipments of waste to be held and loaded for offsite shipment.

D.4 FACILITY EQUIPMENT PERFORMANCE

During 2019, the bunkers and other structures in the WMA remained fit for service. Waste stored in SMAGS is being removed, and this process will be completed in 2020. Repackaging of soil stored in drums and concrete stored on pallets from LLW Bunker 6 was begun in late 2018, and continued in 2019. The low level waste will be shipped to CRL. Medium-Level Waste Bunker 4 did not have new waste placed in 2019 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues.

Medium-Level Waste Bunker 7 is ~85% full. The percentage full values are estimates only. Road transportable totes of liquid waste formerly stored in B431 were transferred to the heated B430 pending future processing. B431 contains historic waste and is used as temporary storage for waste repackaging-characterization operations. B432 and B433 contain various historic wastes and wastes held in various stages of repacking operations.

The Soil Storage Compound is empty of stored waste soil bags. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018. No caulking was required in 2019.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.1.5.1.2 and indicate limited migration of tritium beside the ILW bunkers and no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have only found limited levels of contaminants, below drinking water guidelines, suggesting the structures and barriers of soil and upwards groundwater flow are performing as expected.

D.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

As required by Section 8 of the Facility Authorization [52], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests and inspections were completed. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [15], and is further discussed in Section 6.

D.6 WASTES GENERATED

As a result of routine operations solid radioactive waste and liquid radioactive waste were generated in the WMA.

D.6.1 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of solid radioactive and/or hazardous waste generated in the WMA in 2019. There was 6.9 m^3 of solid compactable wastes and no solid non-compactable wastes generated in this facility during 2019 from operational activities.

D.6.2 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

See Section 11.1 Waste Management Program for summaries of the volume of liquid radioactive and/or hazardous waste generated in the WMA in 2019.

In 2019, approximately 1988 L of water was removed from storage facilities and collection sumps at the WMA. Of this total, 260 L was from ILW Bunker 4, 1661 L was from ILW Bunker 6, and 67 L from Bunker 7; neither

Above Ground Storage Bunker 8 nor ILW Bunker 4 required pumping in 2018. No water was required to be pumped from the Low Level Bunkers sumps in 2019.

D.7 EFFLUENTS RELEASED

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the WMA as part of routine operations.

D.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

There are no liquid effluents generated from this facility.

D.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

The incinerator was decommissioned in 2018. There are no other radiological airborne releases from this facility. There were no hazardous air gaseous effluents released from this facility.

APPENDIX E AUXILIARY OPERATING FACILITIES

E.1 FACILITY OPERATION

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contains experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops are located in the South High Bay.

The research program in the South High Bay area was completed in 2018, and operational shutdown was started. The operational shutdown, decontamination, and decommissioning of the remainder of the building was completed in 2015. The demolition of Stages 4 and 7 was completed in 2016. The demolition of RD-14M was completed in 2019.

During 2019, WL Site and Nuclear Operation's staff and user groups in Building 300 carried out routine operations which included:

- Non rad laundry activities;
- Respirator fit test / maintenance activities;
- Ongoing CNL Nuclear Engineering & Systems Analysis R&D activities;
- Cleanup activities associated with decommissioning;
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

Decommissioning work conducted in 2019 included the finishing up of the decommissioning of the LLLW holding tanks in room B-38 to be in a demo ready state as well as the disposition of staged waste from past activities.

Health and Safety Facilities (Building 402 and B305)

Building 402 has three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

During 2017 the private business tenant left B305 and the area was repurposed. A licensed gamma cell belonging to the former tenant remained, and in 2019 the gamma cell was moved from Building 305 to the source container located inside the Protected Area of the Waste Management Area (WMA) for storage until a more permanent disposition path is determined.

During 2019, routine operations were carried out and supervised by Site and Nuclear Operations personnel.

E.1.1 RADIATION EXPOSURE

There were no doses exceeding CNSC regulatory limits or CNL's Action Levels to personnel as a result of the operation of the Auxiliary Operating Facilities during 2019. A detailed account of employees' radiological exposures is provided in Section 7.

E.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2019. There were no organizational changes.

No program changes were made for the auxiliary facilities in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

E.3 FACILITY CHANGES

All facility changes were performed using the *Engineering Change Control* procedure [11]. There were no major facility changes made in 2019.

E.4 FACILITY EQUIPMENT PERFORMANCE

All facility changes were performed as per design requirements and specifications.

E.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed.

E.6 WASTES GENERATED

There were no radioactive and/or hazardous wastes generated in the facility as part of routine operations.

E.6.1 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

Building 300 generated 0 m^3 of compactable and 0.4 m^3 of non-compactable low-level radioactive solid waste in 2019.

Building 402 generated 0.7 m^3 of compactable and 0.0 m^3 of non-compactable low-level radioactive solid waste in 2019.

Building 411 site (decommissioned in 2017) had 0.2 m^3 of compactable and 0 m^3 of non-compactable low-level radioactive solid legacy waste processed in 2019.

After processing at the Waste Handling Area, all waste was shipped to the WMA for storage.

See Table 75 for a summary of solid wastes for the last five years.

Table 75: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2015*	2016*	2017	2018	2019
Building 300 (m^3)	48.5	203.3	14.7	4.5	0.4
Building 402 (m^3)	1.4	3.4	2.8	1	0.7
Building 411 (m^3)	19	74.9	355.1	7.6**	0.2**

* Volume prior to compaction, all compactable waste is consolidated at the WHA
** Legacy waste processed in 2018 for building 411 that was decommissioned in 2017

See Section 11.1 Waste Management Program for summaries of the volume of solid radioactive and/or hazardous waste generated in the facility in 2019.

E.6.2 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

There was no liquid radioactive and/or hazardous waste generated in 2019 in this facility.

See Section 11.1 Waste Management Program for summaries of the volume of liquid radioactive and/or hazardous waste generated in the facility in 2019.

E.6.2.1 Research and Development (Building 300) Low-Level Liquid Waste System

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in B300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2019, 186 m^3 of low-level liquid was processed through the B300 LLLWTS. Table 76 shows the historical volumes of LLLW processed through the B300 LLLWTS and also the total volume of B300 and B100 LLLW processed.

Table 76: Historical Records of Low-Level Liquid Waste Processed

	2015	2016	2017	2018	2019
Total Combined Low-Level Waste Liquid Processed (m^3)[a]	512	230	172.3[b]	131.5[c]	189.3[c]
Low-Level Waste Liquid Processed in B300 (m^3)[d]	74	195	46	123	186.5

a All low level liquid waste processed in Active Liquid Waste Treatment Centre for 2014-2016. This total includes laundry and decontamination and ALWTC facilities for 2014 and 2015. For 2016 the total is B100 and B300 and ALWTC. After 2017 all low level liquid waste is processed in B100 and B300.
b This includes 126 m^3 of low level liquid waste that was processed through the Active Liquid Waste Treatment Centre in Building 200.
c All Low-Level Liquid Waste processed through the low-level liquid waste treatment systems in B100 and B300.
d B300 LLLWTS came online in 2017 July.

The total activities given below are the combination of the Shielded Facilities, B300, and B100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the B300 and B100 LLLWTS during 2019 was 0.01 GBq, compared with 0.02 GBq released during 2018. The maximum release in a month during the year was 0.0004 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.0027 GBq for 2019 compared with 0.0026 GBq released during 2018. The maximum release in a month during the year was 6.1E-05 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Americium-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 77 provides a summary of the total activity released for both the B100 and B300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [28]. These values were revised in 2016.

Table 77: B100 and B300 LLLWTS Radioactive Releases

Radionuclide	Total 2019 Effluent (GBq)	Annual Release Limit[a] (GBq/a)	Total 2019 Effluent as a % of Annual Release Limit	Peak Release	
				Max. Monthly Release (GBq)	% of[b] Monthly DRL
Total (Total-Beta Analysis)[c]	0.01	–	–	0.0004	–
Sr-90	2.79×10^{-3}	1.56×10^{2}	1.78×10^{-3}	1.27×10^{-4}	1.09×10^{-3}
Cs-137	8.27×10^{-3}	1.39×10^{2}	5.94×10^{-3}	2.77×10^{-4}	2.38×10^{-3}
Total Alpha (As Pu-239 Equivalent)[d]	2.69×10^{-3}	1.33×10^{1}	2.02×10^{-2}	6.07×10^{-5}	5.47×10^{-4}
Historical Data Total Effluent (GBq)					
	2015[e]	**2016[e]**	**2017[e]**	**2018[e]**	**2019[e]**
Total (Total-Beta analysis)[c]	0.14	0.04	0.04	0.02	0.01

a The annual release limit is calculated by multiplying the DRL by 12.
b Derived Release Limits and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [28].
c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.
d Derived Release Limits and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11×10^{1} GBq/month [28].
e Years 2014 to 2016 effluent was all processed in ALWTC. 2017 effluent was processed in ALWTC and B300 LLLWTS. 2018 had all effluent processed in B300 and B100 LLWTS.

E.7 EFFLUENTS RELEASED

There were no radioactive or hazardous, liquid or gaseous effluents released from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in B300 Room B-33.

E.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

E.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX F WR-1 REACTOR

F.1 FACILITY OPERATION

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [56]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [57]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [56].

In 2017, the new LLLWTS as described in Section F.3 collected approximately 1000 L of liquid which was not enough to process and pump out to the river. This amount was carried over and processed in 2018. In 2019, the LLLW system processed a total of 2.8 m^3 of liquid waste.

Routine operations in the WR-1 facility, as defined by T*he Monitoring and Surveillance Plan for the WR-1 Deferment Period* [56], were carried out by the five (four and one trainee) Site and Nuclear Operations Technologists assigned to Building 100.

F.1.1 RADIATION EXPOSURES

Site and Nuclear Operations Branch personnel monitored the WR-1 facility. Site and Nuclear Operations staff that monitor WR-1 also support decommissioning activities in the ALWTC. Any such exposures were not recorded separately from those for other operations. The average and maximum individual whole-body effective dose received by facility staff for 2019 were 0.05 mSv and 0.06 mSv respectively. The average and maximum individual equivalent dose to the skin were 0.05 mSv and 0.06 mSv respectively. The collective effective dose was 0.24 person·mSv. There were no extremity doses in 2019.

The Site and Nuclear Operations Branch personnel participated in routine bioassay testing which involved bi-annual whole-body counts and gross beta of urine samples every 60 days. There was no indication of any internal radiation exposures to facility personnel.

There were no doses exceeding CNL's Action Levels or CNSC regulatory limits to personnel as a result of WR-1 activities during 2019.

F.2 FACILITY DOCUMENTATION AND STAFFING

There were no changes in the staffing or organization for the operating staff responsible for WR-1 in 2019.

No program changes were made for WR-1 in 2019. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

F.3 FACILITY CHANGES

All facility changes were performed as per the approved Engineering Change Control procedure [11]. .

Operational clean-up activities (covered under the current Environmental Assessment) were continued in the WR-1 facility, as well as sampling and characterization work in support of the source term study. These activities included the removal of the Transparent Header Test Facility (THTF) and the sampling of the sand in the crawlspace. The THTF was located in room 648 and consisted of a full scale cast acrylic transparent header and thirty transparent polyvinyl chloride (PVC) feeder tubes. It was a full scale model of a CANDU Primary Heat Transport System header. The THTF was removed to gain access to the floor slabs that the THFT was built on in order to help enable future decommissioning activities of the building.

Approximately 20 m³ of low concentration (3.4E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained.

F.4 FACILITY EQUIPMENT PERFORMANCE

During 2019, the operations status of WR-1 remained unchanged. There were no changes to the reactor's equipment. Facility maintenance was done as per the facility maintenance plan.

F.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

During 2019, all planned activities for systems required to be operated, tested and inspected were carried out as per the approved facility maintenance plan. Monthly housekeeping and fire prevention inspections were completed.

F.6 WASTES GENERATED

There were no radioactive and/or hazardous wastes generated in the facility as part of routine operations.

F.6.1 SOLID RADIOACTIVE AND/OR HAZARDOUS WASTES

Solid radioactive and/or hazardous waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

See Section 11.1 Waste Management Program for summaries of the volume of solid radioactive and/or hazardous waste generated in the facility in 2019. During 2019, 4.8 m^3 of low-level radioactive compactable waste and 0 m^3 non-compactible waste was generated from Building 100/WR-1 operations, and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

F.6.2 VENTILATION SYSTEM

The system operated satisfactorily during 2019. A chiller system was operated as required through the summer months. Routine Poly-Alpha-Olefin testing of the Building 100 HEPA filters was carried out satisfactorily. All filters had acceptable penetrations of less than 0.03%

F.6.3 LIQUID RADIOACTIVE AND/OR HAZARDOUS WASTES

Liquid radioactive and no hazardous waste was generated in the facility as part of routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of liquid radioactive and/or hazardous waste generated in WR-1 in 2019.

During 2019, 2.8 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Section E.6.2.1 in Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.7 EFFLUENTS RELEASED

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the facility as part of routine operations.

F.7.1 LIQUID RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

There are no liquid effluents generated from this facility.

F.7.2 GASEOUS RADIOACTIVE AND/OR HAZARDOUS EFFLUENTS

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Radioactive air emissions from the facility are included in Section 9.4 of this report. There were on hazardous air emissions from this facility.

APPENDIX G NON-NUCLEAR FACILITIES

G.1 FACILITY OPERATION

The WL non-nuclear facilities status and changes for 2019 are as noted in Table 78.

Table 78: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Shut Down in 2019	None	None	Buildings & Lands D&D Project Personnel, Facilities	Decommissioning initiated
304	Waste Clearance Facility	Shut Down in 2019	None	None	Buildings & Lands D&D Project Personnel, Facilities	Decommissioning initiated
306	Waste Clearance Facility	Removed in 2016	None	Removed from Use	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility - Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility - Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Operational	None	None	All Site/Visitors	No change
408	Stores	Removed in 2017	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Operational	None	None	Security and Common Services	No change
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
415	Warm Storage	Removed in 2017	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Operational	None	None	Transportation, Security and Stores	No change
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Operational	None	None	Buildings & Lands D&D Project Personnel, Facilities	Decommissioning initiated
426	Quonset: Cold Storage	Operational	None	None	Utility	No change
427	Cold Mechanical Storage	Removed in 2016	None	Removed from Use	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	Removed from Use	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Operational	None	None	Maintenance	No change
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	No change
597	Portable Boiler Building 1	Operational	None	None	Powerhouse Operators and Maintenance	No change
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hydro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

G.1.1 RADIATION EXPOSURE

There were no doses exceeding CNSC regulatory limits or CNL's Action Levels to personnel as a result of the operation of the non-nuclear facilities during 2019. A detailed account of employee's radiological exposures is provided in Section 7.

G.2 FACILITY DOCUMENTATION AND STAFFING

There were no policy, program or procedural changes for the non-nuclear facilities in 2019. There were no changes in organization in 2019, two senior staff retired and two new trainee Operators were hired.

G.3 FACILITY CHANGES

All facility changes were managed in accordance with the *Engineering Change Control* procedures [11].

G.4 FACILITY EQUIPMENT PERFORMANCE

Systems and equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2019, as noted in Table 78.

G.5 PLANNED MAINTENANCE TESTING AND INSPECTIONS

Routine maintenance was carried out, and equipment tests and inspection were completed in 2019 with no significant results, as noted in Table 42.

G.6 WASTES GENERATED

There were no radioactive and/or hazardous wastes generated in Non-Nuclear Facilities as part of routine operations.

G.6.1 DECOMMISSIONED BUILDINGS AND EFFLUENTS RELEASED

In 2019, four non-nuclear facilities, the Large Scale Vented Combustion Test Facility buildings, consisting of B308, B309, B310 and B311, were decommissioned. The final End-State Decommissioning Report will be prepared when all the other non-nuclear buildings on the South-side and North-side have been decommissioned. Decommissioning activities also commenced for Buildings 303, 304 and 424.

There were 1.25E+09 L and 3.83E+07 L of effluent released from buildings B422 (Outfall Monitoring Station) and B907 (Sewage Lift Station and Lagoons) respectively.

G.6.2 LANDFILL DUGOUT WATER MONITORING

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2019 the dugouts had very low water levels or were dry during the summer sampling period. The location of the dugouts are shown in Figure 13. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

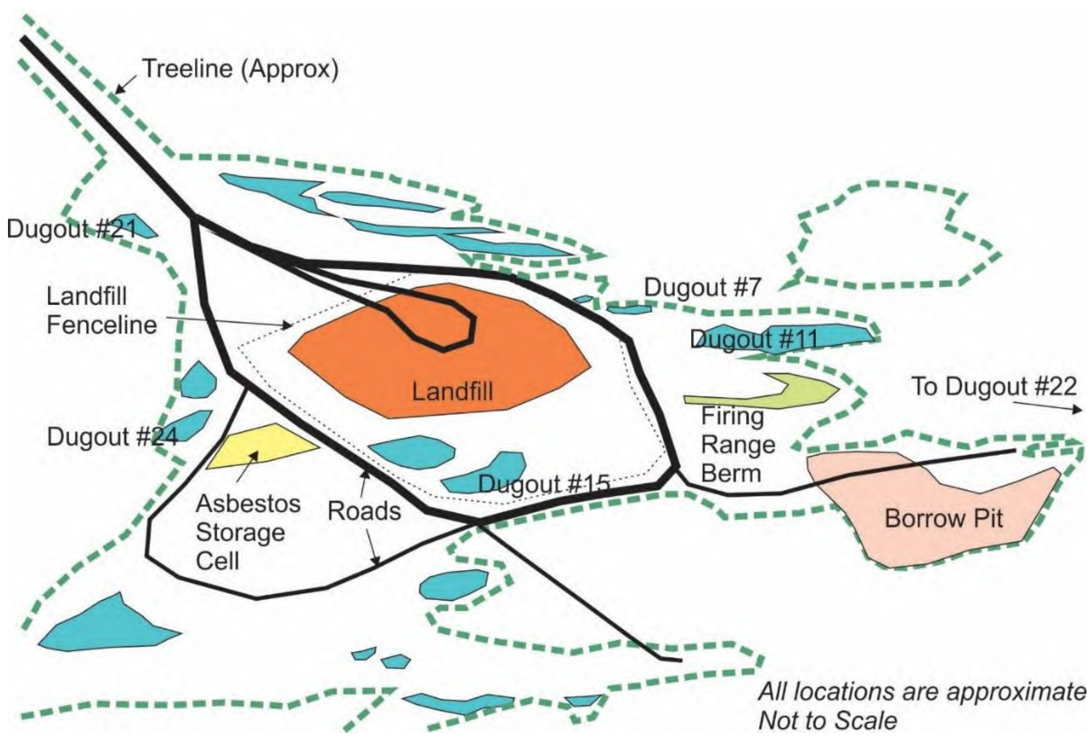

Figure 13: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Table 79 and Table 80 respectively. All alpha results for 2019 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. All beta results for 2019 were near the detection limits, and are below the drinking water screening level of 1.0 Bq/L. Both alpha and beta results for 2019 are consistent with previous results obtained from 2014 to 2018.

Table 79: Gross Alpha Results from the Landfill Dugouts

Sample	**Gross Alpha (Bq/L)**					
Location	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Dugout #7	< 0.07	< 0.11	< 0.14	< 0.17	< 0.17	0.07
Dugout #11	< 0.07	< 0.10	< 0.10	< 0.14	< 0.14	< 0.05
Dugout #15	0.12	< 0.16	0.16	0.10	0.10	0.28
Dugout #21	0.06	< 0.12	0.16	0.07	0.07	Dry
Dugout #22	0.08	< 0.13	< 0.11	< 0.14	< 0.14	0.11
Dugout #24	< 0.13	< 0.16	< 0.18	< 0.19	< 0.19	0.29

Table 80: Gross Beta Results from the Landfill Dugouts

Sample	**Gross Beta (Bq/L)**					
Location	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Dugout #7	0.04	0.17	0.19	0.17	0.17	0.11
Dugout #11	0.06	0.09	0.07	0.02	< 0.10	< 0.05
Dugout #15	0.19	0.40	0.35	< 0.07	< 0.07	0.12
Dugout #21	0.11	< 0.12	0.12	< 0.05	< 0.05	Dry
Dugout #22	< 0.04	< 0.13	< 0.06	< 0.13	0.13	< 0.05
Dugout #24	0.07	0.39	0.26	0.08	< 0.08	0.25

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past seven years, and a small amount was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019. The higher tritium level in Dugout 15 in 2019 is double the tritium level measured in 2018 - this may be the result of the higher amount of evaporation in 2019 leading to a concentration in the dugout water. All results are well below drinking water limits of 7000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2019 that contain < 4 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 81.

Table 81: Results from the Landfill Dugouts

Sample Location	Tritium (Bq/L)					
	2014	2015	2016	2017	2018	2019
Dugout #7	< 4	< 4	< 4	< 4	< 4	< 3
Dugout #11	< 4	< 4	< 4	< 4	< 4	< 4
Dugout #15	33	41	98	82	105	212
Dugout #21	< 4	< 4	< 4	NA	< 4	Dry
Dugout #22	< 4	< 4	< 4	< 4	< 4	< 4
Dugout #24	< 4	< 4	5.5	< 4	76	< 4

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill has been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing was conducted in 2018 to include Sr-90 and Tc-99 (Table 82), two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99. In 2019, only Sr-90 was measured, and was found to be at the detection limit. The water from these dugouts and wells is not used for human consumption.

Table 82: Sr-90 and Tc-99 Results from the landfill Dugouts in 2019

Sample Location	(Bq/L)	
	Sr-90	Tc-99
Dugout #7	< 0.10	NA
Dugout #11	< 0.10	NA
Dugout #15	< 0.10	NA
Dugout #21	Dry	Dry
Dugout #22	< 0.10	NA
Dugout #24	< 0.10	NA

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia

(N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron (8460 ug/L) were detected in 2019 in Dugout #15, this is higher than in 2018 (5460 ug/L), a continued increase in boron levels from 2017 (1630 ug/L). The value in the last two years is higher than the Drinking Water Guideline for that parameter (5000 ug/L). Molybdenum decreased to 74 ppb in 2019 from 145 ppb in 2018 in Dugout #21, remaining higher than the Drinking Water Guideline for that parameter (73 ug/L). Manganese was found to be at or higher than drinking water guidelines of 50 ug/L in Dugout #7 (50 ug/L), Dugout #15 (96 ug/L), and Dugout #24 (74 ug/L). No volatile organics were detected, and no other parameters were detected and/or at concentrations of concern.

Groundwater results will be discussed in the annual environmental monitoring report [26]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [27].

G.6.3 LANDFILL DUGOUT SEDIMENT MONITORING

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, as such no sediment sampling was conducted in 2019.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program.

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

ANNUAL COMPLIANCE MONITORING REPORT

WHITESHELL LABORATORIES ANNUAL COMPLIANCE MONITORING REPORT FOR 2020

UNDER LICENCE NRTEDL-W5-8.00/2024

WL-514300-ACMR-2020

Revision 0

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Approval date: 2021/04/27

UNRESTRICTED

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

REVISION HISTORY

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
0	2021/04/27	Issued as "Approved for Use".	R. Swartz	S. Cotnam	J. Gilbert
D2	2021/04/01	Issued for "Review and Comment".	R. Swartz	J. Gilbert S. Cotnam	
D1	2021/03/08	Issued for "Review and Comment".	A. Stelko R. Swartz	A. Bilton Z. Barnicoat C. Bennett J. Betteridge R. Bilinsky S. Brewer A. Caron C. Clark A. Coulas J. DeRuiter R. Desbois K. Duncan D. Fillion V. Golovko S. Khan C. Kitson D. Koopman S. Lawrence M. MacKay J. Martino S. McLean C. Oversby L. Rasmussen A. Rehman T. Reimer J. Reynolds T. Rosentreter B. Scott R. Swartz J. Turcotte	

EXECUTIVE SUMMARY

This annual compliance monitoring report for the 2020 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 and CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* as a summary report of annual compliance monitoring and operational performance.

This annual compliance report provides Canadian Nuclear Laboratories (CNL) 2020 performance data for WL and is organized by 14 Safety and Control Areas (SCAs)[1], as well as a report on each of the WL nuclear and non-nuclear facilities.

The following provides overall performance highlights for 2020 activities:

- There were no serious process failures at WL.
- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2020 were below their respective Derived Release Limits (DRL).
- Significant progress was made on decommissioning of Building 200, the former Active Liquid Waste Treatment Centre (ALWTC), with the building now partly demolished.
- The WL site maintained safe and compliant performance under COVID-19 Pandemic conditions and protocols.

Below is a summary of the annual compliance report for calendar year 2020.

- **SCA - Management System**: WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning, based on Canadian Standards Association (CSA) N286.6 and aligned with CSA N286-12, monitored through many means including audits, inspections, self-assessments and program/management system reviews.
- **SCA - Human Performance Management**: A significant effort towards training individuals in human performance related areas was initiated as a result of the fieldwork pause in November, and training of Apparent Cause Analysts is complete.
- **SCA - Operating Performance**: WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of "events". The total number of internal event reports raised continues to show a strong reporting culture. There were four Canadian Nuclear Safety Commission (CNSC) reportable events.
- **SCA - Safety Analysis**: Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL's nuclear facilities, helping meet health, safety, security, environmental and regulatory

[1] The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas.

requirements. The ALWTC Safety Analysis Report and Facility Authorization documents were obsoleted as the facility is now being demolished.

- **SCA - Physical Design**: The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba.
- **SCA - Fitness for Service**: The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. Regular preventative or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service.
- **SCA - Radiation Protection**: No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 3.0 mSv and collective doses remained below 50 person-mSv (33.3 person-mSv) for 2020. Members of the public received no measureable radiation doses. The Controlled Area reduction initiative was completed for the WL site north side.
- **SCA - Conventional Health and Safety**: Implementation of CNL's Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture. Safety advisories are regularly issued to staff about imminent issues that could impact their safety.
- **SCA - Environmental Protection**: The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment. Radiological emissions were 0.00019% of the Derived Release Limit (DRL) for air emissions and 0.67% of the DRL for liquids. The monitoring program confirms that the WL site is operating in a manner that protects workers, the public, and the environment. WL maintained their ISO-14001 registration, and are compliant to a number of CSA environmental standards.
- **SCA - Emergency Management and Fire Protection**: The Emergency Management program at WL was focussed on supporting COVID-19 planning and coordination efforts.
- **SCA - Waste Management**: WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 554 m^3 of radioactive waste to Chalk River Laboratories (CRL), and 513 m^3 (109,031 kg) of recycled waste shipped off-site.
- **SCA – Security**: The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for high-security sites. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC. The CNSC Order, which included the requirement to stand up a Tiered Response Force, was closed.
- **SCA - Safeguards**: There were no issues identified with International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL. The IAEA Technical group visited for planning use of remote camera monitoring equipment to support the upcoming fuel shipping campaign to CRL.

- **SCA - Packaging and Transport**: There were 230 radioactive transport packages making up 36 loads that were safely and successfully sent off-site, including approximately 528 m^3 of low-level waste and 26 m^3 of intermediate-level waste shipped to CRL.
- **Other matters of regulatory interest**: One virtual meeting of the WL Public Liaison Committee took place, with the other meeting replaced by a written update due to the COVID-19 pandemic. Numerous public information sessions and Indigenous engagements (mainly virtual) were held on the Whiteshell Reactor 1 (WR-1) in-situ decommissioning and overall activities of the WL Closure Project.
- **Facilities** (operating nuclear facilities, permanently shut down facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: significant progress in decommissioning the Active Liquid Waste Treatment Centre, Building 200, with the building now approximately 50% demolished; all waste has been removed from Shielded Modular Above Ground Storage (SMAGS) in preparation to turn the Building 923 into a Cask Loading Facility; work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes continued with commencement of off-site fabrication of extraction equipment; operational cleanout of the Health and Safety Facilities Buildings 402 and 305 was started in preparation for decommissioning/demolition; plus three non-nuclear facilities, the Containment Test Facility Building 303, Waste Clearance Facility Building 304, and the WR-1 Organic Monitoring Building 424 were demolished.

CNL is committed to achieve high standards of operational safety and security. The information and data presented in this report support the conclusion that safe and secure performance is being achieved at the Whiteshell Laboratories site, while enhancements are being implemented to further improve results.

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INTRODUCTION

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the eastern bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL.

Activities are now underway to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see the Decommissioning Strategies Section below).

Name:	**Whiteshell Laboratories**
Location:	1 Ara Mooradian Way Pinawa, Manitoba R0E 1L0

Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook* (LCH) *for* Whiteshell Laboratories (WL), herein referred to as "Licence Conditions Handbook") [2], and Section 3 Annual Compliance Monitoring Report of CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2020 January 01 to December 31.

This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to the 14 Safety and Control Areas as they are applied across all CNL.

The intent of this report is to provide sufficient detail to demonstrate how WL programs are meeting the regulatory requirements as it pertains to the licence [1] and the LCH for WL [2].

Facilities Included in this Report

Appendices A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities included in this report are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and Building 305), and WR-1 Reactor.

Summary of Licenced Activities

There are no new licenced activities. The WL Site Licence was previously renewed in 2019 for five years, effective 2020 January 01.

Decommissioning Strategies

As discussed in 2015, work is underway to complete decommissioning of the entire WL site (current schedule is to be complete in 2027). This includes leaving in-situ the selected WMA trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this change. The Environmental Impact Statement supporting this is in progress.

Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [5], advising that as an agent of Her Majesty in Right of Canada, AECL’s liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee remains valid and in effect, as per the communication issued on 2020 August 25 [6].

1 MANAGEMENT SYSTEM

1.1 Management System Program

WL adheres to the Corporate Management System. See Section 1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL Quality Assurance Plan [7] supports the CNL Management System Manual [8] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to CSA N286-12 [9] and N286.6-98 [10].

1.2 Audits, Inspections and Self-Assessments

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL-wide Audits for the reporting year 2020.

As per the requirements of the Management System [8], both Safety Control Areas and Facilities conduct various audits, inspections, and self-assessments to ensure that the management system is functioning in according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate actions taken to resolve any deficiencies.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Corrective Action Program (CAP).

1.2.1 Audits

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL-wide Audits for the reporting year 2020.

External Audits

The external audit conducted at WL is summarized in the table below.

Table 1: External Audits

Title	Type of Audit	No. of Actions Raised	No. of Actions Completed
SAI Global S2 Surveillance Audit of the WL Environmental Management System	14001:2015	2	0

Internal Quality Audits

The internal audit completed by the Quality Audits and Processes branch in 2020 is summarized in the table below.

Table 2: Internal Quality Audits

Title	Audit Scope	No. of Actions Raised	No. of Actions Completed
Quality Audit of Environmental Protection	14001:2015	3	0

1.2.2 Inspections

CNSC Inspections

There were no CNSC inspections conducted at WL in 2020.

Inspections by Other Regulatory Bodies

A Physical Inventory Verification (PIV) inspection was carried out by the IAEA on 2020 November 04. This inspection was a sampling of accessible items containing Special Fissionable Material and changing of two IAEA Canister Seals. A Design Information Verification inspection was carried out by the IAEA on 2020 November 05. This inspection verified the information provided in the Design Information Questionnaire.

1.2.3 Self-Assessments

In 2020, there were 14 self-assessments conducted at WL covering various aspects of the Management System, including both safety and control areas, and various facilities.

Table 3: List of Self-Assessment Conducted at WL in 2020

Title	Facility/Department
Assessed the registration and control of radiation sources	WL Radiation Protection (RP)
Assessed the WL radiation dose reporting to NEW workers	WL RP
Assessed the WL RP Program Compliance Review	WL RP
Self-assessment on the WL Industrial Hygiene instrumentation inventories effectiveness	WL Occupational Safety and Health (OSH)
Self-assessment on Fall Protection Personal Protective Equipment (PPE) and High Angle Rescue (HAR) Equipment	WL OSH
Effectiveness of the implementation of the OSH Program at WL	WL OSH
Assessed the WL Sample Management Office	WL Environmental Protection
Assessed WL-510400-OI-366-01 – WL Lock Out Tag Out (LOTO)	WL Site and Nuclear Operations
Assessed the WL Integrated Work Control Process Procedure	WL Site and Nuclear Operations

Title	Facility/Department
Effectiveness and implementation of the Waste Management Specific Block Training provided at WL	WL Waste Management
Assessed records (Section 37 of the Nuclear Security Regulations SOR-2000-209	WL Emergency Services
Compliance of WL EM QA Plan WL-514200-QAP-001 to 17025, Control of Records.	WL Environmental Management
Compliance of Whiteshell Environmental Monitoring to the Whiteshell Environmental Monitoring QA Plan WL-514200-QAP-001 and to ISO/IEC 17025:2017, Internal Audits and Self-Assessments.	WL Environmental Management
Compliance of WL EM QA Plan WL-514200-QAP-001 Rev 1, Section 8.9 Management Reviews to ISO/IEC 17025:2017	WL Environmental Management

1.3 Management Reviews

A Quality Assurance Program/Management System Review is in progress for 2018/19 and 2019/20.

2 HUMAN PERFORMANCE MANAGEMENT

2.1 Human Performance Program

WL adheres to the Corporate Human Performance (HU) Program. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.1.1 Program Improvements and Accomplishments

The effectiveness of the HU program at WL has been enhanced through the following improvements:

- Apparent Cause Analysis (ACA) – In 2020 January, WL experienced a Site Event Day Reset (S-EDFR), and this event revealed a gap in the number of certified Cause Analysts on-site. WL had not conducted an ACA in a few years, therefore WL engaged the aid of a trained Cause Analyst from the Port Hope site. The analyst conducted the ACA and, at the same time, trained and certified five WL analysts. WL will continue the development of their newly certified Cause Analysts by partaking in the upcoming CNL sponsored TapRoot training initiative that will take place in 2021.
- Prior to the reduced operations as a result of the COVID-19 pandemic, WL personnel travelled CRL to observe and benchmark with the CRL Performance Assurance Team.
- For 2020, WL had planned to educate WL staff on the various Performance Assurance activities. The COVID-19 Pandemic hindered delivery of in-person training of the course *HU-1038 Human Performance Awareness – Fundamentals and Nuclear Safety Culture*. As a result, WL actively engaged the Performance Assurance Program to enable WL employees to participate remotely in the newly developed virtual HU-1038 sessions.
- On 2020 November 16, the WL Closure Project (WLCP) went into a ten-week fieldwork pause in response to an adverse trend in human performance. As a corrective action, the project took a proactive response to address several human performance issues and apparent gaps within WL's programs. A multidisciplinary team made up of OSH, RP and Work Planning professionals from across the CNL organization were assembled to guide and support the WL team through remobilization of field work. This team has been and will continue into 2021 to conduct comprehensive reviews and gap analyses of all relevant documentation governing and guiding the training of staff, and conduct of RP, OSH and Integrated Work Control (IWC) programs, with an emphasis on Job Hazard Analysis / Job Safety Analysis and IWC processes. Roll out of Phase A – Drive Accountability and Strengthen Communication initiative is underway. Meetings continue to be held with each level of the management team to review and gain feedback on the initiatives identified following an employee listening campaign on safety. A significant effort towards training individuals in these areas has been initiated.

As a follow up to safety concerns expressed by the WL Site Safety and Health Committee to the CNL Health and Safety Policy Committee, the WL General Manager held a series of listening campaigns to gather feedback about concerns employees might have about site safety. Feedback received has been rolled up into actions for management to implement as part of the above fieldwork pause initiatives, with the remainder assigned to the Site Safety and Health Committee for resolution.

2.2 Training Program

2.2.1 Program Improvements and Accomplishments

The effectiveness of WL Training Program has been enhanced through the following improvements:

- WL Training developed and provided in person Return to Work COVID-19 training to employees and contractors.
- Through the COVID-19 pandemic restrictions and a largely remote workforce, WL Training provided virtual ergonomic awareness documentation and one-on-one assessments to remote workers to ensure work areas were ergonomically sound.
- WL New Employee Orientation (NEO) evaluation was initiated.

2.2.2 Required Training

CNL maintains a list of positions and roles requiring SAT training programs in compliance with REGDOC-2.2.2, Personnel Training [11].

Training and Development evaluated the training programs for listed positions and roles at WL against the main elements of SAT. The results led to initial individual action plans which are being managed and further evaluated by the Curriculum Review Committees (CRC). Additional corrective actions and program improvements will be identified and managed by the CRCs going forward.

Some WL listed positions and roles require additional training documentation development to achieve full SAT-compliance. Current workers are qualified based on existing training programs combined with their years of experience in the role. Existing training programs include classroom training, practical training, computer-based training, and mentor style training. These experienced workers will assist as Subject Matter Experts (SMEs), in the development of training documentation that is required to achieve full SAT-compliance.

All WL personnel, both employees and contractors are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work under the licence [1]. Table 4 provides a list of federally/provincially legislated training courses that appear in position-specific training plans at WL.

Table 4: WL Operating Staff Training in 2020

Course Code	Course Title	No. of Attendees
FIRE-1001-Online	Fire Prevention	97
FIRE-3001	Fire Extinguisher – Practical	104
OSH-1001-Online	Crane (Safe Indoor Hoist) – Theory	3
OSH-1002-Online	Lift Truck Operation – Theory	10
OSH-1003	Aerial Platform – Theory	20
OSH-1003-Online	Aerial Work Platform – Theory	10
OSH-1004	Lock Out / Tag Out	54
OSH-1004-Online	Lock Out / Tag Out Exam	27
OSH-1004-Virtual	Lock Out / Tag Out (Virtual)	27

Course Code	Course Title	No. of Attendees
OSH-1005	Working at Heights	69
OSH-1005-Online	Working at Heights	34
OSH-1005-Virtual	Working at Heights (Virtual)	4
OSH-1006	Confined Space Entry	14
OSH-1006-Online	Confined Space Exam	7
OSH-1007	Asbestos Module 6E	6
OSH-1033-Online	Ladder Safety	20
OSH-1034-Online	Hazard Prevention Program	20
OSH-1042-Online	WHMIS – 2015	18
OSH-1046-Online	Heat Stress	9
OSH-3003	Aerial Platform – Generic Practical	10
OSH-3003-Multi	Aerial Platform – Practical (All Equipment Codes)	5
OSH-3005	Working at Heights – Practical	34
OSH-9060-Online	MSDS Online Viewer Training	1
TD-1016-Online	Preventing Violence in the Workplace	16
TD-9030-Online	Harassment Prevention	39
HU-1038	Human Performance Awareness – Fundamentals & Nuclear Safety Culture	34
HU-1036-Online	Pre job Brief	24

2.2.3 Contractor Training

Before accessing the Whiteshell Laboratories (WL) site, contractors are required to complete the following in person training:

- Contractor Safety Orientation,
- Radiation Protection Group 4 (if required),
- CNL Contractor Code of Conduct, and
- CNL COVID-19 Awareness and Daily COVID-19 screening.

WL utilizes the contract terms and conditions, in addition verifying and approving the contractor company's safety programs and training records, to ensure contractors are qualified to work at WL.

WL oversees contractors' work in the field and all WL work control protocols apply.

2.2.4 Training Evaluations Summary

In 2020 there were nine Tired Response Force (TRF) Instructor Evaluations performed and documented in CNL's electronic records repository, ATOM.

In addition, WL utilizes trainee feedback forms to capture learner input as part of training program improvement and maintenance activities.

3 OPERATING PERFORMANCE

3.1 Operating Program

WL adheres to the Corporate Operating and Decommissioning Programs. See Section 3.1 and Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review board and other internal assessment activities such as self-assessments and audits (see Section 1.2).

The CNSC has previously been notified of revisions to Facility Authorization documents [12] (note that this was the voiding of a Facility Authorization), as per the *Licence Conditions Handbook*.

3.1.1 Operations / Decommissioning Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [13] for WL are given in Appendix A through Appendix F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [14] processes.

Relevant modifications to WL facilities are given in Appendix A through G.

3.2 Reporting Requirements

3.2.1 Reportable Events

In 2020, there were 4 events that occurred at WL that were deemed reportable to the CNSC. They are listed in the table below.

Table 5: Reportable Events to the CNSC at WL in 2020

Event No.	Title	SCA	Facility (if applicable)
ERM-20-0126	WL- Reportable Event - Failure to Submit Notification to CNSC of Revised Criticality Safety Document (CCSF-123400-CSD-001 / CSD-11)	Operating Program	WL CCSF
ERM-20-1140	WL - Breach of Security Protocol	Security	N/A
ERM-20-1772	WL - Reportable Event – Non Compliance to the WL Waste Management Area Facility Authorization WLWMA-00583-FA-001	Operating Program	WL WMA
ERM-20-2412	WL - Reportable Event - Confirmed COVID-19 Case at WL	Other	N/A

Reports to other regulatory agencies consisted of three Hazardous Occurrence Investigation Reports (HOIR) made to Employment and Social Development Canada (see Section 8 Conventional Health and Safety for further details).

3.2.2 Trending of Events Related to Operational Activities

As events at WL occur, they are recorded in the Improvement Action (ImpAct[2]) system. This information is regularly reviewed and analyzed to identify any trends. Event Code based trend reports are also prepared to analyse ImpAct data on monthly bases to identify trends. Monthly site wide and WL specific trend reports are prepared by CRL Performance Assurance and shared with WL. WL specific trends are also specified in the monthly Contractor Assurance System scorecard.

The following trends were identified and raised as ImpActs:

- ERM-20-2866, WL - Adverse Trend in Safety Events at Whiteshell, and
- ERM-20-2920, WL TREND - Engineering Change Control (ECC) Non-Compliance.

The use of the ImpAct process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

In 2020, a total of 350 ImpActs were raised by CNL employees at WL (report is based on responsible department). ImpActs raised in 2020 being lower than previous years is due to the reduction in operations and a large number of employees working from home as a result of the COVID-19 pandemic.

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

The following table summarizes ImpActs raised over the past 5 years.

Table 6: Number of ImpActs raised at WL

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2016	9	0	1	25	491	526
2017	5	0	0	42	448	496
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609
2020	13	0	3	58	276	350

a Level 0 will be assigned if the ImpAct is deemed to be a “duplicate or non- problem” and a recommendation to close the Impact will be given.

2 ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

4 SAFETY ANALYSIS

4.1 Safety Analysis Program

WL adheres to the Corporate Safety Analysis Program. See Section 4.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, three facilities have SARs and Facility Authorizations: Shielded Facilities (SF), WMA and Concrete Canister Storage Facility (CCSF). The ALWTC SAR and Facility Authorization documents were obsoleted in 2020 [12]. An assessment is in progress to determine if the SF SAR needs to be revised.

A SAR is being prepared for the standpipe/bunker remediation, Intermediate-Level Liquid Waste (ILLW) Processing Centre and conversion of the SMAGS building to a Cask Loading Facility. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC for acceptance, before these facilities are operated.

4.2 Nuclear Criticality Safety Program

WL adheres to the Corporate Nuclear Criticality Program. See Section 4.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The effectiveness of the Nuclear Criticality Safety (NCS) program at WL has been enhanced through the following:

- Continuing to provide technical and regulatory site-wide support to various CNL groups to improve and strengthen the Program processes.
- Holding semi-annual meetings with CNSC staff, to provide updates on the status of the NCS program.
- Providing general NCS training to WL.
- Providing NCS Program review on WL engineering risk assessments.

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSDs) for the Waste Management Area (CSD-27), the Cask Loading Facility (formally the Whiteshell Laboratories SMAGS Building B923) (CSD-73) and the Intermediate-Level Liquid Waste Processing Centre (CSD-74) are in progress to allow retrieval of waste from the WMA. The remaining WL CSDs have not been updated during this review period.

5 PHYSICAL DESIGN

5.1 Design Program

WL adheres to the Corporate Design Program. See Section 5.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In 2020 March, a Certificate of Authorization was renewed with Engineers Geoscientists Manitoba. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of The Engineering and Geoscientific Professions Act.

5.1.1 Safety Related Structures Systems and Components

Any changes affecting Safety Related Structures, Systems and Components (SSC) at WL were controlled through the Engineering Change Control Process [14].

5.2 Pressure Boundary Program

WL adheres to the Corporate Pressure Boundary Program. See Section 5.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL *Pressure* B*oundary (PB) Quality Assurance (QA) Manual* [15] defines the pressure boundary measures applicable to WL facilities and is consistent with CNL's PB Program requirements.

The *Pressure Boundary Quality Assurance Manual* [15] was previously accepted by Inspection and Technical Services (ITS) Manitoba. A Certificate of Authorization, issued by ITS, permits CNL to perform Pressure Boundary work as described in the Quality Assurance Manual until expiry in 2021 March. The process of updating the *Pressure Boundary Quality Assurance Manual* [15] and renewal of this Certificate of Authorization will commence in 2021 January.

6 FITNESS FOR SERVICE

6.1 Fitness for Service Program

The Site and Nuclear Operations Branch provides monitoring and operation of building's, processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedure reviews are conducted on a five year cycle. As facilities are decommissioned procedures are obsoleted. Procedures to operate the facilities in order to enable decommissioning efforts are prepared as required.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service, WL staff ensure that critical systems, structures and components related to the safe decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities that ensure that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the facility's Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plan are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed as they are identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

6.1.3 Condition of Structures

Waste storage structures include the WMA bunkers and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [16] has been developed and implemented to confirm the ongoing fitness-for-service of the concrete storage facilities (termed “bunkers”) at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done, to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site they will be removed from the inspection process. The 2020 annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [16].

Although the SMAGS building is not a bunker it is included in the bunker inspection. A repair, conducted in 2016, to the north wall of SMAGS that extended into the core of the slab, remained stable through 2020 with no new crack expressions (the walls of SMAGS are pre-cast concrete slabs). All other repair items for the bunkers and SMAGS were minor in nature and were tracked through the WL work request system.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes. Requests for patching were placed in 2020, several canisters will require more extensive patching of pour pockets that have gradually become more noticeable over time, however no increased field was noted. There was no degradation of the exposed metallic portions of the canisters. Fifteen of sixteen canisters were opened in 2020 to allow for borescope inspections of the accessible portions of the fuel baskets. The visible portions of the baskets appeared to be in good condition.

Environmental monitoring was conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers, SMAGS or concrete canisters.

7 RADIATION PROTECTION

7.1 Radiation Protection Program

WL adheres to the Corporate Radiation Protection Program. See Section 7 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2020 included:

- Reconfiguration of the WMA Controlled Area exit building and change facility;
- Waste Holding Controlled Area established on north side of WL site;
- Implementation of gamma walk-through monitors at the exit from the WL site north side and entry into the new module office complex at the WMA;
- Introduction of alpha-beta scintillation floor contamination monitors for building release monitoring;
- Implementation of survey meter calibrations by an external RP instrumentation calibration service
- Acquisition and use of water misting equipment for nuclear facility demolition;
- Formal registration of radioactive material storage areas; and
- Clarification of site processes for the de-registration and disposal of radiation sources.

The planning of radiological work is integrated into the WL site work control and planning process. Health Physics and Radiation Surveyor staff are engaged in the provision of radiological safety and ALARA assessments, providing authoritative advice regarding radiation protection matters, preparing radiological safe work documents, providing oversight of the execution of radiation work, and in the planning and conduct of radiological clearance surveys. Health Physics staff develop radiological work assessments in support of the safe planning and conduct of WL decommissioning activities. Radiological clearance plans, surveys and release reports are completed for building demolitions.

WL RP performance metrics are measured and tracked weekly through WL Closure Project status reports and quarterly through the WL Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies and opportunities for improvement, establish and effectively implement corrective and preventative action plans.

7.1.2 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2020, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to Thermoluminescent Dosimeters (TLD) badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition[3]. Table 7 summarizes maximum daily recorded doses and dose rates for PAD work in 2020 and previous four years, and a summary of PAD alarms. In 2020, the maximum PAD recorded daily dose received by a worker was 0.28 mSv and the highest dose rate measured in the year was 5.56 mSv/h. These were associated with planned exposures associated with decommissioning activities in the Building 200 ALWTC. There were no PAD dose alarms and 28 PAD dose rate alarms in 2020. The PAD alarms are summarized in Table 7.

Table 7: Personal Alarming Dosimeter Summary

	2016	2017	2018	2019	2020
PAD – Maximum Daily Dose (mSv)	0.08	0.17	0.24	0.42	0.28
PAD – Maximum Dose Rate (mSv/hr)	1.44	1.99	4.95	5.82	5.56

At the beginning of 2020, managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by First Line Managers and Supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified, planned and optimized. At the end of 2020, there was 1 individual with a readjusted DCP of 4 mSv, 4 individuals with a readjusted DCP of 3 mSv, 23 individuals with an assigned DCP of 2 mSv, and the remainder of workers with a DCP of 1 mSv. Workers with readjusted DCPs were approved by a Health Physicist for planned radiological work associated with Building 200 decommissioning. No worker dose exceeded their assigned DCP in 2020.

7.1.3 Contamination Control

Regular contamination surveys of workplaces, material transfers and personnel exiting nuclear facilities and controlled areas are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls and to warn of abnormal of unplanned airborne contamination conditions.

Table 8 shows the number of personnel, workplace and material contamination events identified in 2020 and over the past five years. None of the contamination events in 2020 resulted in a recordable whole-body, skin or internal dose.

In 2020, material contaminations were associated with historical surplus equipment being found with low level contamination during operational clean-up surveys or during material transfer surveys.

In 2020, there were no airborne contamination exposure events and no radioactive material spills.

The following table outlines contamination events that occurred at WL in 2020 and over the past five years:

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[3] PAD dose rate alarm set points are selected to alert workers of the presence of local areas of higher gamma dose rates or an unexpected increase in work area dose rates. Work may continue if repositioning to a lower dose rate area below the alarm point and dose rates are confirmed to below dose rate back-out points.

Table 8: Contamination Events

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	**Personal Clothing**[a]	**Radiological Work Clothing**[b]	**Total**	**Surface**[c,d]	**Vehicle / Materials**[b,c]
2016/17 FY	1	0	0	1	8	
2017/18 FY	0	0	1	1	3	
2018/19 FY	1	0	5	6	6	0
2019 CY	3	0	4	7	2	4
2020 CY	2	0	3	5	1	1

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area.
b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area.
c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas
d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2020, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2020 December 31, the total number of registered sealed or contained sources at WL, was 54. Two Cesium (Cs)-137 instrument calibration sources were added to the registry and one Americium (Am)-241 source was removed from the registry and sent for waste storage at the WL WMA.

7.2 Dosimetry

WL uses the CRL licensed Dosimetry Service Provider (DSP) for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory standard S-106 [17] requires external exposure measurements to meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[4].

[4] Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.1).

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a committed effective dose from occupational intakes exceeding 1 mSv per year.

7.2.1 Radiation Doses to Personnel

Table 9 to Table 12 summarize the monitored radiation doses at the WL site for 2020. Doses are summarized for employees, contractors and visitors and are subdivided into Nuclear Energy Worker (NEW) and non-NEW status. Doses in the tables of this report do not include doses received by WL employees and contractors working at sites other than WL.

In 2020, there were no exceptions for individual monitoring of non-CNL employees and visitors at WL.

There were no operations of exposure devices in 2020 which required employees or contractors to be placed on a two-week dosimetry period, and there were no formal dose calculations required during 2020 for local area skin contamination.

No neutron dosimeters were assigned to employees during 2020.

In 2020, 168 individuals underwent internal bioassay, which involved urinalysis and/or whole-body counting. Sixteen individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective dose estimates were necessary as a result of any bioassay sampling in 2020.

Table 9: Effective Dose for WL

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (person·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	348	115	219	6	8	-	-	-	2.97	0.14	0.10	33.32
	Contractor	26	21	5	-	-	-	-	-	0.05	0.02	0.00	0.12
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Contractor	114	114	-	-	-	-	-	-	0.00	-	0.00	0.00
	Visitor	69	69	-	-	-	-	-	-	0.00	-	0.00	0.00
	Totals	559	321	224	6	8	0	0	0	-	-	-	33.44

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons that were historically employee and/or contractor NEWs, but have returned to WL as visitor while retaining their historical NEW status.

Table 10: Distribution of Equivalent Dose to the Skin for WL

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (person·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	**Employee**	348	115	213	6	11	3	-	-	6.80	0.26	0.18	61.05
	Contractor	26	21	5	-	-	-	-	-	0.05	0.02	0.00	0.12
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	**Contractor**	114	114	-	-	-	-	-	-	0.00	-	0.00	0.00
	Visitor	69	69	-	-	-	-	-	-	0.00	-	0.00	0.00
Totals		559	321	218	6	11	3	0	0	-	-	-	61.17

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons that were historically employee and/or contractor NEWs, but have returned to WL as visitor while retaining their historical NEW status.

Table 11: Distribution of Equivalent Dose to the Hands and Feet for WL

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (person·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	35	7	8	7	10	3	-	-	6.46	1.83	1.46	51.18
	Contractor	1	-	1	-	-	-	-	-	0.23	0.23	0.23	0.23
	Visitor[c]	0	-	-	-	-	-	-	-	-	-	-	-
Non-NEW	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Totals		36	7	9	7	10	3	0	0	-	-	-	51.41

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons that were historically employee and/or contractor NEWs, but have returned to WL as visitor while retaining their historical NEW status.

Table 12: Summary of Dose Components Received as a Result of Licensed Activities for 2020[a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	348	33.32	2.97	0.14	0.10	348	61.05	6.80	0.26	0.18	35	51.18	6.46	1.83	1.46
	Contractor	26	0.12	0.05	0.02	0.00	26	0.12	0.05	0.02	0.00	1	0.23	0.23	0.23	0.23
	Visitor[d]	2	0.00	0.00	-	0.00	2	0.00	0.00	-	0.00	0	-	-	-	-
Non-NEWs	Contractor	114	0.00	0.00	-	0.00	114	0.00	0.00	-	0.00	0	-	-	-	-
	Visitor	69	0.00	0.00	-	0.00	69	0.00	0.00	-	0.00	0	-	-	-	-
	Total	559	33.44	-	-	-	559	61.17	-	-	-	36	51.41	-	-	-

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor[d]	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Non-NEWs	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Total	0	0.00	-	-	-	0	0.00	-	-	-	0	0.00	-	-	-

a All quantities are measured in mSv unless otherwise noted.
b Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
c Average of all measured doses that include the zero dose value, rounded to two decimal places.
d Visitor NEWs are persons that were historically employee and/or contractor NEWs, but have returned to WL as visitor while retaining their historical NEW status.

7.2.1.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2020 was 2.97 mSv and the site collective dose was 33.4 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the five-year dosimetry period from 2016 to 2020 at WL was 7.24 mSv.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2020 was 6.80 mSv and the site collective dose was 61.2 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2020 was 6.46 mSv and the site collective dose was 51.4 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2020, the maximum individual effective dose from the time the pregnancy was declared at WL was 0.01 mSv to the end of the calendar year.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2020, the maximum individual effective dose to a non-NEW at WL was 0.00 mSv.

Table 13 provides a summary of radiation doses by worker group in 2020. The majority of radiation doses were received by RP and Trades staff, and 79% of their doses were attributable to Building 200 ALWTC decommissioning activities.

7.2.1.2 Radiation Dose Changes or Trends

Table 14 shows external whole body dose received from 2016 to 2020, and Figure 1 displays the maximum individual and collective dose from 2001-2020.

Worker doses have been on the rise since 2017, as WL decommissioning activities began to focus on buildings and facilities with increased radiological hazards. The increase in dose in the past several years can be attributed primarily to the decommissioning activities of Building 200 (ALWTC). The number of workers receiving occupational doses above 0.2 mSv in a calendar year has been staying steady at about 40 workers in recent years with 2020 being down to 25 workers. The number of workers receiving doses above 1 mSv reduced to below 10 workers from below 15 workers the previous year.

7.2.2 Program Exceedances

During 2020, radiation dose to all persons working at WL were below the WL dose Action Levels [2] and the respective CNSC regulatory limits [18]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 13: Summary of Worker Group Radiation Doses at WL for 2020

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	Person·mSv	Person·mSv	Person·mSv
Nuclear Facilities						
SF Staff (HCF and IFTF)[c]	6	0.10	0.20	0.58	1.35	0.71
WR1 and ALWTC Staff	4	0.05	0.09	0.20	0.20	0
WMA and CCSF Staff[c]	5	0.06	0.19	0.32	0.32	0
Support Workgroups						
Radiation Protection Staff [d]	42	0.31	2.40	13.20	26.03	29.32
Trades Staff [e]	47	0.26	2.97	12.29	26.09	19.27
All Remaining Staff						
Other Staff [f]	384	0.02	0.49	6.85	7.18	2.11
WL Site[g]	488	0.07	2.97	33.44	61.17	51.41

a Includes photon and neutron; there were no tritium committed effective doses for 2020.

b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.

c HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; ALWTC= Active Liquid Waste Treatment Center; WMA= Waste Management Area; CCSF= Concrete Canister Storage Facilities; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.

d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.

e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL site in general.

f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.

g WL Site includes 348 CNL staff (WL and staff visiting from other CNL sites) and 140 contractors working at the WL site during 2020.

Table 14: WL External Whole-Body Dose Performance 2016 to 2020

Performance Metric	2020	2019	2018	2017	2016
Site Collective Worker Dose (p-mSv)	33.44	49.6	40.2	19.9	16.5
Max Individual Worker Dose (mSv)	2.97	3.09	1.65	1.41	0.36
Number of Workers > 0.2 mSv in a year	25	38	39	42	30
Number of Workers > 1 mSv in a year	8	14	12	1	0
PAD[a] – Maximum Daily Dose (mSv)	0.28	0.40	0.24	0.17	0.08
PAD – Maximum Dose Rate (mSv/h)	5.56	5.82	4.95	1.99	1.44

a Personal Alarming dosimeter.

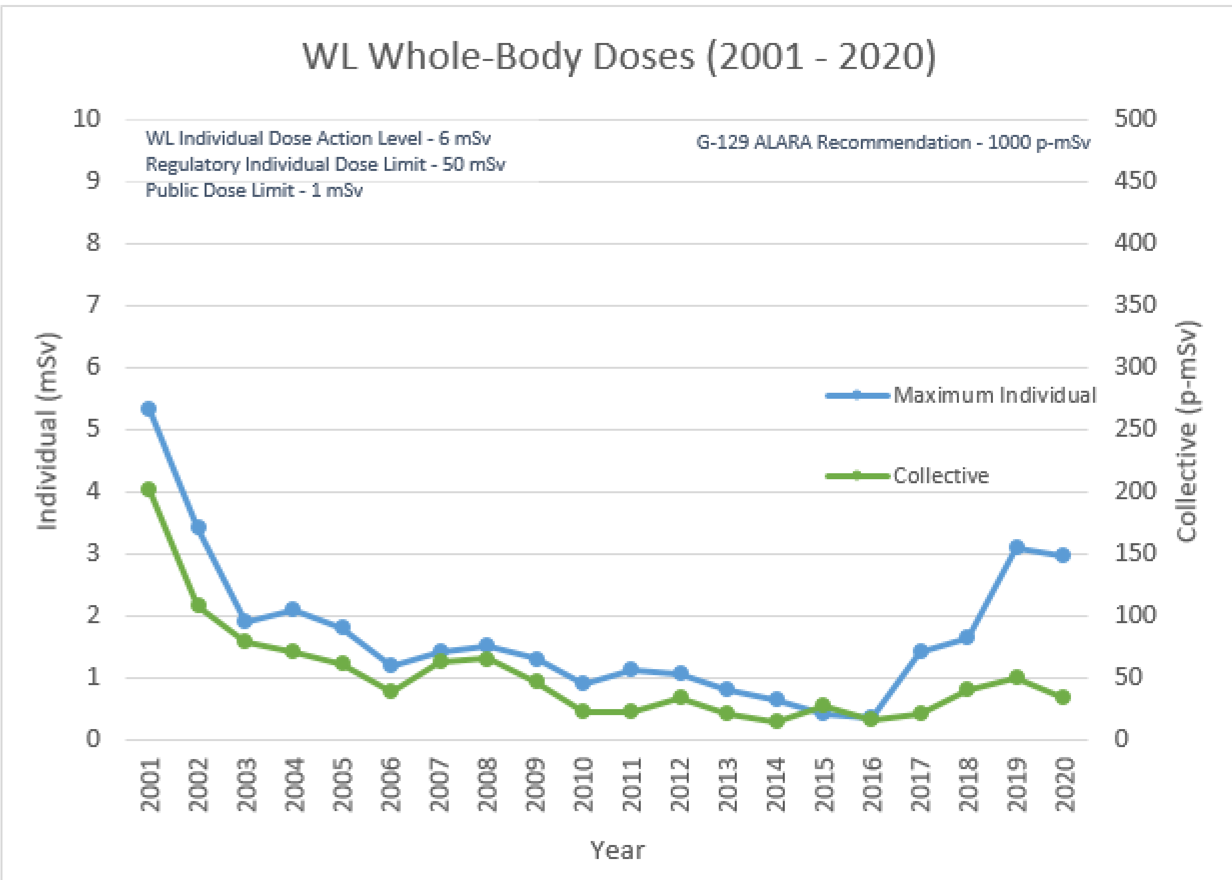


Figure 1: Whole-Body Effective Doses (2001 – 2020)

8 CONVENTIONAL HEALTH AND SAFETY

8.1 Conventional Health and Safety Program

WL adheres to the Corporate Conventional Health and Safety Program. See Section 8 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives are continuing or began in 2020:

- WL OSH specialists continued to work with the Health Centre on conducting the required audiology testing.
- OSH presence in the field continued at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to WL’s internal safety success.
- Contractors continued to be “pre-qualified” prior to bidding on WL contracts. The pre-qualification process involves reviewing safety statistics and the safety programs of the potential bidders.
- WL continued to participate in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- There were 19 internal Safety Advisories sent to WL site employees. The bulletins are intended to inform WL employees about imminent issues that could impact their safety. WL continued to be proactive in the approach to safety.
- Near Miss Reporting (a known industry best practice) continued with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 15). Near Miss reporting at WL always includes an investigation/fact finding session. The majority of Near Miss reports also generate an ImpAct. Whether an ImpAct is generated or not, the possibility of a human error trap being involved in the Near Miss incident is always considered, evaluated and followed up as appropriate.
- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.
- See Section 2.1.1 for a discussion on the initiatives taken as a result of the 2020 November WL fieldwork pause.

Table 15: Summary of WL Near Miss Reporting

Year	2016	2017	2018	2019	2020
Near Miss Reported	79	60	53	46	10

Summary of changes to the OSH Program procedures/processes:

- A review / re-assessment of Personal Protective Equipment and Clothing (PPE&C), specifically head protection, at the Whiteshell site was completed. This resulted in revealing that the type, class and expiration of hard hats on site did not meet the requirements. A hard hat campaign was initiated to remove all expired hard hats in addition to obtaining the appropriate class and type for the work being carried out on site.

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis.

In 2020, the WL Site Safety and Health Committee received 93 inquiries out of which 6 remained open and in progress. There was one inquiry carried over from 2019. The Site Safety and Health Committee acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 50 site health and safety inspections completed in 2020.

8.1.3 HOIRs and Lost-Time Injuries

There was 1 lost time injury reported to Employment and Social Development in 2020 at WL. There were 3 hazardous occurrences (HOIRs) at WL that were reported to Employment and Social Development Canada in 2020. CNSC staff received copies of these notifications, as per the requirements of the CNSC REGDOC-3.1.2 [3].

The following is a Summary of injury rate data for the last 5 years.

Table 16: Summary of WL Injury Rate Data

	2016	2017	2018	2019	2020
WL Employees					
Person Hours Worked	684,450	706,000	688,000	642,000	584,030
Lost-Time Injuries	1	3	1	0	1
Working Days Lost	5	27	5	0	2
Frequency[a]	0.29	0.85	0.28	0	0.34
Severity[b]	1.46	7.76	1.45	0	0.68
WL Contractors[c]					
Lost Time Injuries	0	1	0	0	0
Working Days Lost	0	0[d]	0	0	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

c The Number of Person Hours worked are not divulged by Contractors, as such Frequency and Severity rates cannot be calculated.

d Number of days lost is unknown as the contractor terminated the employee.

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2020.

9 ENVIRONMENTAL PROTECTION

9.1 Environmental Protection Program

WL adheres to the Corporate Environmental Protection (EnvP) Program. See Section 9 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

WL has an integrated Environmental Protection Program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program, and the Groundwater Monitoring Program. The WL Environmental Protection Program is designed to implement the requirements of:

- CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [19],
- CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [20],
- CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [21],
- CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [22],
- CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [23], and
- ISO 14001:2015, *Environmental Management Systems* [24].

The integrated Environmental Protection Program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

This report will focus and discuss the implementation of the WL Effluent Verification Monitoring Plan [25]. This plan defines the methodologies and protocols followed in performing the effluent verification monitoring required in CSA N288.5-11 [20].

The WL site has maintained its ISO 14001 [24] registration in 2020 with initial registration in 2010.

The CNSC has previously been notified of revisions to *Environmental Protection documents* [26], as per the *Licence Conditions Handbook.*

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control (QA/QC) programs as required by CSA N288.5 [20]. General quality assurance objectives for CNL's Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [27] for analytical laboratories.

Whiteshell Laboratories Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 2,470 quality verification tests during 2020 on WL's radiochemical counting equipment. Of these tests, 98.4% fully complied with acceptance criteria. The results of these tests are shown Table 17.

Table 17: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	705	4	99.4
Total Beta (Instrumentation)	705	20	97.2
Gamma (Instrumentation)	396	2	99.5
Tritium	664	13	98.0
2020 Total	**2470**	**39**	**98.4**

In 2020, the WL Effluent verification program continued performing regular field Quality Verification testing on the Outfall, Lagoon, and Ditch effluent sampling (Table 18). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

In 2020, the WL Effluent verification program missed collecting a traveling blank for the Fall Discharge. In the event that abnormal effluent data was observed in the Lagoon samples, this traveling blank would be ruling out the possibility that the abnormal result was due to the process of transporting the samples, or due to other factors in the sampling environment besides the effluent. With no abnormal effluent data being generated from the lagoon, the impact of missing this sample is minimal, but the environmental program understands the importance of the sample and remains committed to collecting it in the future.

Table 18: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	N/A	N/A	4	100%
Conductivity	4	1.15 uS/cm	4	100%
Total Organic Carbon	4	< LMDL	4	100%
Phenols	4	< LMDL	4	100%
TSS	4	<LMDL	4	50%
Phosphorus	4	<LMDL	4	75%
Oil and Grease	4	< LMDL	4	100%
Mercury	4	0.0005 ug/L	4	75%
Chromium	4	< LMDL	4	100%
Copper	4	0.02 mg/L	4	75%
Magnesium	4	< LMDL	4	100%
Iron	4	< LMDL	4	100%
Lead	4	0.0002 mg/L	4	100%
Nickel	4	< LMDL	4	100%
Potassium	4	< LMDL	4	100%
Sodium	4	< LMDL	4	100%
Strontium	4	< LMDL	4	100%
Uranium	4	< LMDL	4	100%
Zinc	4	< LMDL	4	100%
Bromodichloromethane	4	0.003 mg/L	4	75%
Chloroform	4	0.129 mg/L	4	75%
Toluene	4	< LMDL	4	100%
Radiological Parameters:				
Gross Alpha	N/A	N/A	2	100%
Gross Beta	N/A	N/A	2	100%
Cesium-137	N/A	N/A	2	100%
Americium-241	N/A	N/A	2	100%
Potassium-40	N/A	N/A	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Lead-214	N/A	N/A	2	100%
Beryllium-7	N/A	N/A	2	100%
Strontium-90	N/A	N/A	2	100%
Plutonium-238	N/A	N/A	1	100%
Plutonium-239/240	N/A	N/A	1	100%
Sewage Lagoon				
Non-Radiological Parameters:				
Phenols	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
TSS	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Phosphorus	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Oil and Grease	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Mercury	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Chromium	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Copper	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Iron	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Lead	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Nickel	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Zinc	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Total Chlorine	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Radiological Parameters:				
Tritium	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Plutonium 238	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Plutonium 239/240	N/A (Missed Sample)	N/A (Missed Sample)	N/A	N/A
Ditches				
Non-Radiological Parameters:				
pH	N/A	N/A	2	100%
Conductivity	5	1.42 uS/cm	2	100%
Phenols	5	0.0002 mg/L	2	100%
TSS	5	0.26 mg/L	2	50%
Phosphorus	5	< LMDL	2	0 %
Oil and Grease	5	< LMDL	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Mercury	5	0.001 ug/L	2	100%
Chromium	5	0.0002 mg/L	2	100%
Copper	5	0.0186 mg/L	2	100%
Iron	5	< LMDL	2	100%
Lead	5	0.0002 mg/L	2	100%
Nickel	5	< LMDL	2	100%
Zinc	5	< LMDL	2	100%
Radiological Parameters:				
Gross Alpha	5	< LMDL	2	100%
Gross Beta	5	< LMDL	2	100%
Tritium	5	< LMDL	2	100%
Cesium-137	5	< LMDL	2	100%
Americium-241	5	< LMDL	2	100%
Cobalt-60	5	< LMDL	2	100%
Radium-228	5	< LMDL	2	100%
Europium-154	5	< LMDL	2	100%
Lead-210	5	< LMDL	2	100%
Thorium-228	5	< LMDL	2	100%
Thorium-230	5	< LMDL	2	100%
Thorium-234	5	< LMDL	2	100%
Uranium-235	5	< LMDL	2	100%
Radium-226	5	< LMDL	2	100%
Actinium-228	5	< LMDL	2	100%
Potassium -40	5	< LMDL	2	100%
2020 Total	**224**	**--**	**164**	**95%**

LMDL = Laboratory Method Detection Limit

Out of the 164 quality verification tests, 154 of these tests meet the acceptance criteria of the program, to yield a 95% pass rate. Reviewing the travelling blank data, and comparing it to the field results, the environmental program has concluded that the source being used for the travel blank water is slightly contaminated with Copper, Lead, Chloroform, and Bromodichloromethane. The traveling blank results for these parameters are not reflective of contamination being picked up while sampling.

In 2020, the WL Environmental Management group took part in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses were offered through the Canadian Association for Laboratory Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 19 and Table 20. There were four unacceptable test results out of thirty for the Environmental Research Associates inter-laboratory comparison studies, resulting in an 87% pass rate. The four unacceptable test results related to the analysis of a single sample, and the error resulted from the analyst processing and reporting on the wrong sample.

For the Proficiency Testing Canada inter-laboratory comparison studies, a 100% pass rate was achieved.

Table 19: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2020

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-32	Air Filter Radionuclides	Americium-241	(pCi/Filter)	74.7	33.87	53.3 - 99.6	Not Acceptable
MRAD-32	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	1390	43.24	902 - 1700	Not Acceptable
MRAD-32	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	351	447.57	288 - 460	Acceptable
MRAD-32	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	422	57.93	359 - 536	Not Acceptable
MRAD-32	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	694	249.28	569- 1060	Not Acceptable
MRAD-32	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	29.3	28.46	15.3 - 48.3	Acceptable
MRAD-32	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	66.4	62.56	40.3 - 100	Acceptable
MRAD-32	Water Radionuclides	Americium-241	pCi/L	45.3	45.95	31.1 - 57.9	Acceptable
MRAD-32	Water Radionuclides	Cesium-134	pCi/L	1520	1291.71	1150 - 1670	Acceptable
MRAD-32	Water Radionuclides	Cesium-137	pCi/L	2390	2273.87	2050 - 2720	Acceptable
MRAD-32	Water Radionuclides	Cobalt-60	pCi/L	2760	2659.10	2380 - 3170	Acceptable
MRAD-32	Water Radionuclides	Zinc-65	pCi/L	1190	1214.68	1060 - 1500	Acceptable
MRAD-32	Water Gross Alpha/Beta	Gross Alpha	pCi/L	165	121.40	60.2 - 228	Acceptable
MRAD-32	Water Gross Alpha/Beta	Gross Beta	pCi/L	158	110.43	79.0 - 217	Acceptable
MRAD-32	Water Tritium	Tritium	pCi/L	6280	5857.16	4730 - 7640	Acceptable
MRAD-33	Air Filter Radionuclides	Americium-241	(pCi/Filter)	22.2	23.42	15.8 - 29.6	Acceptable
MRAD-33	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	296	253.96	192 - 363	Acceptable

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-33	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	413	430.00	339 - 542	Acceptable
MRAD-33	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	497	527.03	422 - 631	Acceptable
MRAD-33	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	500	589.01	410 - 764	Acceptable
MRAD-33	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	26.1	34.21	13.6 - 43.0	Acceptable
MRAD-33	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	85.9	82.98	52.1 - 130	Acceptable
MRAD-33	Water Radionuclides	Americium-241	pCi/L	176	174.86	121 - 225	Acceptable
MRAD-33	Water Radionuclides	Cesium-134	pCi/L	911	790.81	688 - 1000	Acceptable
MRAD-33	Water Radionuclides	Cesium-137	pCi/L	1510	1459.55	1290 - 1720	Acceptable
MRAD-33	Water Radionuclides	Cobalt-60	pCi/L	1560	1517.84	1350 - 1790	Acceptable
MRAD-33	Water Radionuclides	Zinc-65	pCi/L	917	942.34	816 - 1160	Acceptable
MRAD-33	Water Gross Alpha/Beta	Gross Alpha	pCi/L	111	83.84	40.5 -153	Acceptable
MRAD-33	Water Gross Alpha/Beta	Gross Beta	pCi/L	194	225.67	97.0 - 267	Acceptable
MRAD-33	Water Tritium	Tritium	pCi/L	12000	11368.84	9040 - 14600	Acceptable

* MRAD: Multi-Media Radiochemistry

Table 20: Proficiency Testing Canada Accreditation Inter-Laboratory Comparison Program CNL WL - 2020

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2020	CO1A-1	Conductivity	(µS/cm)	623	612	94	Acceptable
	CO1A-2	Conductivity	(µS/cm)	575	562		
	CO1A-3	Conductivity	(µS/cm)	451	441		
	CO1A-4	Conductivity	(µS/cm)	828	810		
March -2020	CO4A-1	TSS	(mg/L)	10	9	93	Acceptable
	CO4A-2	TSS	(mg/L)	46	48		
	CO4A-3	TSS	(mg/L)	95	90		
	CO4A-4	TSS	(mg/L)	200	192		
March -2020	C15-1	pH	(pH units)	5.1	4.89	79	Acceptable
	C15-2	pH	(pH units)	7.12	6.97		

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
	C15-3	pH	(pH units)	3.34	3.17		
	C15-4	pH	(pH units)	8.25	8.22		
October-2020	CO1A-1	Conductivity	(µS/cm)	239	241	99	Acceptable
	CO1A-2	Conductivity	(µS/cm)	119	119		
	CO1A-3	Conductivity	(µS/cm)	544	545		
	CO1A-4	Conductivity	(µS/cm)	780	777		
October-2020	CO4A-1	TSS	(mg/L)	18	20	95	Acceptable
	CO4A-2	TSS	(mg/L)	77	77		
	CO4A-3	TSS	(mg/L)	101	103		
	CO4A-4	TSS	(mg/L)	187	189		
October-2020	C15-1	pH	(pH units)	5.08	5.09	92	Acceptable
	C15-2	pH	(pH units)	7.96	8.00		
	C15-3	pH	(pH units)	9.4	9.49		
	C15-4	pH	(pH units)	8.64	8.72		

9.3 Supplementary Studies

In 2020, the WL site began to do temporary enhanced monitoring on the effluent verification ditches for the year. The enhanced monitoring is being done to confirm the absence of a number of radiological and non-radiological parameters. The enhanced monitoring involved doing an open scan for Volatile Organic Carbons, semi-volatile organic carbons, and an expansion of the metals and gamma isotopes list currently being used to monitor the ditches.

Whiteshell is reviewing the data, and is deciding whether there is a need to add any of these parameters to the effluent verification monitoring program going forward.

9.4 Effluent Monitoring - Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [28] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, *Environmental Monitoring in 2020 at Whiteshell Laboratories* [29] and *2020 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

9.4.1 Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

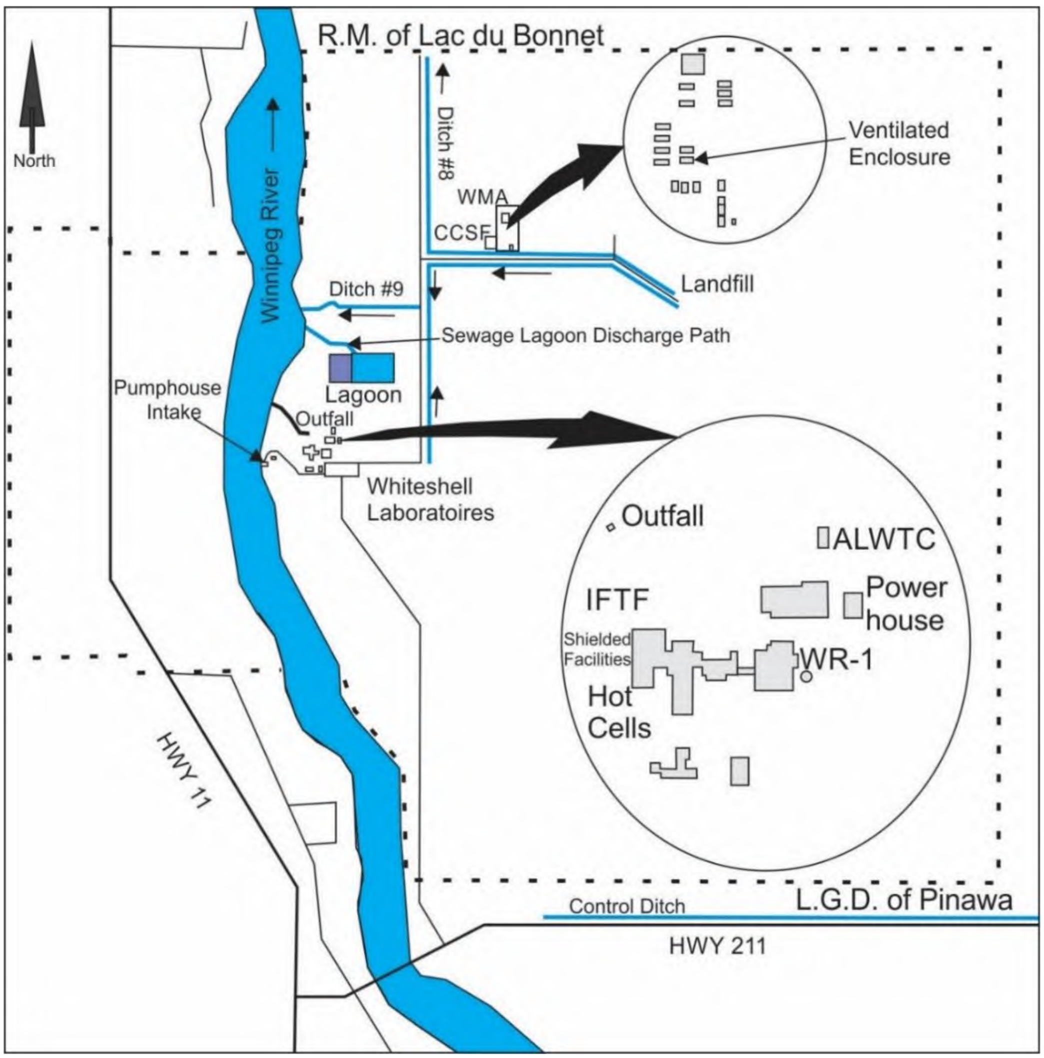


Figure 2: Effluent Monitoring Locations

Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable DRLs [30]. The DRLs now in use at WL came into effect on 2016 September 01. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction and analysis of individual beta emitting radionuclides, such as Strontium (Sr)-90, complemented by examination of historical data.

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in the CSA CAN/CSA-N.288.1-M87 [31]. The DRLs have been revised to meet the current CAN/CSA N288.1-08 [32], and these were accepted by the CNSC in 2016 August. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [33]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[5] that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3.2, the increase in 2019 and 2020 liquid effluents is due to the higher detection limit values for Am-241 and Plutonium (Pu)-239/240.

[5] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).

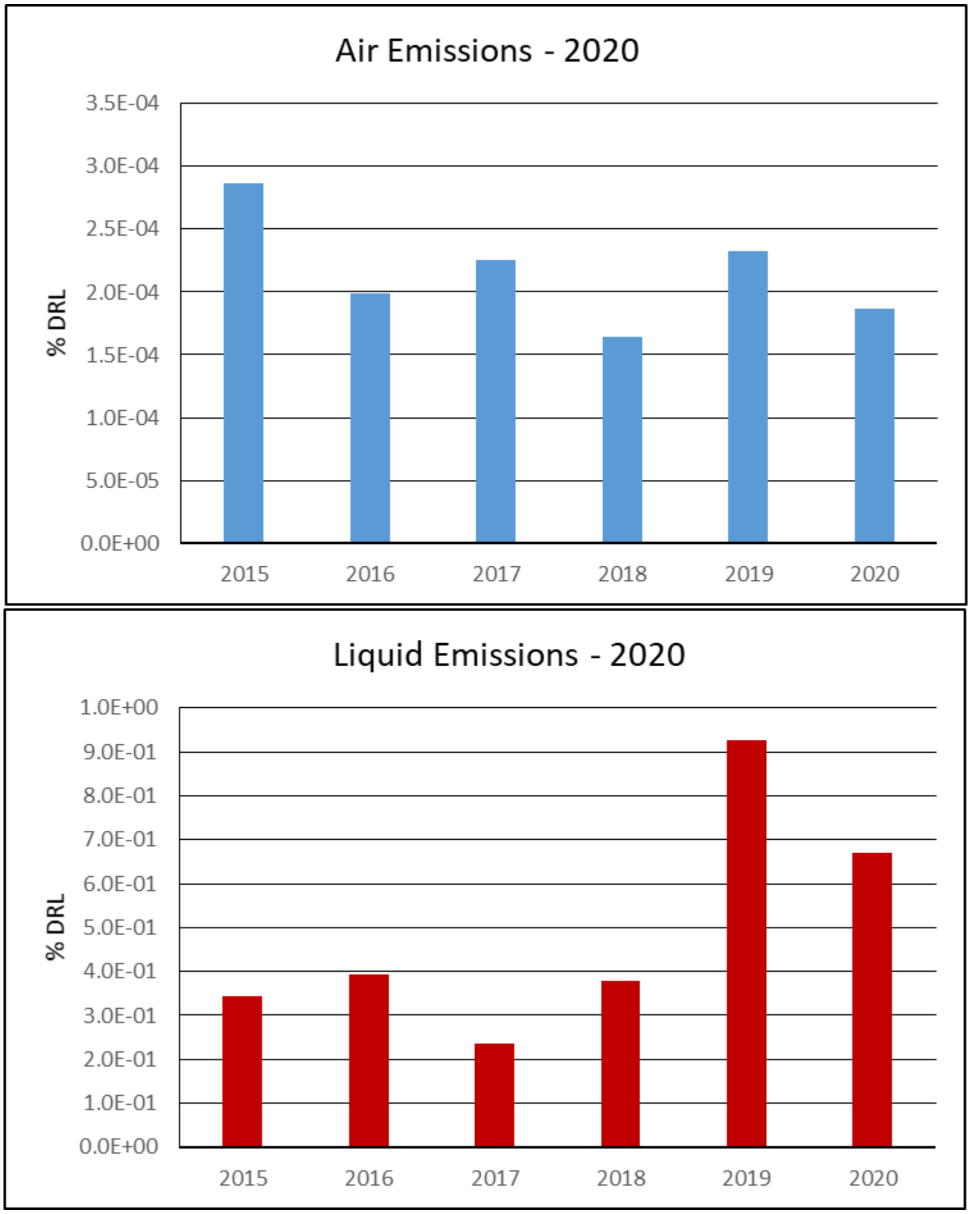


Figure 3: Trends for Airborne and Liquid Emissions form WL for 2015 to 2020

(Note: The Liquid Emissions for 2020 need to be corrected to include the actual 4 quarter Pu isotope data expected in the beginning of March.)

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Action Levels[6] derived from the DRLs as specified in Reference [30]. The Action levels were recalculated based on current CNSC guidance and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

9.4.1.2 Airborne Effluents Monitoring

9.4.1.2.1 Monitoring Points, Schedules and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. These activities include waste compaction in the Waste Handling Area, located in the Immobilized Fuel Testing Facility (IFTF), and decommissioning activities in the ALWTC. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)
- Active Liquid Waste Treatment Centre (ALWTC) (Building 200)

Air effluents from Buildings 100, 200 and 300 are sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 21. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. Any proposals on modifications to the monitoring program will be communicated to CNSC staff. In 2020, Building 200 (ALWTC) was prepared for demolition and the ventilation system was shut down in 2020 October. Monitoring of stack effluents for Building 200 ceased after October 13. The reported air emissions in 2020 for this building represent average weekly emissions up to this point in time.

[6] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

Table 21: Radiological Air Effluent Monitoring Schedule – 2020

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
Building 100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
Building 200 V1F	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
Building 200 V2F	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
Building 300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
Building 300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured but passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water Bubbler for tritium.

W Weekly

N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The WL maintenance planning team performs the measurements for the stack flows and the RP team measures the Sampler flow. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [30]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (Sr-90 for gross beta and Pu-239 and Pu-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 22 and Figure 3 for the years 2015 to 2020. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also includes tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. Airborne emissions remain a small fraction of the release limit. The result for 2020 (0.00019% of the DRL) is less than for 2019, and for the average for the last five years. Total site gross alpha in 2020 is slightly higher than in 2019 and the last five years average. It remains near detection limit values. The gross beta emissions are less than in 2019 and similar to the last five-year average. In 2020, the air emissions from all facilities were below Administrative Levels and regulatory Action Levels.

Tritium emissions from the WR-1 stack were less than 2019 and the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative level (1.52E+10 Bq/week) for the facility and well below the Action Level (7.62E+10 Bq/week) and DRL (1.65E+15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence. Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Buildings 100 and 200, and work in the Shielded Facilities and Concrete Canister Storage Facility. Environmental airborne dust monitoring was performed close to the east, north, west and south boundaries of the WL campus during building demolitions. This monitoring demonstrated that in 2020 no significant airborne radioactivity was released off site from building demolitions. The results of this monitoring are described in the *2020 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

Table 22: Radionuclides in Air Effluents from WL Facilities – 2015 to 2020

Location/Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2015 (Bq/wk)	2016 (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	2019 (Bq/wk)	Five-Year Average		2020		2020 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building													
Gross Alpha[b]	1.73E+09	1.71E+04	3.61E+02	4.16E+02	3.82E+02	2.65E+02	2.89E+02	3.43E+02	1.98E-05	3.07E+02	1.78E-05	1.39E+03	8.01E-05
Gross Beta[b]	6.92E+09	1.68E+05	1.80E+03	1.91E+03	1.83E+03	1.07E+03	1.95E+03	1.71E+03	2..47E-05	1.62E+03	2.34E-05	6.49E+03	9.38E-05
Tritium	1.65E+15	7.62E+10	1.90E+09	6.24E+08	9.68E+08	2.51E+08	6.43E+08	8.77E+08	5.32E-05	2.51E+08	1.52E-05	1.61E+09	9.78E-05
ALWTC													
Gross Alpha	1.73E+09	1.00E+04	3.33E+02	2.25E+02	2.37E+02	3.13E+02	3.12E+02	2.84E+02	1.64E-05	3.80E+02	2.20E-05	5.92E+02	3.42E-05
Gross Beta	6.92E+09	2.02E+04	3.17E+02	2.33E+02	2.92E+02	3.24E+02	4.54E+02	3.24E+02	4.77E-06	4.59E+02	6.76E-06	4.46E+02	6.57E-06
HCF													
Gross Alpha	1.73E+09	1.58E+04	6.00E+02	6.00E+02	6.00E+02	6.00E+02	6.10E+02	6.02E+02	3.48E-05	6.00E+02	3.47E-05	6.00E+02	3.47E-05
Gross Beta	6.92E+09	6.82E+04	1.11E+03	1.05E+03	1.15E+03	1.04E+03	2.05E+03	1.28E+03	1.89E-05	8.43E+02	1.24E-05	3.62E+03	5.34E-05
IFTF													
Gross Alpha	1.73E+09	1.48E+04	5.88E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.80E+02	3.35E-05	6.37E+02	3.68E-05	3.65E+03	2.11E-04
Gross Beta	6.92E+09	3.76E+05	1.12E+03	8.92E+02	1.04E+03	8.41E+02	1.84E+03	1.15E+03	1.69E-05	1.18E+03	1.74E-05	2.70E+03	3.98E-05
Total Tritium (as %DRL)			1.15E-04	3.78E-05	5.87E-05	1.52E-05	3.90E-05	6.31E+08	5.32E-05	2.51E+08	1.52E-05	1.61E+09	9.78E-05
Total Alpha (as %DRL)			1.09E-04	1.05E-04	1.04E-04	1.02E-04	1.03E-04	1.81E+03	1.05E-04	1.92E+03	1.11E-04	6.23E+03	3.60E-04
Total Beta (as %DRL)			6.28E-05	5.90E-05	6.23E-05	4.73E-05	9.21E-05	4.46E+03	6.52E-05	4.10E+03	6.04E-05	1.33E+04	1.94E-04
Total (%DRL)			**2.87E-04**	**2.02E-04**	**2.25E-04**	**1.64E-04**	**2.33E-04**	**2.23E-04**		**1.86E-04**		**6.51E-04**	

a The DRL's shown are for members of the public at the WL boundary as described in reference [30].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A – Not applicable

9.4.1.3 Liquid Effluent Monitoring

9.4.1.3.1 Monitoring Points, Schedules and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the Outfall, the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the process water outflow (Outfall), which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways, around buildings through the weeping tile system, cooling water used in process and experimental facilities, and holding tank discharges including those from the new active liquid waste treatment system tanks based in Building 100 and Building 300. The ALWTC was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 23.

Table 23: Radiological Liquid Effluent Monitoring Schedule – 2020

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	Frequency	Method	Beta Screen	Gross Beta	Gross Alpha	Tritium	Gamma Spec (liquid)	Gamma Spec (ash)	Sr-90 (ash)	U-238 Pu-239/240 Pu-238	C-14
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wca	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, twice a year for the Lagoon.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2018 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.
a Screening sample only.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2020 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers, which reduced the contribution from the washing of footwear in 2018. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is now directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4 L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 40 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (Am-241, Cs-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for Pu-239/240, Pu-238 and Pu-241 isotopic analyses. In 2020, Outfall samples were analyzed for Carbon (C)-14 and tritium because they are known to exist in WR-1 and decommissioning activities have a potential for releasing these isotopes. The activities of tritium and C-14 at the Outfall continued to be below the lower limits of detection.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. Lagoon water residence time is more than three months, to allow for biodegradation and settling. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail later). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon's north side. In 2020, the lagoon was only discharged in the fall because there was enough freeboard that a spring discharge was not necessary.

The outflow of the Lagoon is continuously sampled during discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium, and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at the control point are also released to the Winnipeg River from the two ditches indicated in Figure 2. Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (441 mm) in 2020 was less than in 2019 (646 mm), and in 2018 (467 mm). The winter, spring and fall of 2020 were relatively dry. The highest precipitation was received in June, July and August. Ditches were sampled 15 times during April to the beginning of October, with 1 to 3 sampling sessions per month.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[7]. The samples are analyzed for gross alpha, gross beta and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are

7 The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

submitted for gamma spectrometric and radio strontium analysis. If the alpha activity is above 0.5 Bq/L, the samples are submitted for gamma spectrometric and uranium analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [30]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cs-137 for beta activity and Pu-239 and Pu-240 for alpha activity. With the introduction of total uranium (U) and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

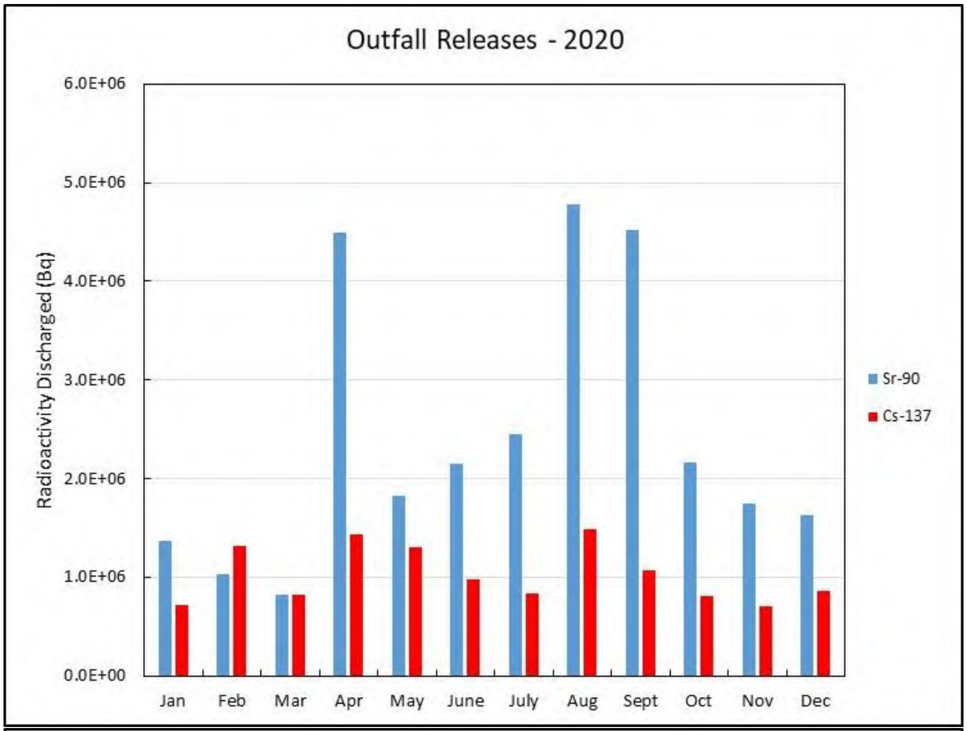
9.4.1.3.2 Monitoring Results

The liquid emission results are summarized in Table 25 and Figure 3 for the years 2015 to 2020. Average monthly emissions, in Becquerel's, are shown for gross alpha, gross beta, total U (including U-234, U-235, and U-238), Am-241, Sr-90 and Cs-137 for the releases from the Outfall and the Lagoon. In addition, quarterly activities of Pu-239/240 and Pu-238 were reported for Outfall effluents. A plot of the monthly Cs-137 and Sr 90 releases as Bq from the Outfall in 2020 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of Sr-90 and Cs-137 from the tanks in 2020 were 2.23E+06 Bq and 4.55E+06 Bq, respectively. These releases were only a fraction of the total Sr-90 (2.90E+07 Bq) and Cs-137 (1.23E+07 Bq) releases from the Outfall. There was little correlation between the patterns of releases from the tanks with the pattern of releases from the Outfall because the tank releases were only a small fraction of the total releases. The additional Sr-90 and Cs-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical site contamination events and historical radioactivity disposition in the storm drain line from Building 200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970's, although more likely from the Building 200 drain line. Sr-90 and Cs-137 releases from the Outfall were highest in April and August-September. The April peak correlates with spring snow melt, while a high rain event toward the end of August likely triggered the August-September peak. Periods of high precipitation are believed to flush contamination into the Outfall from storm drains and previously contaminated process piping.

At the end of 2020, the results of weekly Outfall screening tests indicated the release of higher than normal Cs-137 activities in November that came within half an administrative level. There was a close correlation in time with Building 200 (ALWTC) demolition activities. Although these results were not yet corroborated by the more accurate results of ash analyses, CNL chose to notify the CNSC and to disclose to the public. Subsequently, monthly composite results from ash analyses showed that November Cs-137 activities were not higher than usual. An investigation into the discrepancy between the two analyses revealed that a routine step in the analytical process for the weekly screening samples was not performed properly, resulting in an incorrect result. Specifically, the Cs-137 peak from the background was not being accounted for in the gamma spectrum for the sample, producing erroneously high Cs-137 results.

Note, all monthly releases from the Outfall were well below the administrative release level[8]. Releases of gross alpha were slightly less than the 2019 releases, and higher than the five year average. Gross beta releases in 2020 were similar to the 2019 releases and higher than the five year average. Sr-90 releases in 2020 were lower than in 2019 and the five year average. The Cs-137 releases were slightly below 2019 releases and the five year averages. Am-241 and total uranium releases were lower than 2019 releases. The relatively constant emissions of gross alpha, gross beta, Sr-90 and Cs-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Pu-239/240 and Pu-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.21). In 2020, Outfall water was also analyzed for the presence of C-14, which could be introduced by the discharge tanks from Building 100. C-14 was below detection levels (varying from 0.86 to 1.26 Bq/L) in Outfall samples. Given that the DRL for C-14 is 1.06E+08 Bq/month, the detection limit of 1.65 Bq/L would correspond to a %DRL value of 0.23. Measurements of C-14 in site intake water from Building 902 were also below detection values.

[8] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the ALARA process.



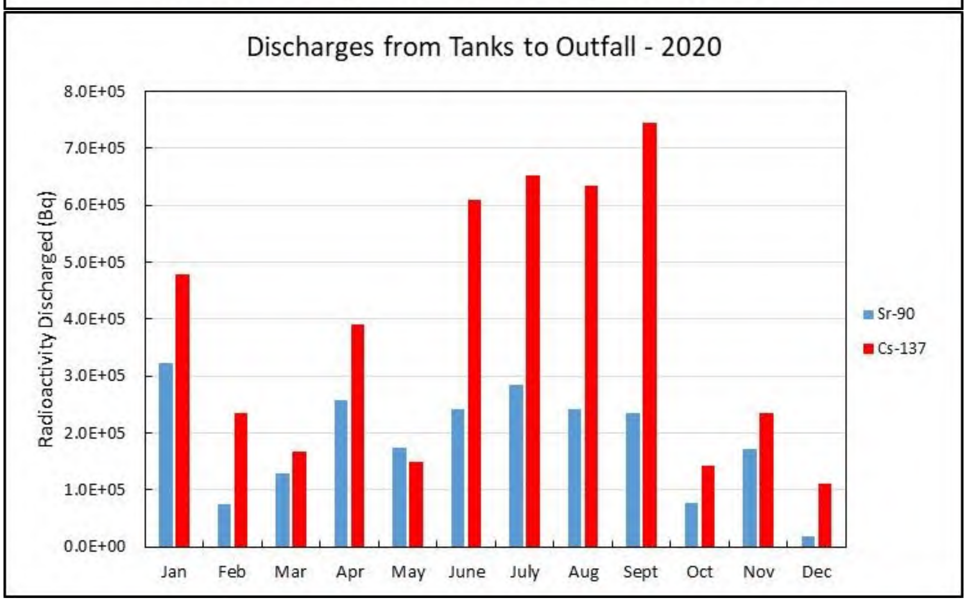


Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2020

The 2020 Lagoon discharge occurred only in the fall because there was enough freeboard that a spring discharge was not necessary. The Lagoon gross alpha releases were higher than 2019 values and the five year average (Table 25). Activities of total uranium (natural) and Am-241 were lower than in 2019, while plutonium-239/240 determined for lagoon samples was higher than in 2019. In 2020, the uranium activity accounted for about 8 percent of the gross alpha activity. Based on the reported activities, the remaining gross alpha activity could be accounted for by the activity of Am-241 and Pu-239/240. It should be noted that the activities of these latter two elements are at detection limit values. Therefore, the actual releases of Am-241 and Pu- 239/240 are less than reported here. The % DRL values of total uranium, Am-241 and Pu-239/240 (which are reported instead of gross alpha) were very low (0.001, 0.051 and 0.087 % DRL, respectively). The gross beta and Sr-90 discharges were higher than in 2019, while the Cs-137 discharges were lower. Releases of Sr 90 and Cs-137 were below 0.002% and 0.005% of their respective DRLs. All releases were well below administrative release levels.

The averaged results for the two drainage ditches and control sample are shown in Table 24.

Table 24: Annual mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2015 to 2020

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2015**	**2016**	**2017**	**2018**	**2019**	**Five-Year Average**	**2020[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.22	0.12	0.14	0.52	0.19	0.24	0.12±0.06
Gross Alpha	0.50	0.07	0.15	0.17	0.11	0.18	0.15	0.15	0.10±0.12
Tritium	7 000	3	< 4.2	4.4	4.8	5.3	5.5	5.0	4.3±0.5
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.15	0.09	0.13	0.32	0.20	0.18	0.11±0.07
Gross Alpha	0.50	0.07	0.09	0.09	0.09	0.16	0.20	0.13	0.06±004
Tritium	7 000	3.00	11.8	17.4	21.1	9	10	14	6.5±6.5
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.16	0.10	0.15	0.14	0.19	0.15	0.11±0.07
Gross Alpha	0.50	0.07	0.14	0.11	0.10	0.22	0.114	0.14	0.07±0.06
Tritium	7 000	4	< 4.4	4.8	4.67	<4	<4	4.4	4.7±0.9

a Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. LLD is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.

b LLD = Lower Limit of Detection.

c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2020, the gross beta activities in Ditches 8 and 9 were lower than in 2019. The 2020 gross alpha activities were lower in Ditch 8 and in Ditch 9 compared to 2019. The gross beta values were similar to the control sample collected off of Highway 211. Given the variability in their values, the gross alpha values were similar to the control ditch. The control sample is unaffected by CNL's operations. Compliance with the *Guidelines for Canadian Drinking Water Quality* [34] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [35] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

The alpha and beta results remained below the trigger levels for gamma spectrometry, Sr-90 and uranium analysis mentioned in Section 9.4.1.3.1. As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amount measured in drainage Ditch 8 (4.3±0.5 Bq/L) and Ditch 9 (6.5±6.5 Bq/L) were not significantly different from that noted at the control location (4.7±0.9 Bq/L). A number of ditches close to WMA are known to contain tritium. In 2020, the amount of tritium reaching the Ditch 8 and 9 locations was not significant. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [34].

Table 25 summarizes the data for releases of liquid effluents[9] for the years 2015 to 2020. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2020 was 0.67% of the DRL, which is lower than 2019 and higher than the five-year average (0.45%). The main reason for the higher 2019 and 2020 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release from the Outfall in 2020 was Pu-239/240 at 0.27 % of the DRL. The primary contributors for Lagoon emissions were Pu-239/240 and Am-241, averaging 0.087% and 0.050% of the DRL, respectively. Both of these contributors had activities at detection level values.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 26) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

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9 The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [34] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 25: Radionuclides in Liquid Effluents from WL – 2015 to 2020

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2015 (Bq/mo)	2016 (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	2019 (Bq/mo)	Five-Year Average		2020		2020 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.43E+08	2.92E+06	2.43E+06	2.20E+06	2.86E+06	4.23E+06	2.93E+06	2.64E-01	3.99E+06	-	7.14E+06	-
Uranium-total	1.25E+10	N/A	NA	NA	1.24E+06	9.13E+05	1.05E+06	NA		9.65E+05	7.72E-03	1.75E+06	1.40E-02
Plutonium-239/240	1.11E+09	N/A	NA	NA	5.76E+05	1.89E+06	3.19E+06	NA		2.32E+06	2.09E-01	2.99E+06	2.69E-01
Plutonium-238	1.16E+09	N/A	NA	NA	7.24E+05	1.53E+06	4.05E+06	NA		1.99E+06	1.72E-01	2.70E+06	2.33E-01
Americium-241	1.04E+09	N/A	NA	NA	1.49E+05	1.07E+05	1.06E+06	NA		9.76E+05	9.38E-02	1.49E+06	1.43E-01
Gross Beta[b]	-	5.00E+08	2.20E+06	1.43E+07	2.06E+07	1.36E+07	2.06E+07	1.43E+07	-	1.98E+07	-	3.28E+07	-
Strontium-90	1.30E+10	N/A	4.42E+06	2.50E+06	4.83E+06	2.39E+06	3.11E+06	3.45E+06	2.65E-02	2.41E+06	1.86E-02	4.77E+06	3.67E-02
Cesium-137	1.16E+10	N/A	2.14E+06	1.31E+06	1.51E+06	1.26E+06	1.14E+06	1.47E+06	1.27E-02	1.03E+06	8.86E-03	1.49E+06	1.29E-02
Tritium	6.80E+13						3.76E+08	-	-	4.09E+08	6.01E-04	8.20E+08	1.21E-03
LAGOON													
Gross Alpha[a]	1.11E+09	5.84E+07	9.70E+05	7.22E+05	1.03E+06	3.92E+05	6.17E+05	7.46E+05	6.72E-02	1.57E+06	-	1.57E+06	-
Uranium-total	1.25E+10	N/A	N/A	N/A	1.66E+05	5.49E+04	1.92E+05	NA		1.19E+05	9.56E-04	1.19E+05	9.56E-04
Americium-241	1.04E+09	N/A	N/A	N/A	2.76E+05	2.44E+05	6.17E+05	NA		5.22E+05	5.02E-02	5.22E+05	5.02E-02
Pu-239/240[a]	1.11E+09	N/A	N/A	N/A	4.22E+05	4.52E+04	7.28E+05	NA		9.67E+05	8.72E-02	9.67E+05	8.72E-02
Gross Beta	-	1.50E+08	4.30E+06	5.76E+06	4.14E+06	2.53E+06	8.00E+06	4.95E+06	-	1.04E+07	-	1.04E+07	-
Strontium-90	1.30E+10	N/A	7.98E+05	1.16E+06	7.26E+05	2.82E+05	1.85E+06	9.63E+05	7.41E-03	2.35E+06	1.81E-02	2.35E+06	1.81E-02
Cesium-137	1.16E+10	N/A	6.85E+04	5.05E+04	6.43E+04	2.44E+02	6.17E+05	1.60E+05	1.38E-03	5.22E+05	4.50E-03	5.22E+05	4.50E-03
TOTAL as %DRL	-	-	**4.10E-01**	**3.24E-01**	**2.61E-01**	**3.79E-01**	**9.27E-01**	-	**4. 60E-01**		**6.71E-01**		**8.71E-01**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 26: Effluents Monitoring Equipment Unavailability – 2020

	Unavailability Criteria[a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 26) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2020, there were no instances in which the unavailability criteria (Table 26) outlined above were exceeded. There were 2 instances of unplanned air monitoring unavailability for tritium in the Building 100 effluent stream, due to air leaks. The total amount of unplanned loss of air monitoring was 111 hours. There were 2 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down. This amounted to a total of 5 planned hours of monitoring unavailability for liquids. One instance of unplanned Outfall monitoring, amounting to 4 hours, occurred when the supply of process water from Building 100 was accidentally cut off. In each instance an estimate of the release during unavailability was calculated as per procedure.

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 22 and Table 25 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2015 to 2020. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2020 were below CNL's Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [30]. All air emissions were below CNL's Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2020 continue to be very low, averaging 0.00019% of the DRL, which is lower than in 2019.

Radioactivity in the WL liquid releases for 2020 was 0.67% of the DRL which is lower than in 2019 (0.93%) and higher than last five-year average (0.45%). The main reason for the higher 2019 and 2020 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Pu-239/240, at detection limit values, was the primary contributor to the Outfall, averaging 0.21% of the DRL. The primary contributors for Lagoon emissions were Pu-239/240 and Am-241, averaging 0.0.087% and 0.050% of the DRL, respectively. Both of these contributors had activities at detection level values. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2020 release results as well as the previous years' trends indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement on hazardous substances monitoring of liquid and airborne effluents for the WL site for 2020. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [28].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedule, and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Sewage Lagoon (referred to as the Lagoon) at point of discharge to the Lagoon drainage ditch, the Process Outfall (referred to as the Outfall), the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low-Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are used as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial Highway 211. More details for each monitoring area are provided in the sections to follow.

Referring to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 27 lists the non-radiological parameters monitored at the inlet or effluent streams sampled, and the sampling schedule followed. The WL monitoring program follows the protocols from the Ontario Ministry of Environment [36] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups (ATGs). These are described in Table 28, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment (SRI). The LMDL and SRI were decided following protocol. The WL monitoring program also meets the regulations set out in the Federal Wastewater Systems Effluent Regulations [37], and the standards from CSA N288.4-10, *Environmental Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [19].

Table 27: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS Tanks	
						Building 300-LLLWTS	Building 100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	Quarterly[c]	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
5b	Total Organic Carbon	Monthly	-	Discharge	-	-	-
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9a	Magnesium	Monthly	-	Discharge	-	-	-
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
-	Potassium	Monthly	-	Discharge	-	-	-
9	Strontium	Monthly	-	Discharge	-	-	-
9a	Uranium	Monthly	-	Discharge	-	-	-
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
16	Bromodichloromethane	Monthly	-	Discharge	-	-	-
16	Chloroform	Monthly	-	Discharge	-	-	-
17	Toluene	Monthly	-	Discharge	-	-	-
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.

b The Monthly = grab sample taken once within each month.

c Quarterly testing began with the third Quarter in the 2020 calendar year.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

Discharging the Lagoon in 2020 required 15 days between October 14 and October 29 in the fall, and there was no discharging of the Lagoon in the spring. Prior to the fall discharge, grab samples of the lagoon effluent were collected for Carbonaceous Biochemical Oxygen Demand (CBOD), acute lethality test[10], and coliform[11] measurements. Remaining lagoon parameters were analyzed in samples that were collected daily and weekly during flow periods.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were fifteen events in 2020.

Whenever a tank was discharged at either of the LLLWTS's, the effluent was sampled.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [36]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system supplies a justifiable set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into ATGs, listed in Table 28. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses, and result reporting.

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[10] The acute lethality test is a pass/fail type of test that is required to be performed by the federal Wastewater Systems Effluent Regulations [37] that came into force 2015 January 01.

[11] Coliform bacteria are a commonly used bacterial indicator of sanitary quality of foods and water.

Table 28: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.001
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.050
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
5b	Total Organic Carbon	High Temperature Combustion	mg/L	-	-	-	
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9a	Magnesium	ICP	mg/L	--	--	--	0.05
9	Nickel	ICP	mg/L	0.02	--	--	0.001
-	Potassium	ICP	mg/L	--	--	--	0.05
9	Strontium	ICP	mg/L	--	--	--	0.001
9a	Uranium	ICP	mg/L	--	--	--	0.0001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0020
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
16	Bromodichloromethane	GC-MS	mg/L	--	--	--	0.0005
16	Chloroform	GC-MS	mg/L	--	--	--	0.0005
17	Toluene	GC-MS	mg/L	--	--	--	0.0004
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.

b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a common estimate of bacterial counts, especially for sewage effluent.

c RMDL = Regulation Method Detection Limit

d The LMDL = Laboratory Method Detection Limit ("MDL" also used).

e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is found for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results because of equipment failure, maintenance/calibration outages or operator action requiring "unavailability" to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 26) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2020, there were no instances in which the unavailability criteria (Table 26) outlined above were exceeded. There were no instances of non-radiological air monitoring unavailability. There were 2 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down. This amounted to a total of 5 planned hours of monitoring unavailability for liquids. One instance of unplanned Outfall monitoring, amounting to 4 hours, occurred when the supply of process water from Building 100 was accidentally cut off. In each instance an estimate of the release during unavailability was calculated as per procedure.

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2020. These include an averages summary table and a comparison against the CNL's Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2020 are presented in Table 29 through Table 33. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [36]. The next three give the CNL monthly guideline concentration, LMDL (Table 28) and units for each measurement. The next six columns provide comparison of the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven columns have a summary of the results for the 2020 monitoring period (explained further below).

WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 28.

Within the 2020 results section, the number of samples included in the average ("# Spl.") is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled "ND's") gives the number of samples in which the analyte was not detected and was therefore deemed a "zero" result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables found at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number allows some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 30 through Table 33, yearly average values for parameters marked with an asterisk show that a monthly guideline was exceeded for at least one month during the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected in Table 35, and compared to the previous five years).

Table 29: Averages Summary for Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2020							
ATG	**Parameter**	**Monthly Guide[b]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.[a]**	**RSTD (%)[e]**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.30	7.03	7.42	7.41	7.43	7.32	12	0	6.43	7.93	7.17	7.81	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	-	N/A	12	0	8.2	11.0	9.0	8.96	10.8
6	Phosphorus	1.0	0.003	mg/L	0.111	0.040	0.026	0.020	0.017	0.043	12	0	0.010	0.018	0.014	16.3	0.017
7	Conductivity	N/A	2.0	µS/cm	103	104	93.0	107	107	103	12	0	90	100	98	3.38	N/A
8	TSS	25	1.0	mg/L	2.13	2.63	3.03	2.05	3.15	2.60	12	0	1.5	6.9	3.8	44.2	4824
9	Chromium	0.5	0.001	mg/L	0.0017	0.0002	0	0.0001	0.0005	0.0005	12	6	0	0.0014	0.0006	106	0.562
9	Copper	0.5	0.0005	mg/L	0.014	0.007	0.004	0.005	0.007	0.007	12	0	0.003	0.012	0.007	40.2	9.05
9a	Iron	1.0	0.01	mg/L	0.405	0.32	0.310	0.233	0.331	0.320	12	0	0.139	0.365	0.242	22.6	299
9	Lead	0.1	0.0002	mg/L	0.003	0.001	0.0002	0.0001	0.0001	0.0009	12	7	0	0.0004	0.0001	131	0.181
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	-	N/A	12	0	3.47	3.77	3.62	2.98	4387
9	Nickel	0.5	0.001	mg/L	0.0018	0.0008	0	0	0.0001	0.0005	12	10	0	0.0011	0.0002	234	0.355
9	Potassium [f]	-	0.05	mg/L	-	-	-	-	-	N/A	12	0	0.761	0.871	0.823	4.06	995
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	-	N/A	12	0	2.00	2.54	2.23	8.19	2735
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	-	N/A	12	0	0.022	0.024	0.023	2.94	28.4
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	-	N/A	12	7	0	0.0001	0.0000	124	0.069
9	Zinc	0.5	0.005	mg/L	0.0025	0.0023	0	0	0	0.0010	12	11	0	0.0262	0.0022	346	6.26
12	Mercury	1.0	0.002	µg/L	0.0087	0.0016	0	0.0002	0	0.0021	12	8	0	0.0085	0.0016	106	0.003
14	Phenolics	0.02	0.001	mg/L	0.0013	0.0014	0.0017	0.0002	0.0007	0.0011	12	12	0	0	0	N/A	0
16	Bromodichloromethane [f]	-	0.0005	mg/L	-	-	-	-	-	N/A	12	2	0	0.0029	0.0015	62.1	1.78
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	-	N/A	12	0	0.006	0.200	0.068	76.9	76.2
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	-	N/A	12	12	0	0	0	N/A	0

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2020							
ATG	**Parameter**	**Monthly Guide[b]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.[a]**	**RSTD (%)[e]**	**Load (kg)**
25	Oil & Grease	15	1.0	mg/L	1.4	0.4	0.1	0.1	0	0.4	12	12	0	0	0	N/A	0
--	Estimated Flow (total volume for year)			m^3	1.36E+06	1.30E+06	1.21E+06	1.18E+06	1.01E+06	1.21E+06	1.21E+06						

a Averages were calculated by setting to zero results reported as “< DL”.
b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.
c # Spl. is the number of samples analyzed and reported.
d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).
e RSTD = Relative Standard Deviation
f New parameter (2020) being tracked by the effluent monitoring program
N/A not applicable

Table 30: Averages Summary for Lagoon

					Monitoring Point: Lagoon												
					Averages from Previous Five Years						**Results for Year 2020**						
ATG	**Parameter**	**Monthly Guide[a]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[b]**	**NDs[c]**	**Min.**	**Max.**	**Vol. Wt. Avg.**	**RSTD[d] (%)**	**Load (kg)**
-	CBOD	25	2.0	mg/L	0.211	0	2.5	17.7	0	4.08	3	3	0	0	0	N/A	0
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.012	0.0099	0.010	0.0097	0.0011	0.0085	3	0	0.001	0.002	0.001	34.64	0.043
-	Total residual Chlorine	0.02	0.05	mg/L	0.023*	0.035*	0.017	0.018	0.022	0.023	3	0	0.051	0.062	0.057	9.91	1.743
--	Total Coliform	N/A	3	MPNUe/100 mL	10.04	35	534	330	200	222	3	0	430	930	763	59.8	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	1.33	5	40	5	13.5	13.0	3	0	3	430	88	196	N/A
3	pH	6 to 9	N/A	pH	8.41	7.01	8.59	8.68	6.66	7.87	15	0	6.42	7.69	7.00	4.72	N/A
6	Phosphorus	1.0	0.003	mg/L	0.171	0.083	0.069	0.131	0.049	0.101	3	0	0.071	0.081	0.075	6.58	2.3
7	Conductivity	N/A	2.0	µS/cm	363	279	223	229	348	288	15	0	401	501	446	5.02	N/A
8	TSS	25	1.0	mg/L	3.89	1.92	4.807	3.8	1.2	3.1	3	0	2.6	4.3	3.9	25.1	120
9	Chromium	0.5	0.001	mg/L	0.0005	0	0	0	0	0.0001	3	3	0	0	0	N/A	0
9	Copper	0.5	0.0005	mg/L	0.0010	0.0016	0.0021	0.0015	0.0007	0.0014	3	3	0	0	0	N/A	0
9a	Iron	1.0	0.01	mg/L	0.216	0.245	0.283	0.370	0.119	0.247	3	0	0.110	0.168	0.116	24.8	3.57
9	Lead	0.1	0.0002	mg/L	0	0	0.0001	0	0	0.0000	3	3	0	0	0	N/A	0
9	Nickel	0.5	0.001	mg/L	0.0004	0.0005	0.0015	0.0015	0.0011	0.0010	3	3	0	0	0	N/A	0
9	Zinc	0.5	0.005	mg/L	0.0005	0.0003	0	0	0	0.0002	3	3	0	0	0	N/A	0
12	Mercury	1.0	0.002	µg/L	0.003	0.0006	0	0	0	0.0007	3	3	0	0	0	N/A	0
4	Phenolics	0.02	0.001	mg/L	0.0007	0.0015	0.0017	0.0033	0	0.0007	3	3	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	2.53	0.45	0.78	0.856	0	0.9480	3	3	0	0	0	N/A	0
--	Estimated Flow (total volume for year) [f]			m^3	5.26E+04	7.46E+04	4.72E+04	1.22E+04	3.83E+04	4.50E+04	3.08E+04						
--	Number of Batches Discharged			--	2	2	2	2	1	2	1 (Fall)						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

d RSTD = Relative Standard Deviation

e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.

f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: The 2019 Spring Discharge = 0 L; 2018 Fall discharge = 3.83E+07 L.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A = not applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 31: Averages Summary for Outfall

					Monitoring Point: Process Outfall [a]												
					Averages from Previous Five Years[b]						Results for Year 2020						
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.54	7.50	7.81	7.76	7.67	7.66	52	0	6.53	8.07	7.50	5.66	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	-	N/A	52	0	8.10	38	13.4	43.28	16814
6	Phosphorus	1.0	0.003	mg/L	0.120	0.040	0.035	0.030	0.022	0.049	52	2	0	0.130	0.021	87.1	25.2
7	Conductivity	N/A	2.0	µS/cm	118	130	139	131	164	136	52	0	110	280	134	19	N/A
8	TSS	25	1.0	mg/L	7.60	2.35	2.97	1.5	4.2	3.72	52	1	0	14.0	5.4	59.3	6657
9	Chromium	0.5	0.001	mg/L	0.0024	0.0001	0	0.0001	0.0006	0.0006	52	32	0	0.0018	0.0005	131	0.651
9	Copper	0.5	0.0005	mg/L	0.010	0.006	0.006	0.005	0.005	0.006	52	0	0.002	0.040	0.010	106	13.5
9a	Iron	1.0	0.01	mg/L	0.36	0.316	0.262	0.186	0.218	0.268	52	0	0.143	0.778	0.302	42.1	381
9	Lead	0.1	0.0002	mg/L	0.0023	0.0004	0.0003	0.0002	0.0002	0.0007	52	21	0	0.0047	0.0004	188	0.481
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	-	N/A	52	0	4.34	7.77	5.46	13.5	6.68
9	Nickel	0.5	0.001	mg/L	0.0027	0.0009	0.0020	0.0006	0.0005	0.0013	52	23	0	0.0022	0.0007	93.9	0.972
-	Potassium [f]	-	0.05	mg/L	-	-	-	-	-	N/A	52	0	0.883	3.090	1.111	30.41	1348
9	Sodium [f]	-	0.05	mg/L						N/A	52	0	2.63	22.2	4.40	71.3	5223
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	-	N/A	52	0	0.028	0.041	0.033	9.01	39.9
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	-	N/A	52	0	0.0002	0.0008	0.0004	26.6	0.485
9	Zinc	0.5	0.005	mg/L	0.004	0.003	0.001	0.001	0.004	0.003	52	21	0	0.035	0.006	114	0.306
12	Mercury	1.0	0.002	µg/L	0.012	0.001	0	0.0006	0.0009	0.003	52	49	0	0.0061	0.0002	444	0.0003
14	Phenolics	0.02	0.001	mg/L	0.0011	0.0017	0.004	0.0001	0.0003	0.0014	52	51	0	0.0010	0.0000	721	0
16	Bromodichloro methane [f]	-	0.0005	mg/L	-	-	-	-	-	N/A	52	20	0	0.0012	0.0005	85.17	0.547
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	-	N/A	52	0	0.0093	0.0500	0.0259	39.25	31.4

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2020							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	-	N/A	52	52	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	2.40	0.82	0.19	0.10	0.02	0.71	52	52	0	0	0	N/A	0
--	Estimated Flow (total volume for year)			m^3	1.33E+06	1.41E+06	1.13E+06	1.16E+06	1.25E+06	1.26E+06	1.21E+06						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A = Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Note: There were no monthly guideline exceeds for any monitored parameter.

Table 32: Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2020					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2015	2016	2017	2018	2019	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.46	7.50	7.88	7.81	7.73	7.68	15	0	7.25	8.12	7.64	3.43
6	Phosphorus	1.0	0.003	mg/L	0.116	0.049	0.071	0.045	0.043	0.065	15	1	0	1.10	0.135	202
7	Conductivity	N/A	2.0	µS/cm	554	571	445	690	586	569	15	0	110	720	451	41.6
8	TSS	25	1.0	mg/L	2.4	2.3	1.4	1.65	1.92	1.93	15	1	0	7.3	3.4	70.1
9	Chromium	0.5	0.001	mg/L	0.0012	0.0004	0	0	0.0005	0.0004	15	12	0	0.0013	0.0002	207
9	Copper	0.5	0.0005	mg/L	0.003	0.002	0.0015	0.0015	0.0013	0.0019	15	2	0	0.0023	0.0010	58.7
9a	Iron	1.0	0.01	mg/L	0.191	0.208	0.192	0.083	0.147	0.164	15	0	0.051	0.549	0.205	64.8
9	Lead	0.1	0.0002	mg/L	0.0009	0.0002	0	0	0	0.0002	15	15	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.004	0.005	0.004	0.003	0.003	0.004	15	2	0	0.005	0.003	44.9
9	Zinc	0.5	0.005	mg/L	0.004	0.004	0.002	0.001	0.001	0.003	15	12	0	0.009	0.001	211
12	Mercury	1.0	0.002	µg/L	0.0061	0.0055	0	0.0020	0.0009	0.0029	15	8	0	0.0055	0.0014	123
14	Phenolics	0.02	0.001	mg/L	0.0006	0.0022	0.0070	0.0002	0.0006	0.0021	15	10	0	0.0067	0.0008	229
25	Oil & Grease	15	1.0	mg/L	1.4	0.85	0.4	0.13	0.17	0.59	15	14	0	1.3	0.08	387

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					Monitoring Point: DITCH 9 (Westbound)[a]											
					Averages from Previous Years[b]						Results for Year 2020					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**#Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.14	7.05	7.67	7.69	7.58	7.43	15	0	6.76	7.81	7.32	3.54
6	Phosphorus	1.0	0.003	mg/L	0.136	0.053	0.045	0.042	0.004	0.062	15	7	0	0.21	0.039	177
7	Conductivity	N/A	2.0	µS/cm	216	193	214	538	400	312	15	0	120	330	224	23.6
8	TSS	25	1.0	mg/L	1.5	2.4	2.1	2.1	2.7	2.2	15	3	0	8.9	3.3	76.8
9	Chromium	0.5	0.001	mg/L	0.0018	0.0003	0	0	0.0005	0.0005	15	11	0	0.0020	0.0004	177
9	Copper	0.5	0.0005	mg/L	0.0027	0.0008	0.0013	0.0021	0.0018	0.0017	15	0	0.0007	0.0070	0.0018	83.2
9a	Iron	1.0	0.01	mg/L	0.446	0.575	0.326	0.315	0.250	0.382	15	0	0.162	0.951	0.558	47.6
9	Lead	0.1	0.0002	mg/L	0.0009	0	0	0	0	0.0002	15	14	0	0.0002	0.0000	387
9	Nickel	0.5	0.001	mg/L	0.003	0.003	0.002	0.003	0.003	0.003	15	0	0.001	0.007	0.004	45
9	Zinc	0.5	0.005	mg/L	0.005	0.006	0.002	0.004	0.003	0.004	15	2	0	0.008	0.006	44.3
12	Mercury	1.0	0.002	µg/L	0.0078	0.0087	0	0.0021	0.0016	0.0040	15	7	0	0.056	0.005	285
14	Phenolics	0.02	0.001	mg/L	0.0009	0.0021	0.0086	0	0.0005	0.0024	15	13	0	0.0015	0.0002	270
25	Oil & Grease	15	1.0	mg/L	1.6	1.1	0	0	0	0.54	15	14	0	1	0.1	387

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					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						Results for Year 2020					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2015	2016	2017	2018	2019	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.27	7.22	7.76	7.83	7.72	7.56	15	0	7.24	7.86	7.54	2.37
6	Phosphorus	1.0	0.003	mg/L	0.182	0.148	0.083	0.065	0.104	0.116	15	5	0	0.28	0.071	119
7	Conductivity	N/A	2.0	µS/cm	465	347	380	939	579	542	15	0	230	570	385	32.5
8	TSS	25	1.0	mg/L	3.44	3.28	6.2	2.9	7.0	4.6	15	2	0	14	3.1	108
9	Chromium	0.5	0.001	mg/L	0.0013	0.0003	0	0	0.0008	0.0005	15	14	0	0.0013	0.0001	387
9	Copper	0.5	0.0005	mg/L	0.0025	0.0005	0.0010	0.0015	0.0018	0.0015	15	1	0	0.0013	0.0009	32.1
9a	Iron	1.0	0.01	mg/L	0.416	0.714	0.594	0.674	0.762	0.632	15	0	0.242	0.919	0.464	42.9
9	Lead	0.1	0.0002	mg/L	0.0036	0.0005	0.0002	0	0.0002	0.0009	15	14	0	0.0003	0.0000	387
9	Nickel	0.5	0.001	mg/L	0.003	0.003	0.002	0.005	0.003	0.003	15	0	0.001	0.003	0.002	34.3
9	Zinc	0.5	0.005	mg/L	0.005	0.003	0	0.013	0.011	0.006	15	14	0	0.010	0.001	387
12	Mercury	1.0	0.002	µg/L	0.0082	0.0127	0	0.0004	0.0007	0.0044	15	11	0	0.0038	0.0008	178
14	Phenolics	0.02	0.001	mg/L	0.0006	0.0022	0.0074	0.0001	0.0007	0.0022	15	12	0	0.0073	0.0006	292
25	Oil & Grease	15	1.0	mg/L	1.1	1.1	0	0.3	0	0.5	15	14	0	0.91	0.01	387

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Averages were calculated by setting to zero results reported as "< W."

c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = "< W," result = 0).

f RSTD = Relative Standard Deviation

N/A = not applicable

Table 33: Averages Summary for the Low-Level Liquid Waste Treatment Systems

					Monitoring Point: Building 100 & 300 LLLW Treatment Systems [a]												
					Averages from Previous Five Years[b]						**Results for Year 2020**						
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.97	7.50	7.52	7.39	7.54	7.58	40	0	6.94	8.36	7.69	4.06	N/A
6	Phosphorus	1.0	0.003	mg/L	0.270	0.145	0.370	0.327	0.554	0.333	40	0	0.0055	2.10	0.503	83.5	0.054
7	Conductivity	N/A	2.0	µS/cm	518	326	267	348.84	352	362	40	0	218	1200	473	41.4	N/A
8	TSS	25	1.0	mg/L	12.73*	4.38	14.67*	16.28*	8.25	11.2	40	1	0	43	15.0*	67.0	1.62
9	Chromium	0.5	0.001	mg/L	0.0032	0.0016	0.0007	0.0006	0.0009	0.0014	40	12	0	0.0033	0.0011	75.3	0.022
9	Copper	0.5	0.0005	mg/L	0.301*	0.128	0.509*	0.516*	0.512	0.393	40	0	0.012	1.060	0.423*	70.4	0.046
9a	Iron	1.0	0.01	mg/L	2.22*	9.37*	3.39*	1.660*	0.465	3.42*	40	0	0.06	6.16	1.77*	87.4	0.190
9	Lead	0.1	0.0002	mg/L	0.006	0.006	0.014	0.0112	0.0057	0.0086	40	0	0.0006	0.0158	0.0047	67.4	0.072
9	Nickel	0.5	0.001	mg/L	0.0097	0.0180	0.0066	0.0055	0.003	0.0084	40	0	0.0012	0.0248	0.0040	95.2	6.44
9	Zinc	0.5	0.005	mg/L	0.089	0.096	0.180	0.272	0.152	0.158	40	0	0.0157	0.523	0.124	82.2	0.022
12	Mercury	1.0	0.002	µg/L	0.147	0.161	0.130	0.060	0.030	0.106	40	14	0	0.051	0.01	136	0.036
14	Phenolics	0.02	0.001	mg/L	0.002	0.007	0.007	0.01*	0.005	0.006	40	4	0	0.037	0.005	126	0.086
25	Oil & Grease	15	1.0	mg/L	4.35	0.60	0.73	0.88	0.59	1.43	40	30	0	12	0.70	288	6.94
--	Estimated Flow (total volume for year)			m^3	5.12E+02	2.30E+02	1.72E+02	1.32E+02	1.89E+02	2.47E+02	1.07E+02						
--	Number of batches discharged			--	34	14	24	50	68	38	40						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Averages were calculated by setting to zero results reported as "< DL."

c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).

f RSTD = Relative Standard Deviation

N/A = not applicable

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

Discharges of effluent coming from the new low level liquid waste treatment systems are being combined, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. The CNL guideline limits are derived from the most recent legislation available. They are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 34 supplies a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2020 or at any time during the previous five years.

As with the average summary table provided, for each monitoring point, the first two columns in the table identify the Ministry of Environment ATG and parameter names. The next three give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns show the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

To assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 34: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2020		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	100	100	83	100	12	0	100
	8	TSS	25	1.0	mg/L	92	100	78	92	100	90.8	12	1	92
	9	Copper	0.5	0.0005	mg/L	67	100	67	33	42	68.4	12	5	58
	9a	Iron	1.0	0.010	mg/L	75	67	44	50	83	63.8	12	7	42
	14	Phenolics	0.02	0.0010	mg/L	100	100	100	92	100	98.4	12	0	100
Outfall	8	TSS	25	1.0	mg/L	83	100	100	100	100	96.6	12	0	100

Notes:

- Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table.
- Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that parameter at the monitoring point. This year there were eleven occurrences when one of three parameters (Iron, Copper, and Total Suspended Solids (TSS)) from the LLLWTS had monthly values higher than CNL monthly guidelines. Figure 5 shows the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, and Figure 8 for each parameter, and the explanations for the observed high values can be found in Section 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is shown by a broken red line in the corresponding figures.

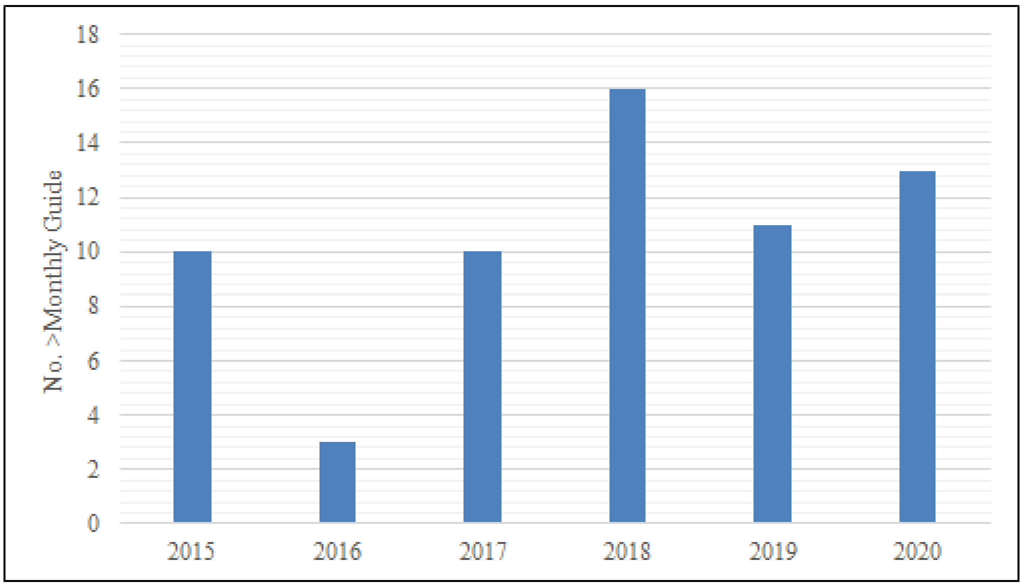

Figure 5: Non-Radiological Monitored Effluent Parameters Above Monthly Guidelines

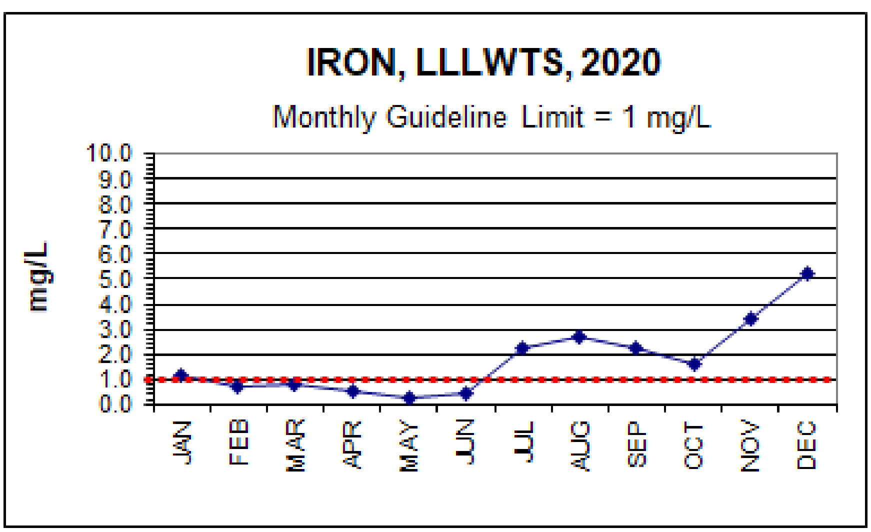

Figure 6: Monthly Average Iron Concentrations of Effluents from the

Low-Level Liquid Waste Treatment System for 2020

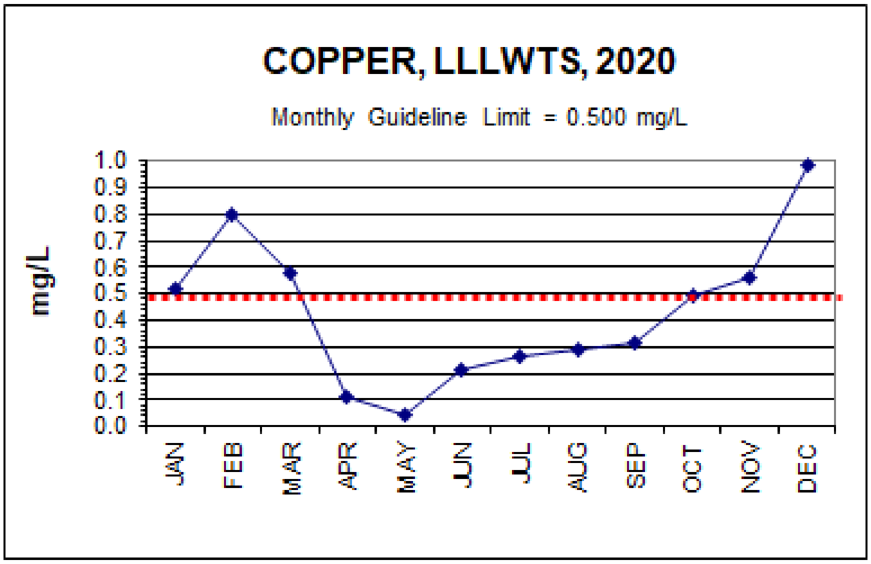

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2020

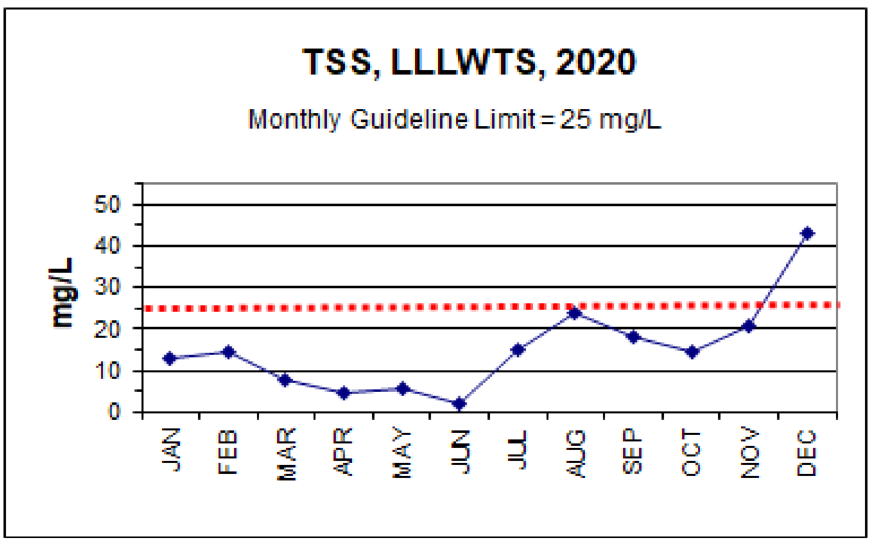

Figure 8: Monthly Average TSS Concentration of Effluents from the Low-Level Liquid Waste Treatment Systems for 2020

9.5.1.4.4 Monitoring of Intake Water from the Winnipeg River

Except for bottled drinking water, all the water needed to run the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 29, where they are compared to available data for the previous five years. Figure 9 shows the estimated amount of water used monthly for 2020.

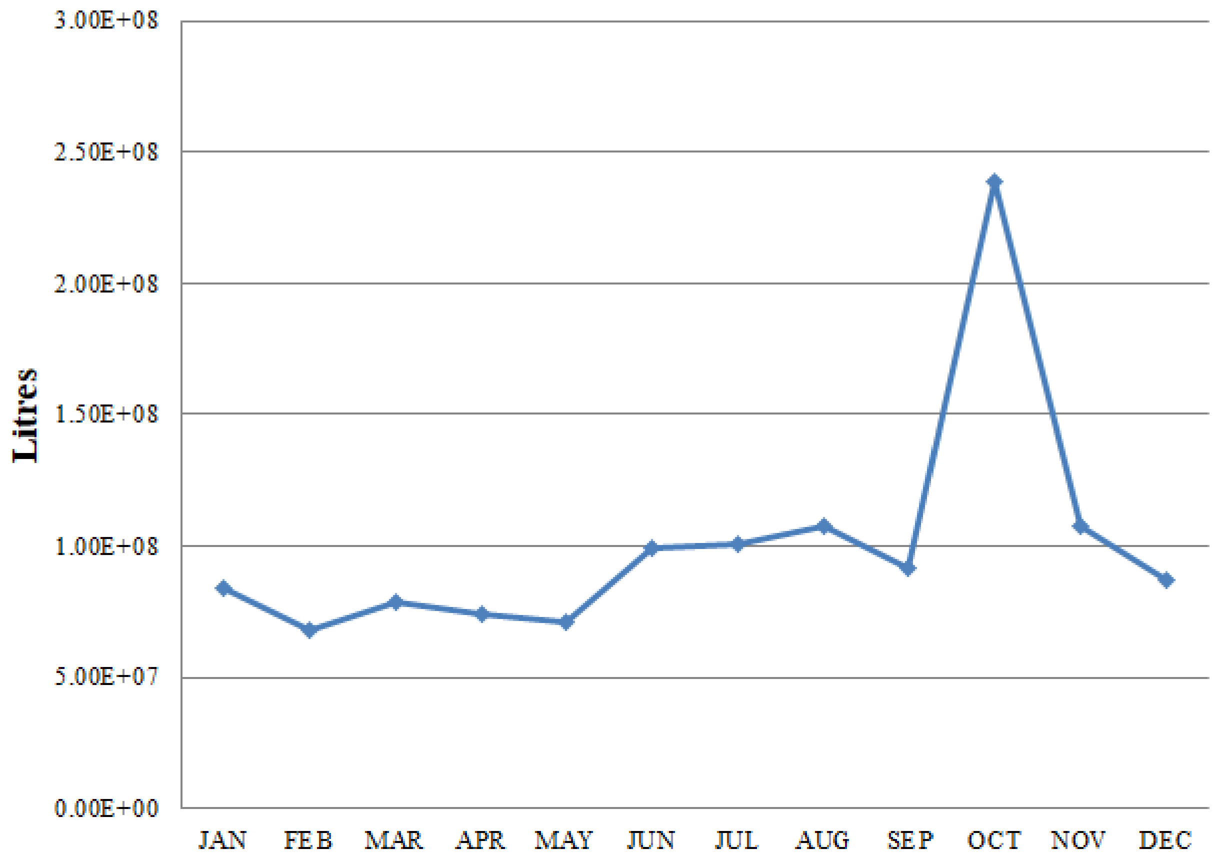

Figure 9: Monthly 2020 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2020 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 1.21E+06 m^3 of water was pumped from the river over the year.
- Compared to the five-year average, increased concentrations (> 10%) were seen for TSS, Chromium, and Zinc.
- Parameters that had their concentrations improve (> 10% decrease) this year compared to the average seen for the last five years are Phosphorus, Iron, Lead, Nickel, Mercury, Phenolics and Oil & Grease.
- Water consumption for the site increases during the summer months as the chillers and air compressors that are used in the summer are cooled by the river water.
- The spike in October in water usage was related to the Building 200 demolition which began in October. The water was used for dust control for the demolition of the building.

Intake water results can have a significant impact on the environmental performance of the WL site and they will continue to be monitored closely. In 2020, the WL site expanded the monitoring program to encompass additional parameters at the site's intake and Outfall monitoring station. This was done to verify and supply justification that the effluent monitoring program is properly identifying and analyzing for the proper contaminants of concern being released into the environment through the site's operations.

The concentrations seen at the intake are used as the base line to determine if measured concentrations at the Outfall are a result of site operations. The additional parameters that were included in the effluent monitoring program were the following: Total Organic Carbon, Manganese, Strontium, Uranium, Potassium, Bromodichloromethane, chloroform, and Toluene.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell had only one period of discharge during the 2020 calendar year. This period of discharge occurred in the fall between October 14 and October 29. There was no discharge in the spring. The total amount of effluent discharged from the Lagoon in 2020 was 30,838 m^3.

Prior to discharging, the Lagoon was tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the cell occurs. During fall discharge, grab-samples were collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters are collected on a weekly basis during the discharge.

The vertical scale from which surface height is found was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

$$\begin{aligned}\text{Volume (in L)} &= \text{Height x [Width\_Bottom x Length\_Bottom} \\ &+ 0.5\text{(Width-Width\_Bottom) Length\_Bottom} \\ &+ 0.5\text{(Length-Length\_Bottom) Width\_Bottom} \\ &+ (1/3)\text{ (Width-Width\_Bottom) (Length-Length\_Bottom)]}\end{aligned}$$

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

$$\text{Volume (in L)} = 636\ 655{*}d + 206.886{*}d^2 + 0.02133{*}d^3 \text{ for depth “d” (in cm)}$$

The position of the Lagoon's water surface was recorded once or twice daily while emptying. The daily flow was calculated from changes in the contained volume. This permitted calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in deciding meaningful average concentrations.

The fall discharge of the secondary cell was allowed to proceed after initial testing. Once discharging begins, the pH is checked daily throughout the discharge period.

Table 30 summarizes the results of the fall discharge. Some notable points are:

- Compared to the five-year average, there was an increase in concentrations (> 10%) for Total Residual Chlorine, Total Coliforms, Fecal Coliforms, Conductivity, and TSS.
- Compared to the five-year averages, CBOD, Unionized Ammonia, pH, Phosphorus, Chromium, Copper, Iron, Nickel, Lead, Mercury, Zinc, Phenolics, and Oil & Grease were all lower (> 10% decrease).
- No trout mortality was seen in the fall lagoon effluent sample that underwent acute lethality testing.

The WL Lagoon discharge was compared against the limits set by the federal government in the Wastewater Systems Effluent Regulations in The Canadian Gazette [37]. The limits in force were met in all cases.

The results of the federally regulated parameters are discussed below:

- Carbonaceous Biochemical Oxygen Demand - annual volume weighted average was 0 mg/L, which is less than the 25 mg/L limit.
- TSS - annual volume weighted average was 1 mg/L which is less than the 25 mg/L limit.
- Un-ionized Ammonia - the maximum concentration was 0.0011 mg/L which is less than 1.25 mg/L limit.
- In 2020, WL found out that the proposed Wastewater System Effluent Regulations limit for Total Residual Chlorine coming into effect in 2021 is not applicable for the operation of the WL Lagoon because the WL site does not chlorinate their wastewater.

9.5.1.4.5.2 Process Outfall

The Outfall monitoring station functioned as expected during 2020. The total discharge volume was 1.21 GL. This volume is lower than the previous five-year average of 1.26 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 52 samples of each parameter for the year.

Table 31 summarizes the results obtained, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were no instances of CNL's monthly guidelines being exceeded at the Outfall monitoring station.
- The only parameters that had a significant increase (> 10%) compared to the 5-year average were TSS, Copper, Iron, and Zinc. All metal concentrations detected are so close to the detection limit, a slight increase seen in the concentrations is having a significant percentage increase being seen in the Outfall.
- Compared to the five-year average, Phosphorus, Chromium, Lead, Nickel, Mercury, Phenolics and Oil and Grease concentration levels significantly decreased (>10%).
- In the third quarter of 2020, CNL began performing Acute Lethality Testing on the Outfall effluent on a quarterly basis. No trout mortality was seen in either of the quarterly samples collected in 2020.

Overall, the Process Outfall and sampling station ran successfully during 2020.

In 2020 the WL site expanded the monitoring program to encompass additional parameters at the site's intake and Outfall monitoring station.

Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene. Currently, CNL can show that the source of the Potassium and Sodium being introduced to the Outfall is a result from the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products that result from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL will be expanding the monitoring program to include looking for these parameters at upstream monitoring locations in hopes of being able to find a source for them.

Going forward the environmental monitoring program will continue to monitor for the parameters mentioned above in the Intake and the Outfall, and will be report on them in this annual report.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were fifteen events from 2020 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparison is made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines this year. The measurement data are summarized in Table 32. The following are notable points for the 2020 ditches results:

- Phosphorus, TSS, Iron were the parameters that had a higher concentration than the previous five-year average for Ditch 8. The parameters that had a higher concentration than the previous five-year average for Ditch 9 were TSS, Iron, Nickel, Zinc, and Mercury. The control ditch had no parameters having observed concentrations higher than the previous five-year average.
- All metal concentrations detected are very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase being observed in Ditch 8 and Ditch 9.
- All concentrations remain well below the CNL's monthly guideline limit and pose no concern.
- All parameters measured in Ditch 8 and Ditch 9 are comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.

It should be noted that sediment control measures were put in place for projects in the WMA in 2020, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria do not include all parameters listed in CNL's non radiological guideline limit values; however, the post-discharge analysis includes all these parameters. CNL staff have determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the earlier system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging requires a day or less to complete, and can be more gradual if needed.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to find pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the Research and Development (R&D) Complex in Building 300 and Building 100 should still be similar enough that a comparison is worthwhile.

In 2020, 0.11 ML was discharged from the LLLWTS.

The weighted averages of the joint releases from the LLLWTS are presented in Table 33 and monthly plots for the parameters that exceed the monthly guidelines are in Figure 6, Figure 7, and Figure 8.

The following are notable results for 2020:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being seen at the Outfall monitoring location downstream in the process.
- There were increases (> 10%) in the annual average concentrations of Phosphorus, Conductivity, and TSS, compared to the previous five-year average results.
- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines seven times (January, July, August, September, October, November, and December). The overall Iron concentration seen for the year is lower than the previous 5-years.
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines five times in 2020 (January, February, March, November, and December). Frequent exceedances are being seen in relation to the new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon

as the new tanks were commissioned and used, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration seen at the Outfall is still well below the monthly guideline limits.

- The TSS concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in December.
- This was an abnormal year for the effluent produced from the LLLWTS. The cause of the increase in Iron and TSS concentrations has not been fully determined. There are two suspected causes. The first being the fact that reduced operations that CNL undertook to mitigate the spread of COVID-19, and then the safety shutdown the site entered in November, resulted in less facility operationally generated effluent being produced. This led to the effluent to display characteristics of the passive water generated by the facility (i.e., Groundwater collected by the sump pits). The other suspected cause is the relocation of the environmental laboratories from Building 402 to the Shielded Facilities. The environmental laboratories frequently work with soil, and may be introducing TSS and Iron into the system as a number of the drain lines in the environmental laboratories are being directed to the LLLWTS in the facility. The majority of the effluent being generated by the environmental laboratories does not require the treatment operations offered by this system, but it is possible it is affecting the effluent stream non-radiological characteristics. Effluent generated from the environmental labs was previously being directed to the domestic system on site and would have been discharged through the lagoon. These increases in concentration are not having a detrimental effect on the water quality at the Outfall, as all concentrations being observed are below guideline limits.

For the Lagoon and Outfall, volume-weighted loads were calculated (explained below), expressed in kilograms. All analytical data used previously in calculating averages are represented in the load.

9.5.1.5 Loading Calculations

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 35 shows the results from the calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- Total Residual Chlorine, TSS, and Copper are the parameters that had a load increase greater than 10% when compared to the five-year average.
- This increase in overall load for TSS is similar to the increase observed for the TSS concentration at the intake over the same 5-year period.
- All other parameters, excluding Iron, had a significant decrease of 10% or more in their loads when compared to the 5-year average.

For the parameters that have been monitored for at least the last 5 years, the sum of the total parameter loads (7,207 kg) has increased compared to last year (6,174 kg), and is higher than the five-year average (6,766 kg). This difference is mostly due to the elevated concentration for TSS been seen in the Outfall this year.

Table 35: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2020		
			2015	2016	2017	2018	2019	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	21.5	0	132	216	0	73.9	3	3	0
		Site Total	**21.5**	**0**	**132**	**216**	**0**	**73.9**	**3**	**3**	**0**
-	Un-ionized Ammonia	Lagoon	0.61	0.74	0.46	0.118	0.042	0.394	3	0	0.043
		Site Total	**0.61**	**0.74**	**0.46**	**0.118**	**0.042**	**0.394**	**3**	**0**	**0.043**
-	Total residual Chlorine	Lagoon	1.23	2.6	0.808	0.220	0.831	1.14	3	0	1.743
		Site Total	**1.23**	**2.6**	**0.808**	**0.220**	**0.831**	**1.14**	**3**	**0**	**1.743**
5b	Total Organic Carbon	Outfall	-	-	-	-	-	-	52	0	168414
		Site Total	-	-	-	-	-	-	**52**	**0**	**168414**
6	Phosphorus	Lagoon	8.98	6.2	3.29	1.59	1.90	4.39	3	0	2.3
		Outfall	152	55.4	38.0	42.6	27.7	63.1	52	2	25.2
		Site Total	**161**	**61.6**	**41.3**	**44.2**	**28.6**	**67.3**	**55**	**2**	**27.5**
8	TSS	Lagoon	205	143	227	46.4	44.7	133	3	0	120
		Outfall	11440	3504	3142	2031	5764	5176	52	1	6657
		Site Total	**11650**	**3647**	**3369**	**2077**	**5809**	**5310**	**55**	**1**	**6777**
9	Chromium	Lagoon	0.02	0	0	0	0	0.004	3	3	0
		Outfall	3.08	0.35	0	0.06	0.818	0.862	52	32	0.651
		Site Total	**3.10**	**0.35**	**0**	**0.06**	**0.818**	**0.866**	**55**	**35**	**0.651**
9	Copper	Lagoon	0.05	0.12	0.10	0.018	0.027	0.063	3	3	0
		Outfall	12.95	9.5	6.61	7.63	7.03	8.74	52	0	13.5
		Site Total	**13.00**	**9.6**	**6.71**	**7.65**	**7.06**	**8.80**	**55**	**3**	**13.5**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2020		
			2015	2016	2017	2018	2019	Average	# Spl. [b]	NDs[c]	Load (kg)
9a	Iron	Lagoon	11.37	18.3	13.34	4.52	4.56	10.42	3	0	3.57
		Outfall	501	417	291.1	258	296	353	52	0	381
		Site Total	**512**	**435**	**304**	**263**	**301**	**363**	**55**	**0**	**385**
9	Lead	Lagoon	0	0	0.003	0	0	0.0006	3	3	0
		Outfall	2.70	0.55	0.312	0.23	0.220	0.802	52	21	0.481
		Site Total	**2.70**	**0.55**	**0.32**	**0.23**	**0.220**	**0.804**	**55**	**24**	**0.481**
9	Nickel	Lagoon	0.02	0.035	0.069	0.019	0.042	0.037	3	3	0
		Outfall	3.29	1.4	1.349	0.836	0.742	1.52	52	23	0.972
		Site Total	**3.31**	**1.4**	**1.42**	**0.855**	**0.784**	**1.55**	**55**	**26**	**0.972**
9	Potassium	Outfall	-	-	-	-	-	-	52	0	1348
		Site Total	-	-	-	-	-	-	**52**	**0**	**1348**
9	Sodium	Outfall	-	-	-	-	-	-	52	0	5223
		Site Total	-	-	-	-	-	-	**52**	**0**	**5223**
9	Strontium	Outfall	-	-	-	-	-	-	52	0	39.9
		Site Total	-	-	-	-	-	-	**52**	**0**	**39.9**
9a	Uranium	Outfall	-	-	-	-	-	-	52	0	0.485
		Site Total	-	-	-	-	-	-	**52**	**0**	**0.485**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2020		
			2015	2016	2017	2018	2019	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0.02	0.024	0	0	0	0.0088	3	3	0
		Outfall	5.89	6.3	1.167	1.77	6.13	4.25	52	21	0.306
		Site Total	**5.91**	**6.4**	**1.17**	**1.77**	**6.13**	**4.28**	**55**	**24**	**0.306**
12	Mercury	Lagoon	0.0002	0	0	0	0	0	3	3	0
		Outfall	0.016	0.005	0	0.001	0.001	0.005	52	49	0.0003
		Site Total	**0.016**	**0.005**	**0**	**0.001**	**0.001**	**0.005**	**55**	**52**	**0.0003**
14	Phenolics	Lagoon	0.08	0.13	0.155	0	0	0.073	3	3	0
		Outfall	1.44	2.1	4.024	0.0001	0.0003	1.51	52	51	0
		Site Total	**1.52**	**2.2**	**4.18**	**0.0001**	**0.0003**	**1.58**	**55**	**54**	**0**
16	Bromodichloro methane	Outfall	-	-	-	-	-	-	52	20	0.547
		Site Total	-	-	-	-	-	-	**52**	**20**	**0.547**
16	Chloroform	Outfall	-	-	-	-	-	-	52	0	31.4
		Site Total	-	-	-	-	-	-	**52**	**0**	**31.4**
17	Toluene	Outfall	-	-	-	-	-	-	52	52	0
		Site Total	**-**	**-**	**-**	**-**	**-**	**-**	**52**	**52**	**0**
25	Oil & Grease	Lagoon	23.5	59	40.40	0	0	24.6	3	3	0
		Outfall	3086	1147	163.5	124	19.1	908	52	52	0
		Site Total	**3109**	**1206**	**204**	**124**	**19.1**	**932**	**55**	**55**	**0**

a Averages were calculated by setting to zero results reported as “< DL.”
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

9.5.2 Airborne Effluent Monitoring

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen for cleaner burning propane used on site. Table 36 presents WL heating fuel consumption from 2015 to 2020. Fuel consumption continues to trend downward (see Section 9.7.2 and Figure 10).

Table 36: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2020
Parameter	**Unit**	**2015**	**2016**	**2017**	**2018**	**2019**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	419 020	361 110	287 982	209 158	243,268	304 108	190,372
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	11.39	9.815	7.827	5.685	6.612	8.2658	5.1743
Total	**TJ**	**11.39**	**9.815**	7.827	**5.685**	**6.612**	**8.2658**	**5.1743**
Heating Demand								
Heating Degree Days	HDD	4942	5573	5403	5855	6079	5570.4	5615

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.

b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

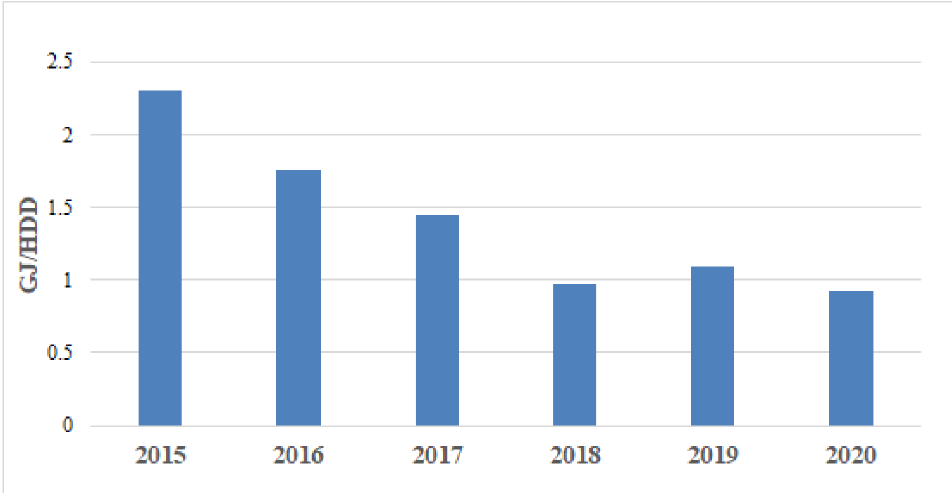

Figure 10: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [39]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in *2020 will be captured in the 2020 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories* [28].

Table 37 outlines the annual CACs generated from site activities. Prior to 2012, annual reports supplied CACs for burning of fuels for heating only. However, to remain consistent with government reporting under the NPRI, the full suite of calculated CAC emissions was reported in 2012 and will continue to be reported as such.

Table 37 shows a small decrease in emissions seen in 2020 compared to the 5-year average for the values for total particulate matter, PM_{10}, and $PM_{2.5}$. These values all met the NPRI reporting threshold this year, and are reported to Environment and Climate Change Canada. Road dust emissions were the major contributor to meeting these reporting thresholds.

Table 37: Stationary Combustion Data and Emissions from WL

Parameter	Unit	Data for Previous Five Years						Data for 2020	NPRI Reporting Threshold
		2015	2016	2017	2018	2019	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	1.044	0.908	0.753	0.536	0.621	0.772	0.0602	20
SO_2	Mg	0.026	0.023	0.020	0.014	0.016	0.020	0.017	20
CO	Mg	0.461	0.399	0.348	0.233	0.271	0.342	0.256	20
TPM	Mg	16.36	15.022	13.651	14.562	10.574	14.034	8.883	20
PM_{10}	Mg	4.199	3.853	3.499	3.726	2.712	3.598	2.281	0.5
$PM_{2.5}$	Mg	0.454	0.415	0.376	0.391	0.292	0.386	0.249	0.3
Volatile Organic Compounds	Mg	0.082	0.071	0.059	0.042	0.049	0.061	0.048	10

9.5.2.3 Greenhouse Gas Emissions

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38] WL must calculate releases under the GHGs emissions notice [40] providing the facility emits over 50,000 tonnes of carbon dioxide equivalent or more within the 2019 calendar-year.

Greenhouse Gas emissions from WL include carbon dioxide, methane, and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill, and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

Table 38 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have decreased slightly from 2019. This decrease can be attributed to the decrease in propane needed to heat the site in 2020 as shown in Table 36. There was a decrease in the number of heating degree days (i.e., decreased demand for building heat based on temperature) in 2020, and Building 200 no longer had to be heated starting in 2020 October. Overall, greenhouse gases are 8% less than the average for the last 5 years.

Table 38: Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2020 Releases
	2015	2016	2017	2018	2019	5-yr. Avg.	
GHG CO_2e tonnes	1957	1883	1873	1678	1756	1829	1692

Note: GHG CO2e tonnes - A unit of measure used to compare between gases that have different GWP. For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to

Environment and Climate Change Canada, following the Federal Halocarbon Regulations [41]. All releases greater than 10 kg are considered reportable.

As seen in Table 39, there were no reportable releases of halocarbons in 2020.

Table 39: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2020	
Type	Global Warming Potential[b]	Ozone Depleting Potential[c]	2015	2016	2017	2018	2019	Number of Losses	Annual Loss (kg)
Refrigerants[a]									
CFC (R-11)	4 600	1	0	0	0	0	0	0	0
CFC (R-12)	10 600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1 700	0	0	0	0	0	0	0	0
HFC (R-134a)	1 300	0	0	0	12.47	0	0	0	0
Fire Suppressants									
Halon (R-1301)	6 900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b GWP per unit mass, compared to CO2 = 1.00
c Ozone Depleting Potential per unit mass, compared to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [41]

9.5.3 Overall Performance

The non-radiological effluent monitoring program set up by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were zero discharges from the Outfall and Lagoon which exceeded the current monthly guideline limits placed on CNL.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances, or reportable events to report in 2020.

9.7 Discussion of Improvement Initiatives

The following sections describe some efforts made during 2020 to identify, understand and/or remove sources of some monitored substances.

9.7.1 Monitoring Site Intake Water and Outfall Effluent

In 2020 the WL site expanded the monitoring program to encompass additional parameters at the site's Intake and Outfall monitoring station. This expansion resulted from the enhanced monitoring that was performed on the Intake and the Outfall in 2019. It was decided that when there was a 20% change in concentration seen when comparing the results for a given parameter at the Intake and Outfall, that these parameters would be incorporated in the effluent verification monitoring program, in order for CNL to learn more about the operational impact of these parameters.

Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene have been added to the list of parameters being measured at these stations. Currently, CNL can show that the source of the Potassium and Sodium being introduced to the Outfall is a result from the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products resulting from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL is planning to do temporary upstream process monitoring (monitoring at LLLWTS in Buildings 100 and 300) to try to be able to explain the operational source of the increase.

Going forward, the environmental monitoring program will continue to monitor for the parameters mentioned above in the Intake and the Outfall, and will report on the impact that operations is having in regards to these parameters in this annual report.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, to heat the site buildings. Starting in 2013, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 10 shows the annual fossil energy consumption since 2015, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 10, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply. Beginning in 2020 October, Building 200 no longer had to be heated as demolition activities on the building began.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2020 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28] (to be issued to the CNSC by 2021 June 30).

10 EMERGENCY MANAGEMENT AND FIRE PROTECTION

10.1 Emergency Preparedness Program

WL adheres to the Corporate Emergency Preparedness Program. See Section 10.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL program continues to adapt to the changes on site, including the demolition of buildings/assets, the construction of temporary structures, the number and composition of staffing levels, and the organisational structure. Vacated buildings are transitioned from building emergency procedures to construction/demolition oriented placards.

COVID-19 planning and coordination was the primary focus for the Emergency Preparedness Program at WL in 2020. Supporting the WL site by providing procedures and guidelines that supported the ever evolving provincial efforts and enabled work to continue safely.

10.1.1 Drills and Exercises

Due to the COVID-19 Pandemic and the hazards it presents, all non-essential and high risk drills and exercises were suspended in 2020. Emergency preparedness staff was re-assigned to pandemic planning, response and recovery operations.

The drills that were conducted after 2020 March were performed in a virtual or physically distanced table top style setting, following all prevention guidelines, to ensure absolute safety for participants and facilitators. In 2020, a total of 94 exercises and drills were delivered at WL. This is a significant drop when compared to the 218 drills/exercises delivered in 2019. Table 40 provides details on the number and type of the exercises and drills conducted in 2020.

Table 40: WL Emergency Preparedness Exercises – 2020

Type of Drill or Exercise	Number Completed in 2020
Fire Drills	10
Site-wide Specialty Drills	56
Table Tops[a]	2
Targeted Communication Exercise	17
Site-wide Communication Exercise	8
Field Exercises (Functional)	1

a Table Tops include specific EOC Skill workshops as well. Each workshop focuses on a unique aspect of the EOC and includes a small practice scenario.

10.1.2 Training

There was no change to the Emergency Operations Centre (EOC) staff structure or personnel in 2020. Due to the moving of staff offices on site there was a need to re-assign some of the building emergency team members and to assign three new members. Due to the COVID-19 Pandemic, it was decided not to run the three new members through the full building emergency team training course, but instead had one-on-one sessions to orient them to the procedures and their responsibilities. Once the COVID-19 Pandemic subsides to a safe level, this training will be formally completed.

10.1.3 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains an EOC, and conducts monthly tests of the technical equipment stored for use in that location. Repairs, improvements and updates are installed as required and when identified. In 2020, only eight of the monthly checks were completed as normally scheduled. To support the reduced operations as a result of the COVID-19 Pandemic that occurred in March, all the EOC laptops were loaned out to support WL staff in working remotely. As the EOC would only be activated virtually during significant COVID-19 restrictions, and as most of the WL EOC staff had CNL issued laptops, there was minimal risk in letting these leave the EOC. No monthly checks were conducted while the computers were out on loan. Monthly checks began again once some of the computers were returned as staff began returning to the site.

Emergency Preparedness also maintains a supply of emergency food rations, which have a five year shelf life. The rations were replaced in 2019 and only require a visual inspection/accounting once per year, which was completed.

10.1.3.1 Emergency Operation Center

As part of WL's EOC framework, there are two teams of EOC staff, and a backup person for each of the team positions that can be engaged to cover for members of either of the two teams. These two teams operate on a two week on-call rotation. There were no changes to the EOC teams in 2020.

All perishable EOC goods and supplies are checked annually and replaced as required.

There were no emergency events requiring activation of the EOC in 2020. The COVID-19 situation was managed by a companywide Pandemic Planning Committee, with oversight from the Crisis Management Team (which includes senior management representatives from the WL Site).

10.1.3.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories continues to maintain the Mobile Nuclear Laboratory (MNL) for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the MNL in 2020.

10.1.3.3 Equipment Checks

Respirators make up the majority of the equipment in the strategically placed emergency cabinets that remain on site. These cabinets are opened and inspected monthly by Radiation Protection staff. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2020.

There were no emergency events requiring the use of this equipment in 2020.

10.1.3.4 Public Address System

The Public Address (PA) system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2020.

10.1.3.5 Secondary Emergency Signals

The WL site still employs an exterior siren as a redundant form of emergency alerting. The system is no longer required and was replaced by the PA system as the primary alerting system. This system will continue to be used as a redundant alerting system until either the equipment fails completely (there have previously been some issues with the equipment) or the building it is mounted to is decommissioned and demolished.

10.1.3.6 EOC Notification System

WL continued to use the Everbridge Mass Notification system in 2020. The system continues to perform well, with a 100% response rate to all monthly communication tests (see Table 41) for the second year in a row.

Table 41: WL EOC Communication Tests: 2020

Y= Yes **N= No**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
EOC Commander	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liaison Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Env. Protection Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safety Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Planning Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Logistics Section Chief	Y	n/a*	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Operations Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nuclear Facilities Representative	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

* Both Logistics Section Chiefs were scheduled to be away during this drill, their alternate (who is not part of the monthly drill) was covering at this time.

In addition to these regularly scheduled monthly drills, a random quarterly drill is conducted. These drills are scheduled for random times and dates, including weekends, evenings and work hours. These random drills include the expanded EOC teams, including all the alternates. Table 42 identifies the response rates of the 2020 WL EOC Staff to the Quarterly Random EOC call out drills.

Table 42: WL EOC Random Quarterly Communication Tests: 2020

	Q1	Q2[a]	Q3	Q4
Response Percentage	100%	n/a	96%	100%

a The Q2 drill was scheduled during the COVID-19 shutdown when only minimum safe staffing was on site, as a result this drill was not conducted.

10.1.4 External Collaborations

Contact is maintained with a variety of other emergency response/management organizations and interested public groups. 2020 was an interesting year for external collaboration due to the COVID-19 Pandemic. None of the planned interactions occurred, but different groups and opportunities for collaboration were available.

10.1.4.1 Local Agencies

WL supported both the Local Government District of Pinawa and the Town of Lac du Bonnet emergency operations centres with planning support and resources during the early part of the COVID-19 crisis. A joint emergency exercise was scheduled between the WL site and the Pinawa Fire Department in 2020, but had to be cancelled due to restrictions on training by the Fire Mutual Aid District as a result of the COVID-19 Pandemic.

10.1.4.2 Provincial Interactions

WL EmP was invited to participate in the Cross Sector Provincial Critical Infrastructure and Municipal Relations Governance COVID-19 teleconference meetings throughout 2020 in support of WL's COVID-19 response. These two meeting allowed WL to engage with the province for clarification on COVID-19 guidelines and orders. During the lull between the first and second wave of COVID-19 in Manitoba, WL EmP was also able to participate in the Manitoba Association of Emergency Coordinators Conference, which brought all Provincial stakeholders together, including all levels of government to share best practices, and review current and potential new legislation.

10.1.4.3 Federal Interactions

The EmP Program Manager continues to maintain membership with the Manitoba Section of the Federal Coordination Working Group. The Federal Coordination Working Group helps WL maintain ties with representatives from multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police (RCMP), Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada, in order to support organizational response.

10.1.5 Unplanned Emergency Events

No incidents requiring initiation of the WL Site Emergency Plan occurred during 2020.

10.2 Fire Protection Program

WL adheres to the Corporate Fire Protection Program. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

There were no reportable fire events at WL in 2020.

10.2.1 Fire Response Drills

Fire drills are conducted annually in accordance with the National Fire Code of Canada [42] and CSA standard N393-13 Fire Protection for Facilities that Process Handle, or Store Nuclear Substances [43].

All fire response drills for the facilities at the Whiteshell site were completed in 2020.

10.2.2 External Collaborations

Whiteshell Laboratories and the Town of Pinawa signed a Fire Protection Service Agreement in 2019 to improve Mutual Aid support capabilities. The agreement is still in effect.

Firefighters engaged in training programs to improve response operations throughout the year. Significant aspects of response-based training included the following:

- 24 personnel are qualified to awareness training in confined space rescue.
- 15 personnel are qualified in NFPA 1006 rope rescue operations.
- 39 personnel are qualified to standard first aid level C.
- 14 personnel are qualified to NFPA 472 Hazmat operations level.

10.2.3 Third Party Audits & Inspections

A third party Fire Protection Audit was conducted in 2018 February. The next audit, as per the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [43], is scheduled for 2021.

10.2.4 Fire Hazard Analysis

All fire hazard analysis documentation for buildings requiring a fire hazard analysis have been reviewed and are being evaluated against the decommissioning schedule. A corrective action plan will be developed to identify the required steps to ensure that Fire Hazard Analysis documentation requiring revisions will be updated as needed.

11 WASTE MANAGEMENT

11.1 Waste Management Program

WL adheres to the Corporate Waste Management Program. See Section 11.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program include:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL Programs to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Closure Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for three of the waste receiving facilities on-site (including the Waste Handling Area and the WMA storage facilities) remained unchanged for 2020.

11.1.1 Waste Management Operations

Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for interim storage.

Demolition of north-side Buildings 303, 304 and 424 was completed. These buildings were formerly the Containment Test Facility, Waste Clearance Facility and the WR-1 Organic Monitor Building. A total of 200 m^3 clearable waste was generated from their demolition; 175 m^3, consisting of construction and demolition debris and asbestos-containing materials, was dispositioned to an off-site waste receiver, while 25 m^3 of metal was recycled.

Decommissioning on the south and north areas of the WL main campus began, which involved asbestos abatement and remediation of eight high temperature water manholes, generating approximately 20 m^3 of waste. All asbestos and non-asbestos insulation, cloth and metal cladding, and jacketing systems on the manholes, were successfully removed and dispositioned to approved licensed facilities. An additional 1,000 m^3 of legacy clean waste stored on the south-side, consisting of concrete (which was rubbilized and segregated of metal rebar for reuse), concrete contaminated with asbestos-containing material, and metal was dispositioned offsite, which was a major clean-up activity to enable the future characterization and remediation of the south-side affected lands planned in 2021.

The Pneumatic Transfer Line (PTL) System West Side located between Building 300 and the IFTF, consisting of polyethylene, asbestos cement conduit and concrete manholes, was decommissioned, which resulted in 20.2

m^3 of waste was generated. This waste primarily consisted of clean asbestos waste; 0.2 m^3 of this volume consisted of Low-Level Waste (LLW) which was compacted with site wide LLW operational waste.

Final decommissioning activities of Building 200 Active Liquid Waste Treatment Centre were completed, enabling the start of the building's demolition in late 2020. 199 m^3 of LLW and 6 m^3 of Intermediate - Level Waste[12] (ILW) waste was generated; of this total, 151 m^3 has been safely dispositioned to CRL, with the remaining 54 m^3 of LLW safely stored in certified transportation packages awaiting shipment to CRL in 2021.

De-inventorying efforts of legacy waste stored in SMAGS was completed in 2020, prompting the same efforts to be diverted to the LLW Quonsets (Building 431, 432 and 433). This activity generated a total of 34.4 m^3 of LLW and 21 m^3 of ILW, which was transported to CRL. The remaining waste in the LLW Quonsets will undergo additional qualification and inspection of waste contents to ensure transportation and waste criteria compliance are met and is to be shipped to CRL in 2021.

Ground remediation east of SMAGS in the WMA was performed to enable the establishment of an outdoor storage pad, referred to as the Recoverable Surface Storage Area (RSSA). A total of 264 m^3 LLW was generated, of which 152 m^3 is stored in certified transportation packages awaiting disposition to CRL, which is scheduled in 2021.

Intrusive inspection of the concrete canisters was successfully executed, which involved support from the IAEA and CRL resources. Completion of this activity supports planning efforts to safely retrieve the high-level wastes intended for transport and storage at CRL starting in 2021.

Table 43 summarizes the quantities of radioactive waste generated in 2020 that was sent to each storage location. Table 44 summarizes the volumes of solid low-level radioactive waste originating from each facility in 2020.

[12] In this context, ILW refers to any waste that does not meet the proposed Near Surface Disposal Facility (NSDF) Waste Acceptance Criteria (WAC) and requires storage in ILW facilities at CRL.

Table 45 summarizes the volumes of solid intermediate-level radioactive waste originating from facilities in 2020. Table 46 summarizes the volumes of solid low-level and intermediate-level radioactive waste transported to CRL for disposition.

Table 43: Radioactive Waste by Storage Location

Storage Facility	Volume (m^3)	
	2019	2020
Low-Level Quonsets (B431, B432, B433)	59.6	32.3
Intermediate-Level Waste Bunkers	0	0
SMAGS[a]	46.0	4.1
Soil Storage Compound	0	0
Total	105.6 m^3	36.4 m^3

a Shielded Modular Above Ground Storage

Table 44: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2019		2020	
	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)	Compactable Waste Volume (m^3)	Non-Compactable Waste Volume (m^3)
Building 100	4.8	0.0	0.8	9.2
Building 200	19.1	167.7	7.2	198.9
Building 300	0.0	0.4	0.3	0.0
Building 303 [a]	0.0	0.0	0.0	0.0
Building 304 [a]	0.0	0.0	0.0	0.0
Building 309 (LSVCTF) [a]	0.0	0.2	0.0	0.0
Building 402	0.7	0.0	0.2	0.0
Building 411[a]	0.2	0.0	0.0	0.0
Building 421	0.2	0.0	0.0	0.0
Building 511	0.0	0.0	0.0	0.0
Building 514[a]	0.0	0.0	0.0	0.0
CCSF	0.0	0.0	0.0	0.0
SF (HCF & IFTF)[b]	101.4	0.0	10.8	0.1
Waste Handling Area	0.0	0.0	0.0	0.0
WMA	6.9	0.0	2.5	0.0
LLW Bunker 6	13.6	406	0.8	0.0
Affected Lands	0.1	1.7	0.2	0.0
Soil Storage Compound[c]	0.0	201.0	0.0	0.0
Total	**162.0 (15.0)**[d]	**766.8**	**22.7 (5.0)**[e]	**208.2**
Total after Compaction	**781.8**		**213.2**	

a Building demolished.
b Operational compactable waste volumes were generated as a result of the refurbishment of the hot cell manipulators.
c The soil storage compound was de-inventoried in 2019.
d This volume of compactable waste was reduced to 15.0 m^3. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.
e This volume of compactable waste was reduced to 5.0 m^3. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

Table 45: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m³)	
	2019	2020
Building 200	0.0	5.8
Total	0.0	5.8

Table 46: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2019		2020	
	LLW Volume (m³)	ILW Volume (m³)	LLW Volume (m³)	ILW Volume (m³)
Building 411	168.0	0.0	0.0	0.0
Building 514	252.0	0.0	0.0	0.0
WMA (Cesium Pond Soil)	28.0	0.0	0.0	0.0
WMA (Grounds Remediation)	0.0	0.0	112.5	0.0
Soil Storage Compound	201.0	0.0	0.0	0.0
SMAGS[a]	834.0	28.0	14.0	7.7
LLW Bunker 6	0.0	0.0	182.0	0.0
Building 200	0.0	0.0	198.8	5.8
LLW Quonsets (B431, B432, B433)	0.0	0.0	20.4	12.8
Total	1,483.0	28.0	527.7	26.3

a Shielded Modular Above Ground Storage – legacy waste generated from various decommissioning projects.

Clearable waste from Controlled Areas was monitored in-situ. Clean bagged waste was monitored using the bag monitor located in the IFTF facility where WL's laundry facility is now stationed; all bagged waste met the screening criteria and was deemed to be suitable for unrestricted release in 2020.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable; this includes both recyclable materials sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

WL summarizes the disposition pathway of non-active waste.

Table 48 summarizes the amount, by material type, of recyclable waste shipped off-site.

Table 47: Non-Active Waste Disposition Pathways

Disposition Location	Volume (m^3)	
	2019	2020
WL Asbestos Disposal Site [a]	0	0
WL Burn Pit	0	247
WL Inactive Landfill	543	0
Recycling[b] **Sent Off-Site**	410	513
Off-Site Landfill [c]	777	1,256
Total	1,730	2,016

a The WL Asbestos Disposal Site stopped receiving waste in 2019 to support the environmental risk assessment. Non-active asbestos is directed to off-site licensed landfills.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted at municipal recycling facilities.

c WL Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

Table 48: Recycled Waste Shipped Off-Site

Material[a]	Weight (kg)	
	2019	2020
Aluminum	0	0
Batteries Shipped	1,708	0
Batteries Recylced	882	227
Cardboard[b]	0	0
Copper and Brass	0	0
E-Waste Shipped	0	347
E-Waste Sold	0	0
Ferrous Metals	798,574	108,457
Glass	0	0
Lumber	0	0
Plastic Shipped	0	0
Plastic Sold	0	0
Stainless Steel	0	0
Lead	3,006	0
Total	804,170	109,031

a This recycling waste pertains to material that is sold or charged to be taken to a material specific recycling facility.

b Cardboard is sent to a municipal recycling facility and inclusive in Table 47

Improvements were made in preventing waste accumulation inside of buildings and transferring the waste to appropriate waste facilities immediately after generation. Improvements continue to be addressed in reference to the lack of processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes radioactive wastes generated from decommissioning activities. Mitigation measures put in place in 2020 included developing a Nuclear Safety Note for the interim storage of cargo containers containing radioactive wastes in the WMA (to be finalized in 2021). The area supporting this initiative is referred to as the Recoverable Surface Storage Area (RSSA), and consists of an outdoor, above ground storage pad to enable the storage and loading of solid low-level waste in sea land containers and storage of oversize LLW items which are awaiting further processing, characterization and/or packaging to be considered compliant for off-site disposition.

11.1.1.1 Liquid Waste Generation

During 2020, 99 m^3 of low-level liquid was processed in the Building 300 LLLWTS and 7.9 m^3 in the Building 100 LLLWTS, for a total of 106.9 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Several buildings and structures were decommissioned in 2020, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition.

Demolition of north-side Buildings 303, 303 Annex, 304 and 424 was completed. The decommissioning of the buildings included the associated services and structures except for the concrete pads, which will be demolished and removed the north-side (main campus) site remediation work is executed.

The Pneumatic Transfer Lines located between Building 300 and the Immobilized Fuel Transfer Facility were fully decommissioned. All polyethylene tubing, asbestos cement conduit and associated manholes were removed, and the underlying soil surveyed and backfilled.

To advance the remediation of the south-side of the main campus, the former concrete rubble pile was packaged and dispositioned off-site. The material consisted of both clean concrete, which was processed (rubbilized and segregated of rebar) to support future reuse, and concrete contaminated with asbestos-containing material which was disposed of in an off-site licensed facility.

Building 200 decommissioning activities involved the continued removal of process systems and equipment to reduce source term hazards. The focus of work involved radiological and waste characterization of tanks, application of fixatives to prepare tanks for future size reduction, and removal and packaging of process piping. Decommissioning was completed mid-2020, enabling building demolition. Approximately 50% of the building was demolished; the remaining portion of the building has been placed in a safe state following an engineering evaluation, with access to the building restricted. Demolition will resume in 2021.

Legacy waste stored in SMAGS was successfully emptied and dispositioned to CRL for storage, supporting the ILW Cask Loading Facility (CLF) infrastructure project. De-inventory efforts expanded to the LLW Quonsets (Building 431, 432 and 433), however the waste will need to be processed and qualified to ensure transportation and waste criteria compliance are met before waste can be dispositioned to CRL. This work is scheduled in 2021.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

Table 49 lists the WL Detailed Decommissioning Plans (DDPs) and their status as of 2020.

Table 49: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
	The Whiteshell Laboratories Detailed Decommissioning Plan: Volume 1 - Program Overview	WLDP-02000-DDP-001 (RC-2143-1, Rev. 4), January 2002	To be Cancelled and Superseded by WLDP-02000-DDP-001, Rev.0.
	The Whiteshell Laboratories Detailed Decommissioning Plan: Volume 1 - Program Overview	WLDP-02000-DDP-001, Revision 0, 2019	Revision 0 of DDP Volume 1 submitted to CNSC for acceptance, and comments were received. To be dispositioned.
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned.
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility is being decommissioned. DDP Volume is available for use.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach)	Facility has been shut down and currently under monitoring and surveillance. Complete Dismantlement and Removal approach has been approved by the CNSC (Revision 3). EA process for ISD is in progress, Revision 4 to be revised with final EA submission. DDP Volume (Revision 3) is available for use.
		WLDP-26400-DDP-001, Revision 4, 2017 (In Situ Decommissioning Approach)	
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC for information and comments received (to be dispositioned).
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001	Facility is operational DDP under development.
	Volume 8 - WMA Part 2: Intermediate - Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 3, 2018	Facility is operational. DDP was sent to the CNSC for acceptance, and comments received. To be dispositioned.
R&D Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use.

Facility	DDP Document Title	Document #	Status
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001	Operational and decommissioning activities ongoing. DDP Volume is available for use.
DP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer Area Buildings and Facilities	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

12 SECURITY

12.1 Security Program

WL adheres to the Corporate Security Program. See Section 12 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Whiteshell Site Security Report [44] outlines the security arrangements that are in place at the WL site. The Security program consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Program and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in REGDOC-2.2.4, *Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness* [45].

Due to the COVID-19 Pandemic, no CNSC Type II Compliance Inspections for the Security Program were conducted in 2020.

CNL-WL received notification from the CNSC on the closure of one enforcement item, Order #9336. Order closure was granted as CNL-WL completed all actions required to address the enforcement items listed in the Order, including the standing up of a Tiered Response Force (TRF), for which training has been completed.

CNL-WL has one open enforcement item (Directive WL-SEC-19-T2-001-D01 – Training). An action plan was submitted to the CNSC resulting in 7 actions required to address the Directive. All actions were completed in 2020. A letter requesting closure of the Directive was sent to the CNSC.

12.1.1 Security Events

In 2020, there was one security event that affected WL, the details of which are considered Classified-Confidential. Information relating to this event were provided to CNSC staff. Corrective actions were completed, and the event is now closed.

13 SAFEGUARDS AND NON-PROLIFERATION

13.1 Safeguards Program

WL adheres to the Corporate Nuclear Materials and Safeguards Management (NM&SM) Program. See Section 13 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

13.1.1 IAEA Activities

The IAEA conducted various types of activities as part of the safeguards approach for CNL, including, but not limited to, IAEA safeguards seals changes, human surveillance, implementation and/or maintenance of IAEA safeguards monitoring equipment, and technical visits. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2, Management System of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The IAEA Technical group performed a technical visit to the WL Concrete Canister Storage Facility on 2020 October 01 for planning use of remote camera monitoring equipment to support the upcoming fuel shipping campaign to CRL.

WL Projects conducted intrusive inspections of the WL Concrete Canisters from 2020 October 20 to November 07, during which the IAEA provided oversight and verified and changed the IAEA canister seals.

A Physical Inventory Verification (PIV) inspection was carried out by the IAEA on 2020 November 04. This inspection was a sampling of accessible items containing Special Fissionable Material and changing of 2 IAEA canister seals.

A Design Information Verification (DIV) inspection was carried out by the IAEA on 2020 November 05. The activities associated with the DIV included:

- Verification of the Design Information Questionnaire:
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

A discussion of IAEA inspections conducted at WL can be found in Section 1.2.2. A list of all IAEA inspections conducted at all CNL sites can be found in Section 1.2.2, Management System of *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4].

14 PACKAGING AND TRANSPORT

14.1 Packaging and Transport Program

WL adheres to the Corporate Transportation of Dangerous Goods Program, which includes the requirements of the Packaging and Transport SCA. See Section 14 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances and radiation devices. The Transportation of Dangerous Goods (TDG) Program applies to any activities involving the transportation of dangerous goods to or from CNL sites. The TDG Program provides an operational framework for the safe off-site transport of dangerous goods by conforming to all applicable laws and regulations, as well as company policies and procedures.

The Waste Certification & Transportation branch is a centralized organizational department responsible for planning, coordinating and executing radioactive waste shipments from the WL site to the off-site disposal or storage facilities in a safe and compliant manner, including having fully trained Radioactive Material Shippers as authorized under the CNL TDG Program.

Significant activities in 2020 included:

- Transportation of 528 m^3 of low-level waste and 26 m^3 intermediate-level waste sent off-site and safely delivered to CRL;
- Throughout 2020, additional technical assessments and studies on the WL used fuel inventory were completed in support of the licensing application of the Used Fuel Transportation Package (UFTP). These assessments were focused on the WL mixed fuel types (i.e., enriched and experimental fuel types, including Uranium Carbide and Uranium Metal fuel types) and the physical operation of the UFTP. The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations starting in 2021 (due to the COVID-19 Pandemic, these transportation operations were delayed and subsequently pushed out from 2020). There is a two-step licensing strategy for the UFTP, with the first phase focusing on licensing the UFTP for non-enriched CANDU fuels and the second phase focusing on WL's inventory of mixed fuel types. The phase UFTP Safety Analysis Report (SAR) Addendum was submitted to the CNSC in 2019 May, with updates provided throughout 2020. The UFTP SAR for Mixed Fuel Types (representing phase two) will be submitted following CNSC acceptance of the SAR Addendum. Additional accomplishments throughout 2020 include the completion of the physical commissioning of the UFTP, the completion of fabrication and Factory Acceptance Testing of the Shielded Interface Module (SIM) for UFTP loading, the inactive commissioning of the UFTP-SIM stack-up at CRL, and the completion of intrusive inspections of the used fuel baskets stored within the Concrete Canister Storage Facility.
- Award of the subcontract to Nuclear Assurance Corporation (NAC) to design and fabricate Type B casks, cask handling equipment and on-site services needed to support ILW transport to CRL was completed. Two versions of the OPTImal Modular Universal Shipping (OPTIMUS) casks, the OPTIMUS-H and OPTIMUS-L are expected for receipt in 2021 pending licence review and acceptance for use.

14.1.1 Shipments

At WL, 230 radioactive transport packages making up 36 loads were safely and successfully sent off-site in 2020. Whiteshell Laboratories complied with the Packaging and Transport of Nuclear Substances Regulations [46] and IAEA Safe Transport of Radioactive Material [47].

15 OTHER MATTERS OF REGULATORY INTEREST

15.1 Public Information and Disclosure Program

WL adheres to the Corporate Public Information Program. See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Public Information Program document [48] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure* [49].

15.1.1 Communications

See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4]

15.1.1.1 Website and Social Media

CNL's Whiteshell Decommissioning web page had 15,987 page views in 2020; this includes boosted and targeted social media advertising as well as information posts.

To support the Whiteshell projects and site, CNL has used social media to promote events, share and receive information, and generally engage with the public. As Table 50 and Table 51 show, social media has been an effective tool to reach and engage stakeholders. CNL's post on 2020 April 16 sharing the support CNL's Whiteshell Laboratories was giving to the COVID-19 response had a high level of engagement with 363 individuals interacting with the content. The high level of engagement on this post demonstrates CNL's success at notifying stakeholders of CNL's involvement in the community in which they are a part of.

Definitions:

Engagements - Measures how much and how often others interact with you and your content in social media.

Shares or retweets - Measures how often the message was shared or forwarded on the twitter website.

Table 50 – Facebook Metrics for WL-Raelated Posts*

Date of Post	Engagement	Shares
2020 January 22	108	14
2020 April 3	874	52
2020 April 16	363	12
2020 June 11	8	0
2020 June 21	816	65
2020 July 20	100	3
2020 August 14	79	6
2020 August 17	111	5
2020 October 27	83	2
2020 October 29	24	2

* Social media data is current as of 2021 April

Table 51- Twitter Metrics for WL-Related Posts*

Date of Post	Engagement	Retweets	Clicks
2020 June 11	11	0	0
2020 October 29	39	3	6

* Social media data is current as of 2021 April

15.1.1.2 Newsletters

CONTACT is an external newsletter distributed to community stakeholders and to residences and businesses in communities surrounding WL, and is available on www.cnl.ca. This publication informs the reader on activities undertaken at CNL's Whiteshell Laboratories and profiles CNL's community activities. Approximately 8,000 homes in the region receive this bilingual newsletter. A spring edition of *CONTACT* was issued in 2020. Since November 2017, five newsletters have been released with topics including the following:

- WL Closure Project and WR-1 Updates
- Highlights of public and Indigenous engagement activities
- Community initiatives demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- Employee Profiles
- Environmental Stewardship including steps to reduce greenhouse gas emissions, wildlife protection and waste minimization

15.1.1.3 Media Coverage

During the 2020 calendar year, media coverage on the Whiteshell Closure Project was fairly light with eight articles in total. See Table 52.

Table 52 – Media Coverage for 2020

Date	Article	Publication
2020 January 09	CNL Licence Renewed for Decommissioning	*The Clipper*
2020 January 23	North Forge receives CNEA Fund Support	*The Clipper*
2020 January	From the Council Chambers of Mayor Blair Skinner	*LGD of Pinawa Municipal Quarterly Newsletter*
2020 January 27	Letter to the PM, Parliament re: Canada's federally owned radioactive Waste	*Hill Times*
2020 April 09	Regional food banks seek additional support	*The Clipper*
2020 April 30	CNL offers support during COVID-19 crisis	*The Clipper*
2020 June	Radiation: Harnessing a Natural Phenomenon	*Discover Magazine*
2020 July 30	Nuclear Waste Disposal Plan Fuels Frustration	*Winnipeg Free Press*

15.1.2 Outreach and Stakeholder Engagement

WL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events. Employees are CNL's greatest ambassadors and they are kept informed of developments so that they can also share information with their relatives, friends, and neighbours. The Whiteshell Laboratories site engages with the public at a number of activities. For 2020, these activities are listed in Table 53.

Table 53: Public Engagements

Date	Location	Activity
2020 January 15	Pinawa, Manitoba	Community Regeneration Partnership meeting
2020 February 04	Pinawa, Manitoba	WR-1 Breakfast Session: Alternatives Analysis
2020 February 17	Whiteshell Laboratories	Tour of the WR-1 reactor to a University of Manitoba Physics Professor
2020 February 29	Winnipeg, Manitoba	WR-1 Presentation to the Association of Engineers & Geoscientists of Manitoba, Filipino sector
2020 May 05	Email update	Public Liaison Committee update via email with an invitation to contact CNL to discuss or with questions
2020 June 23	Virtual	WR-1 Breakfast Webinar: Post Closure Safety Assessment
2020 July 11	Hard-copy mail-out	CONTACT newsletter distributed to approximately 8000 homes
2020 August 20	Lac du Bonnet, Manitoba	CNL booth at the Lac du Bonnet Night Market
2020 August 25	Virtual	WR-1 Breakfast Webinar: Isolation and Containment Barriers
2020 September 05	Lac du Bonnet, Manitoba	CNL booth at the Lac du Bonnet Home and Cottage Expo
2020 September 24	Whiteshell Laboratories	Presentation on the Whiteshell Laboratories history and current decommissioning, following by a site tour to Manitoba Environmental Industries Association (MEIA), Assistant Deputy Minister Conservation and Climate, Director of Environmental Compliance and Enforcement Branch, Industry Workforce Development, Economic Development and Training, Lac du Bonnet MLA
2020 September 29	Virtual	WR-1 Breakfast Webinar: Formulation and Testing of Grout
2020 October 05	Pinawa, Manitoba	Whiteshell Community Regeneration Partnership Meeting
2020 October 05	Whiteshell Laboratories	Tour of the Whiteshell site to the Mayor of Pinawa and two representatives from StarCore Nuclear
2020 November 24	Virtual	Public Liaison Committee meeting

15.1.3 Public Consultation

WL actively works to engage local stakeholders on matters related to CNL activities. In 2020, a number of methods were deployed to gain feedback from and create discussion with interested parties including: participation in trade shows, breakfast sessions, social media, and feedback forms being made available online and at external events, and responses to inquiries being answered. WL strives to create open and transparent communication with all identified stakeholders, and works to address and respond to all inquiries.

Throughout 2020, CNL received 10 community inquiries related to WL (Table 54), largely through the WR-1 Breakfast Session/Webinar series.

Table 54: Whiteshell Laboratories Closure Project Public Inquiries

Nature of Enquiry	Number
Request for Documentation (Licencing, WR-1 EIS)	3
WR-1 Environmental Assessment Schedule	1
WR-1 Safety Case	2
WR-1 Alternative Means	4

15.1.4 Whiteshell Public Liaison Committee

Completing its seventeenth consecutive year of operation, the independently facilitated Whiteshell Public Liaison Committee continued to meet in 2020. Meeting minutes are recorded and actions are tracked and filed for reference. Due to the COVID-19 pandemic, the spring meeting was substituted with a written update emailed to participants in May, along with an invitation to contact CNL with questions or to discuss issues. The Committee met virtually November 24. Below are some highlights of the written update and November 24 presentation:

- WL Closure Project response to the COVID-19 Pandemic and support to the community,
- WL Closure Project Progress Update and Look Ahead,
- Environmental Monitoring and protection of the environment,
- WR-1 Environmental Assessment Update,
- CNSC Regulatory Oversight Review,
- Public and Indigenous Engagement and involvement in the communities,
- Update from the Community Regeneration Partnership Committee.

The committee is comprised of community and stakeholder representatives (as given below), consisting of elected officials and community interest groups. Its mandate is to provide an opportunity for open dialogue between community stakeholders and WL senior management on WL's various environmental and decommissioning projects.

The Whiteshell Public Liaison Committee is represented by:

- Local Government District Pinawa,
- Rural Municipality (RM) of Lac du Bonnet,
- Town of Lac du Bonnet,
- Town of Powerview Pine Falls,
- Town of Beausejour,
- RM of Brokenhead,

- RM of Whitemouth,
- RM of Alexander, and
- Manitoba Sustainable Development.

15.1.5 Whiteshell Laboratories Community Regeneration Partnership

The Whiteshell Laboratories Community Regeneration Partnership was formed as a result of the forthcoming closure of the WL site, and driven by a desire by both the Whiteshell region and CNL to encourage post-closure economic development. The partnership consists of municipalities, economic development organizations, Indigenous communities and CNL. Two meetings took place in 2020 providing opportunities for CNL to provide Project updates to participants and to seek feedback on the Whiteshell Closure Project and the WR-1 Decommissioning Project.

15.1.6 Ongoing Projects

15.1.6.1 WR-1 In Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning (also referred to as in situ disposal) Environmental Assessment (EA) is a key project identified by CNL as part of the overall integrated approach to safely manage and reduce Canada's legacy liabilities. It is a requirement in support of the EA process that the WR-1 project information be made available to CNL neighbouring communities and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Engagement activities were conducted in support of this requirement through a variety of methods including social media and website content, WR-1 in situ disposal Presentations, Meetings, Site Tours and Information Sharing with Stakeholders.

Project specific webpages and content were produced for the WR-1 Decommissioning Project. Content includes: fact sheets, info graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages. See www.cnl.ca/wr-1.

15.2 Indigenous Engagement

CNL follows CNSC REGDOC-3.2.2 Public and Indigenous Engagement: Indigenous Engagement [50] which sets out requirements and guidance for licensees on Indigenous engagement. CNL recognizes and values the ongoing engagement with Indigenous communities. Through its engagement activities, CNL seeks to inform Indigenous communities of ongoing activities at the WL site and the possible effects of these activities to members of communities and the environment, and to seek input and feedback from the communities regarding decommissioning of the Whiteshell Laboratories, the WR-1 Decommissioning Project, environmental monitoring, and to understand traditional and current uses in the vicinity of the WL site.

Through its engagement activities, WL has been able to solicit and respond to First Nations and Métis community input. First Nations and Métis communities have sought more information and engagement on environmental protection, understanding of the in situ disposal proposal and other options, economic opportunities, and the future plans for the WL site. CNL has been working with local First Nations and Métis communities to provide reasonable capacity, and at the same time has engaged communities with opportunities to better understand concerns and build positive relationships.

Table 55 lists the engagement activities from 2020. Further details on Indigenous Engagements are available through the Indigenous Engagement Report.

Table 55: Indigenous Engagement

Date	Event / Activity	Involved Parties	Details
Sagkeeng First Nation (SFN)			
2020 January 20	Memorandum of Understanding	SFN CNL	CNL and SFN sign an MOU to provide capacity support to review CNL's responses to Sagkeeng's comments on the EIS.
2020 February 18	Letter from SFN	SFN	CNL received a letter from the SFN Chief regarding the Alternative Means Assessment and other items.
2020 March 06	Meeting with CNL and SFN	SFN CNL OKT Law The Firelight Group	Review of 2020 February 18 letter from the SFN Chief to CNL and issues noted. Discussed Long Term Relationship Agreement (LTRA).
2020 May 04	Letter from CNL to SFN	SFN CNL	CNL provided responses to questions posted during the March 06 meeting.
2020 June 15	Memorandum of Understanding	SFN CNL	CNL and SFN sign an MOU to fund the completion of Sagkeeng's Alternative Means Assessment.
2020 June 30	Meeting with CNL and SFN	SFN OKT Law CNL	Review of CNL's offer to fund a community liaison position and description of what that role entails.
2020 July 17	Meeting with CNL and SFN	OKT Law CNL	Indigenous Liaison, LTRA, Environmental Monitoring, Regular Recurring Meetings.
2020 August 11	Meeting with CNL and SFN	SFN CNL	CNL met with Sagkeeng's new Indigenous Liaison. Discussed; overview of WL Closure Project, WR-1 ISD project and engagement with SFN to date; and took a preliminary site tour.
2020 August 12	Teleconference	Firelight CNL	Firelight, Sagkeeng's Consultant, provided an update of progress to date on Sagkeeng's Alternatives Assessment work.
2020 August 27	E-mail	SFN CNL	CNL provided an update on engagement activities with community liaison and draft training plan.
2020 September 05	Memorandum of Understanding	SFN CNL	CNL and Sagkeeng sign an MOU to providing funding for a community liaison position.

Date	Event / Activity	Involved Parties	Details
2020 September 08	Site Visit	Sagkeeng's Liaison CNL	Sagkeeng's community liaison came to site; CNL provided an overview of the history of the facility and the proposed decommissioning of the WR-1 reactor.
2020 September 15	Teleconference with Sagkeeng's Lawyer	OKT Law CNL	Sagkeeng's Lawyer and CNL reviewed and discussed Action Items.
2020 September 30	Tree Survey; Workplan Workshop	Sagkeeng's Liaison CNL	Sagkeeng's liaison and CNL met to commence the development of a work plan to guide CNL's future engagement with Sagkeeng's membership. Sagkeeng participated in a tree survey on site and discussed the process with the environmental team.
2020 October 19	Alternative Means Assessment Report	SFN CNL	CNL received Sagkeeng's final report on their Alternative Means Assessment.
2020 October 20	Contribution Agreement	SFN CNL	CNL and Sagkeeng signed a contribution agreement to support Firelight Group's review to CNL's responses to Sagkeeng's comments on the EIS.
2020 October 20	Environmental Monitoring	BRFN HWFN MMF SFN CNL	Community representatives observed fish processing on site and the environmental monitoring team provided an overview presentation.
2020 October 28	Psycho-social Assessment Letter	SFN CNL	CNL received Sagkeeng's completed Psycho-social Assessment Report.
2020 November 02	Teleconference	SFN CNL	Provided an update and discussed setting up follow up workshop to develop key deliverables for engaging Sagkeeng.
2020 November 03	Briefing Note update	SFN OKT Law	CNL provided Sagkeeng representatives with a briefing note for chief and council on CNL's monthly engagement activities.
2020 November 12	Teleconference	SFN Narratives Inc. OKT Law CNSC CNL	Sagkeeng Representatives presented an overview of the psycho-social report and CNL and CNSC asked questions.
2020 November 16	Letter – Sagkeeng's EIS Comments	SFN CNL	CNL received Sagkeeng's feedback on CNL's responses to Sagkeeng's comments on the EIS.

Date	Event / Activity	Involved Parties	Details
2020 November 19	Teleconference – Alternative Means Assessment Overview	SFN Firelight Group CNSC CNL	Sagkeeng presented an overview of the alternative means assessment report and CNL and CNSC asked questions.
2020 November 25	Invitation – CNL's Industry Day	SFN CNL	CNL, in partnership with the Organization of Canadian Nuclear Industries (OCNI), invited community members to participate in the 2020 virtual CNL Industry Day.
2020 November 25	Teleconference	SFN CNL	Sagkeeng's liaison and CNL met to discuss engaging Sagkeeng's membership during the pandemic.
2020 November 26	Teleconference	SFN CNL CNSC AECL	CNL hosted a meeting with Sagkeeng to discuss Sagkeeng's comments and CNL's proposed responses. This meeting took place prior to CNL drafting their responses to test their proposed next steps to address Sagkeeng's concerns (Part I).
2020 December 01	Teleconference	SFN CNL CNSC AECL	CNL hosted a meeting with Sagkeeng to discuss Sagkeeng's comments and CNL's proposed responses. This meeting took place prior to CNL drafting their responses to test their proposed next steps to address Sagkeeng's concerns (Part II).
Manitoba Metis Federation (MMF)			
2020 January 28	Meeting with CNL, MMF and CNSC	MMF CNL CNSC AECL	Monthly update meeting.
2020 March 06	Meeting with CNL, MMF and CNSC	MMF CNL CNSC	Monthly update meeting.
2020 March 24	Meeting with CNL, MMF and CNSC	MMF CNL CNSC	Monthly update meeting.
2020 April 27	Meeting with CNL, MMF and CNSC	MMF CNL CNSC	Monthly update meeting.
2020 May 25	Meeting with CNL, MMF and CNSC	MMF CNL CNSC	Monthly update meeting.

Date	Event / Activity	Involved Parties	Details
2020 June 22	Meeting with CNL, MMF and CNSC	MMF CNL CNSC	Monthly update meeting.
2020 July 06	Environmental Monitoring	MMF CNL	MMF Observed Waste Shipment from Pre-Job to Strapping.
2020 July 06	Meeting with CNL and MMF	MMF CNL	Presentation to MMF on CNL's Transportation of Waste and Emergency Response Capabilities.
2020 August 20	Letter	MMF CNL	CNL provided MMF with CNL's responses to MMF comments on the draft 2017 and 2019 EIS.
2020 August 26	Teleconference Meeting with CNL and Manitoba Métis Federation	MMF CNL	Introduced CNL's Indigenous Engagement Officer and discussed comments on Indigenous Advisory Committee – Participation Agreement.
2020 September 10	E-mail Update	MMF CNL	Provide a list of all fall environmental monitoring activities and invited MMF to participate.
2020 September 17	Environmental Monitoring: Mushroom Collection	MMF CNL	MMF participated in mushroom collection with CNL's environmental monitoring team.
2020 October 14	Métis Cultural Awareness Training	Louis Riel Institute CNL	Métis Cultural Awareness Training provided by the Louis Riel Institute. The cultural awareness training was the first semi-virtual training provided by the Louis Riel Institute, where half of the participants attended online and half were in-person.
2020 October 20	Environmental Monitoring	BRFN HWFN MMF SFN CNL	Community representatives observed fish processing on site and the environmental monitoring team provided an overview presentation.
2020 October 26	Teleconference	MMF CNL	CNL and the MMF met to discuss MMF's feedback on CNL's comments and CNL's proposed next steps.
2020 November 12	Teleconference	MMF CNL	CNL and the MMF had a follow-up meeting to discuss agenda for our coming meeting, the development of a Contribution Agreement for Fall Monitoring Activities; Update on MMF's review of CNL's Indigenous Advisory Committee Outline and community liaison Job Description.

Date	Event / Activity	Involved Parties	Details
2020 November 26	Teleconference – Workshop #1	MMF CNL	CNL hosted a meeting with MMF to discuss areas of interest and possible areas of collaboration. The communication protocol MMF recommend CNL follow, in accordance with MMF’s resolution #8, was also discussed.
Brokenhead Ojibway Nation (BON)			
2020 April 03	Teleconference	BRFN BON HWFN CNL CNSC	CNL provided an update on decommissioning activities.
2020 August 20	Phone call	BON	BON confirmed they do not want to participate in the IAC and was content to continue to engage through the regulatory process.
2020 August 26	Meeting with CNL and HTFC Consultant	HTFC CNL	Meeting with Consultant representing BRFN, BON, and HWFN. Discussed initial thoughts on the Indigenous Advisory Committee – Participation Agreement.
2020 September 14	Invitation – Email	CNL BON	CNL invited BON to participate in their fall environmental monitoring. No response received.
2020 September 15	Letter	CNL BON	CNL provide BON with responses to the community’s comments on the 2017 Draft EIS. Confirmed receipt and forwarded to Chief and Council.
2020 September 16	Invitation – E-mail	CNL BON	Invitation to attend CNL's WR-1 reakfast session webinar - 2020 September 29. No RSVP received.
Black River First Nation (BRFN)			
2020 March 16	Teleconference	BRFN CNL	Discussed next steps and meeting to review the IR responses.
2020 April 03	Teleconference	BRFN BON HWFN CNL CNSC	Discuss the decommissioning of the Whiteshell Site.
2020 August 26	Meeting with CNL and Consultant	HTFC CNL	Meeting with Consultant representing BRFN, BON, and HWFN. Discussed initial thoughts on the Indigenous Advisory Committee – Participation Agreement

Date	Event / Activity	Involved Parties	Details
2020 September 02	Teleconference	CNL BRFN HWFN HTFC Planning & Design	Meeting to discuss the Indigenous Advisory Committee and Black River and HWFNs Engagement Organizational Framework.
2020 September 16	Invitation	CNL BRFN	CNL sent out an invitation to community members to attend the final breakfast session.
2020 October 20	Environmental Monitoring	BRFN HWFN MMF, SFN CNL	Community representatives observed fish processing on site and the environmental monitoring team provided an overview presentation.
2020 October 27	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	HTFC and CNL met to discuss their proposed engagement structure and budget proposal.
2020 November 02	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	HTFC presented an overview of their engagement structure and budget proposal. CNL asked preliminary questions about their proposal
2020 November 12	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	CNL met to discuss their engagement structure and budget proposal.
Hollow Water First Nation (HWFN)			
2020 April 03	Teleconference	BRFN BON HWFN CNL CNSC	Discuss the decommissioning of the Whiteshell Site.
2020 August 26	Meeting with Consultant	HTFC CNL	Meeting with Consultant representing BRFN, BON, and HWFN. Discussed initial thoughts on the Indigenous Advisory Committee – Participation Agreement.
2020 September 02	Teleconference	CNL BRFN HWFN HTFC Planning & Design	Meeting to discuss the Indigenous Advisory Committee and Black River and HWFNs Engagement Organizational Framework.

Date	Event / Activity	Involved Parties	Details
2020 September 16	Invitation	HWFN CNL	CNL sent out an invitation to attend the final breakfast session to all Indigenous participants and encouraged the community to attend.
2020 October 20	Environmental Monitoring	BRFN HWFN MMF, SFN CNL	Community representatives observed fish processing on site and the environmental monitoring team provided an overview presentation.
2020 October 27	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	HTFC and CNL met to discuss their proposed engagement structure and budget proposal.
2020 November 2	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	HTFC presented an overview of their engagement structure and budget proposal. CNL asked preliminary questions about their proposal.
2020 November 12	Teleconference – Engagement Proposal	HTFC Planning and Design CNL	CNL met to discuss their engagement structure and budget proposal.
Wabaseemoong Independent Nations (WIN)			
2020 August 19	Letter	CNL WIN	CNL submitted CNL's responses to Wabaseemoong comments on the EIS.
2020 September 10	Invitation - Email	CNL WIN	CNL provided a list of all fall environmental monitoring activities and invited the community to participate.
2020 September 16	Invitation – Email	CNL WIN	CNL sent the community an invitation to CNL's final breakfast session webinar.
2020 October 08	Email – Site Tour	CNL WIN	CNL proposed a date for the site tour and requested a meeting to discuss Wabaseemoong's comments on the EIS
2020 October 29	Email – Site Tour	CNL WIN	CNL followed up to determine whether Wabaseemoong wanted to discuss CNL's responses to their comments. CNL to date has not received a response.
Grand Council of Treaty 3 (GCT3)			
2020 July 21	Site tour	GCT3 CNL	Tour of WR-1 and the WMA.
2020 August 12	Meeting with CNL and GCT3	GCT3 CNL	Introductory meeting between Grand Council Treaty #3 and CNL's Indigenous Engagement Officer to discuss the WR-1 ISD project.

Table 56: Identified Indigenous Communities

Indigenous Communities and/or Representative Organizations	Identification Rationale and Proximity to WR-1*
Sagkeeng First Nation (Treaty No. 1 and 3)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Proximity to the WL site. Occupy one reserve located 52 kilometres (km) north of the WL site, and downstream along the Winnipeg River. Existing relationship and interest in the WL site.
Brokenhead Ojibway Nation (Treaty No. 1)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Proximity to the WL site. Occupy three reserves: 44 km northwest, 55 km northwest and 73 km southwest of the WL site respectively. Interest expressed, comments on Project description.
Manitoba Metis Federation (MMF)	The MMF is the official democratic and self-governing political representative for the Métis Nation's Manitoba Métis Community. Potential, asserted and/or established Métis harvesting rights in the vicinity of the Project. Interest expressed, comments on Project Description.
Black River First Nation (Treaty No. 5)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Proximity to the WL site. Occupy one reserve 75 km north of the WL site.
Hollow Water First Nation (Anishinaabe (Ojibwa) (Treaty No. 5)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Occupy one reserve, 113 km north of the WL site.
Shoal Lake No. 40 (Treaty No. 3)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy three reserves: 94 km southeast, 110 km southeast and 140 km southeast of the WL site, respectively.
Iskatewizaagegan No. 39 Independent First Nation (Shoal Lake No. 39 First Nation) (Treaty No. 3)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy four reserves: 93 km southeast, 102 km southeast, 110 km southeast and 140 km southeast of the WL site respectively.

Indigenous Communities and/or Representative Organizations	Identification Rationale and Proximity to WR-1*
Northwest Angle No. 33 (Treaty No. 3)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy three reserves: 111 km southeast, 140 km southeast and 176 km southeast of the WL site, respectively.
Wabaseemoong Independent Nations (also known as Wabaseemoong Independent Nations of One Man Lake, Swan Lake and White Dog) (Treaty No. 3)	Potential, asserted and/or established Indigenous and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the WL site. Occupy four reserves: 80 km east, 85 km east, 95 km east and 140 km southeast of the WL site, respectively.
Grand Council of Treaty 3 (specific to this project includes: Shoal Lake No. 40 First Nation, Iskatewizaagegan No. 39 Independent First Nation (Shoal Lake No. 39 First Nation), Northwest Angle No. 33, Wabaseemoong Independent Nations, and Sagkeeng First Nation)	Umbrella treaty organization which represents 28 First Nations and 5 with potential interest in the Project. Treaty 3 territory includes parts of eastern Manitoba, including the WL site.
Chiefs of Ontario (specific to this project includes: Shoal Lake No. 40 First Nation, Iskatewizaagegan No. 39 Independent First Nation (Shoal Lake No. 39 First Nation), Northwest Angle No. 33, and Wabaseemoong Independent Nations)	First Nations umbrella organization that represents 133 First Nations and 4 with potential interest in the Project.

16 ACRONYMS

AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable (economic and social factors being taken into account)
ALWTC	Active Liquid Waste Treatment Center
ATG	Analytical Test Group
CBOD	Carbonaceous Biochemical Oxygen Demand
CCSF	Concrete Canister Storage Facility
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CRL	Chalk River Laboratories
CSA	Canadian Standards Association
CSD	Criticality Safety Document
DCP	Dose Control Point
DDP	Detailed Decommissioning Plan
DL	Detection Limit
DRL	Derived Release Limits
EA	Environmental Assessment
EmP	Emergency Preparedness
EOC	Emergency Operations Center
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCF	Hot Cell Facility
HCFC	Hydrochlorofluorocarbons
HEPA	High Efficiency Particulate Air (Filter)
HU	Human Performance
IAEA	International Atomic Energy Alliance
IFTF	Immobilized Fuel Test Facility
ILLW	Intermediate – Level Liquid Waste
ILW	Intermediate – Level Waste
ImpAct	Improvement Actions

LGD	Local Government District
LLD	Lower Limit of Detection
LLW	Low – Level Waste
LLLW	Low – Level Liquid Waste
LLLWTS	Low – Level Liquid Waste Treatment Center
LMDL	Laboratory Method Detection Limit
LSVCTF	Large Scale Vented Combustion Test Facility
MPNU	Most Probable Number of Units
NFPA	National Fire Protection Association
NPRI	National Pollutant Release Inventory
PAD	Personal Alarming Dosimeters
PIP	Periodic Inspection Plan
PM	Particulate Matter
R&D	Research and Development
RAM	Radioactive Material
RM	Rural Municipality
RMDL	Regulatory Method Detection Limit
RP	Radiation Protection
RSTD	Relative Standard Deviation
SAR	Safety Analysis Report
SCA	Safety Control Area
SF	Shielded Facilities
SMAGS	Shielded Modular Above Ground Storage
SRI	Smallest Reporting Increment
TDG	Transportation of Dangerous Goods
TLD	Thermoluminescent Dosimeters
TSS	Total Suspended Solids
UFTP	Used Fuel Transportation Package
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactor 1

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APPENDIX A Concrete Canister Storage Facility

A.1 Operations

The Concrete Canister Storage Facility (CCSF) is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [51]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2020, staff of the Site and Nuclear Operations Branch monitored the operation of the CCSF.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2020.

Routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

There were no changes in the staffing or organization for the operating staff responsible for the CCSF in 2020.

In 2020, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [51]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the CCSF in 2020. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

A.2 Compliance Monitoring

A.2.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in October.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters.

There was no visible moisture detected from the internal canister space during 2020 monitoring, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.2.2 Monitoring of Ground and Surface Water

Figure 11 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, compliance results for the CCSF are described below.

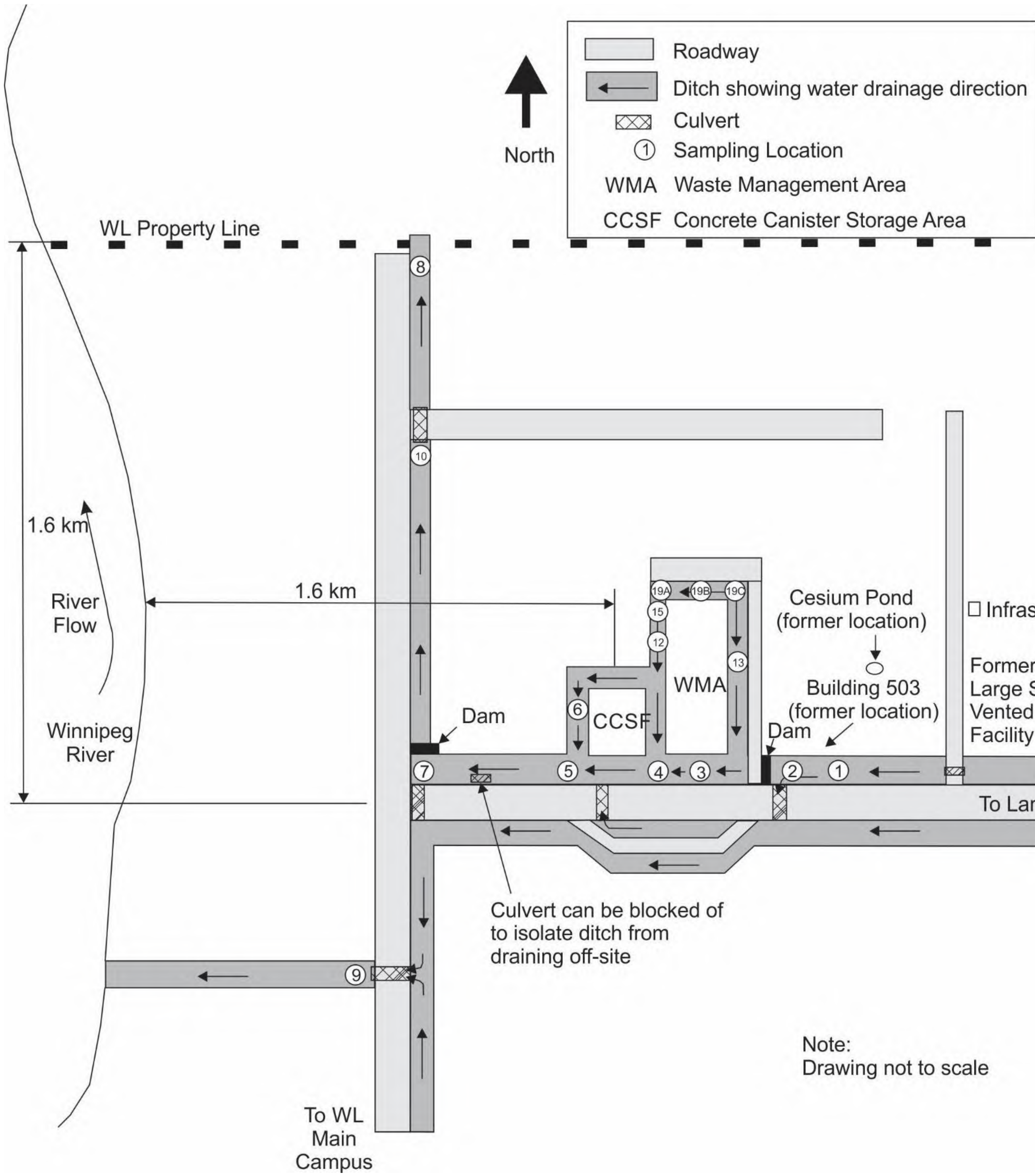

Figure 11: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Appendix D of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Sr-90. Gamma spectrometry analysis provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147 and Am-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [34]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Note that in some occasions locations were sampled on a two day period due to rain conditions on those periods. Ditch Location 5 and Ditch Location 6 samples (see Figure 11 for sampling locations) could contain surface drainage from the CCSF. The gross beta level in Ditch Location 5 and Ditch Location 6 did not reach the trigger level (10 Bq/L) for gamma spectrometry and strontium analysis this year. The highest value noted (0.95 Bq/L) was in Ditch 5 from the June 8 and 10 measurement set. Half of this activity would be attributable to Sr-90 (assuming secular equilibrium with Y-90) at the applicable Maximum Acceptable Concentration of 5.0 Bq/L, and the remaining activity is below the Maximum Acceptable Concentration for Y-90 (30 Bq/L).

The alpha activities were below the trigger level of 0.5 Bq/L, with the exception of Location 5 (0.80 Bq/L) from the June 8 and 10 measurement set.

Ditch samples collected immediately downstream from the WMA (Locations 5, 6 and 7) contained elevated levels of tritium[13] (see Table 59). None of these samples exceeded the associated Maximum Acceptable Concentration of 7,000 Bq/L [34]. The activity seen is likely from the WMA as discussed in Appendix D.

Table 57, Table 58, Table 59 and Table 60 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2020. Operational control-monitoring data from previous years has been included for completeness.

[13] Tritium analysis of samples from Ditch Locations 5 and 6 was previously discontinued due to the higher levels of tritium (~4000 Bq/L) noted at upstream locations associated with the WMA.

Table 57: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
1	0.17	0.21	IF	IF	0.10	0.11	0.19	IF	IF	0.10
2	0.14	0.26	IF	IF	0.06	0.12	0.13	IF	0.20	0.17
3	IF	0.61	IF	IF	IF	3.30	IF	IF	IF	IF
4	IF	1.38	IF	IF	IF	1.40	IF	IF	IF	IF
5	IF	0.34	IF	IF	IF	0.95	0.26	IF	IF	0.87
6	0.23	0.21	IF	IF	IF	0.95	IF	IF	IF	0.48
7	0.52	0.47	0.18	0.18	0.82	2.26	1.01	0.92	1.04	0.99
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.22	0.27	0.17	0.05	0.08	0.06	0.09	0.10	0.08	0.08

a The reference nuclide for total beta is Sr-90.

IF Insufficient flow, water was stagnant in the ditch

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
5	1.63	0.56	1.02	2.37	0.69	0.61

b Arithmetic average of samples collected.

Table 58: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2020									
Locations	01 and 02 Apr	07 Apr	27 Apr	05 May	14 May	08 and 10 Jun	18 Jun	22 Jun	14 Jul	31 Aug
1	0.05	0.05	IF	0.10	IF	0.05	0.11	IF	IF	0.10
2	0.06	0.10	IF	0.15	IF	0.05	0.05	IF	0.42	0.16
3	IF	0.07	IF	IF	IF	0.05	IF	IF	IF	IF
4	IF	0.05	IF	IF	IF	0.80	IF	IF	IF	IF
5	IF	0.09	IF	0.40	IF	0.80	0.30	IF	IF	0.21
6	0.14	0.08	0.15	0.40	IF	0.80	IF	IF	IF	0.24
7	0.13	0.07	0.09	0.22	0.15	0.40	0.14	0.21	0.13	0.16
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.05	IF	0.05	0.05	0.05	0.05	0.15	0.12	0.04	0.04

a The reference nuclide for total alpha is total Uranium.

IF Insufficient flow, water was stagnant in the ditch

NA Sample not available for analysis

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	2015	2016	2017	2018	2019	2020
5	0.23	0.25	0.24	0.29	0.27	0.36

b Arithmetic average of samples collected.

Table 59: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2020									
Locations	01 and 02 Apr	07 Apr	27 Apr	05 May	14 May	08 and 10 Jun	18 Jun	22 Jun	14 Jul	31 Aug
1	3.97	3.89	IF		3.40	4.00	3.90			4.30
2	4.04	4.25	IF		3.40	4.40	3.90		4.20	4.50
3	IF	95.14	IF			600.60				
4	IF	155.00	IF			362.20				
5	IF	46.34	IF			187.90	4.00			31.40
6	76.04	47.26	IF			62.10				114.10
7	81.26	74.37	92.71	135.90	132.90	52.70	119.50	141.70	36.10	136.90
19 A	IF	IF	IF							
19 B	IF	IF	IF							
19 C	IF	IF	IF							
Background	4.10	4.19	3.34	3.00	3.90	4.60	5.20	5.00	4.60	5.60

IF Insufficient flow, water was stagnant in the ditch
NA Sample not available for analysis

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	2015	2016	2017	2018	2019	2020
5	309	706	699	111	117	67

a Arithmetic average of samples collected.

Table 60: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2019									
Locations	01 and 02 Apr	07 Apr	27 Apr	05 May	14 May	08 and 10 Jun	18 Jun	22 Jun	14 Jul	31 Aug
1	0.28	0.16	0.67	IF	1.65	2.62	1.00	IF	IF	3.24
2	0.64	0.35	1.07	IF	2.59	4.14	1.70	IF	0.49	4.39
3	IF	3.11	IF	IF	IF	17.00	IF	IF	IF	IF
4	IF	3.90	IF	IF	IF	25.00	IF	IF	IF	IF
5	IF	2.06	5.48	IF	IF	24.50	12.30	IF	IF	12.30
6	2.57	1.71	5.53	IF	IF	29.40	IF	IF	IF	8.66
7	3.96	2.68	8.54	8.41	11.50	12.10	8.21	10.50	2.40	7.18
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.39	0.58	0.33	0.71	0.63	1.33	1.12	1.35	1.23	0.48

NA Not available

IF Insufficient flow

Historical Uranium Data[a] (Uranium ppb)						
Sample Point	2015	2016	2017	2018	2019	2020
5	NR	NR	NR	24.70[b]	13.8	11.3

a Arithmetic average of samples collected.

b Single Value

A.3 FACILITY CHANGES

All facility changes were performed as per the Engineering Change Control procedure [14]. There were no major facility changes made in 2020.

A.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2020, a program to examine the accessible basket parts was done using a remote borescope camera.

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2020. None of the canisters had a deviation greater than 1°. In 2020, Canister C5 had a deviation of 0.7° to the east. This deviation and those seen on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2020.

As required by Section 8 of the Facility Authorization [51], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2020. The general appearance and fencing were found to be satisfactory on each inspection. Minor infilling was done along the base of the fence to meet security requirements.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes and it has been noted that edges of many pour pockets are more brittle than in the past. Selective patching is done of these pour pockets, only minor patching was conducted in 2020. No increased radiation field was noted from the canisters. There was no degradation of the exposed metallic portions of the canisters.

A.4.1 Canister Site Monitoring and Surveillance

Gamma Field Surveys

Gamma exposure rates from the canisters were measured quarterly in 2020. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No field anomalies were found during 2020, but there was a slight decrease in the average readings on Canister C-18.

Table 61 shows the averaged gamma near contact exposure rates measured during 2020, and for the previous four years.

Table 61: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.07	0.08	0.06	0.09	2020	C13	0.16	0.25	0.15	0.14	2020
	0.11	0.08	0.10	0.12	2019		0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
	0.08	0.08	0.09	0.08	2017		0.18	0.25	0.15	0.18	2017
	0.07	0.08	0.11	0.09	2016		0.17	0.20	0.16	0.14	2016
C6	0.08	0.09	0.07	0.09	2020	C14	0.11	0.17	0.15	0.13	2020
	0.09	0.11	0.10	0.08	2019		0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
	0.08	0.10	0.08	0.06	2017		0.11	0.18	0.17	0.13	2017
	0.09	0.12	0.08	0.07	2016		0.09	0.17	0.14	0.13	2016
C7	0.15	0.12	0.13	0.14	2020	C15	0.29	0.37	0.27	0.29	2020
	0.18	0.16	0.14	0.16	2019		0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
	0.20	0.16	0.14	0.14	2017		0.33	0.39	0.31	0.30	2017
	0.18	0.12	0.17	0.14	2016		0.24	0.31	0.31	0.29	2016
C8	0.11	0.12	0.10	0.09	2020	C16	0.16	0.21	0.15	0.17	2020
	0.11	0.13	0.11	0.11	2019		0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
	0.10	0.10	0.10	0.09	2017		0.18	0.29	0.13	0.17	2017
	0.10	0.12	0.11	0.12	2016		0.15	0.22	0.12	0.16	2016
C9	0.23	0.21	0.14	0.22	2020	C17	0.15	0.13	0.23	0.22	2020
	0.26	0.23	0.17	0.21	2019		0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
	0.25	0.19	0.20	0.22	2017		0.20	0.15	0.23	0.24	2017
	0.23	0.17	0.23	0.23	2016		0.13	0.15	0.24	0.23	2016
C10	0.23	0.20	0.19	0.42	2020	C18	0.67	0.49	1.05	0.55	2020
	0.24	0.28	0.22	0.21	2019		0.69	0.76	1.25	0.62	2019
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018
	0.24	0.30	0.21	0.22	2017		0.70	0.70	1.22	0.70	2017
	0.21	0.27	0.19	0.22	2016		0.73	0.70	1.25	0.64	2016
C11	0.19	0.21	0.23	0.28	2020	C19	0.16	0.17	0.20	0.17	2020
	0.25	0.24	0.29	0.29	2019		0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
	0.26	0.26	0.30	0.30	2017		0.18	0.18	0.25	0.22	2017
	0.19	0.18	0.30	0.32	2016		0.14	0.15	0.19	0.18	2016
C12	0.16	0.19	0.10	0.13	2020	C20	0.14	0.12	0.14	0.16	2020
	0.19	0.21	0.13	0.13	2019		0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018
	0.22	0.25	0.15	0.13	2017		0.16	0.11	0.18	0.18	2017
	0.18	0.18	0.12	0.17	2016		0.15	0.11	0.17	0.20	2016

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h =1 mrem/h

Air Monitoring

Air monitoring was conducted on each of the canisters in the CCSF in 2020. This involves an air pump that circulates air from and outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero.

No anomalies were found during 2020, and there was no change in results as compared with previous surveys.

Table 62 shows the averaged beta readings on each filter measured during 2020, and for the previous four years.

Table 62: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	6	<0.02	2020	C13	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	0.02	2017
	6	0.02	2016		6	0.02	2016
C6	6	<0.02	2020	C14	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	<0.02	2017
	6	0.02	2016		6	<0.02	2016
C7	6	<0.02	2020	C15	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	<0.02	2016		6	0.02	2016
C8	6	<0.02	2020	C16	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	0.02	2016		6	<0.02	2016
C9	6	<0.02	2020	C17	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
	6	<0.02	2016		6	0.02	2016
C10	6	<0.02	2020	C18	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	<0.02	2017
	6	<0.02	2016		6	<0.02	2016

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C11	6	<0.02	2020	C19	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
	6	<0.02	2017		6	0.03	2017
	6	0.02	2016		6	0.02	2016
C12	6	<0.02	2020	C20	6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.03	2017
	6	<0.02	2016		6	<0.02	2016

A.5 WASTES GENERATED

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

See Section 11.1 Waste Management Program for summaries of any volume of radioactive solid and/or liquid waste generated in the CCSF in 2020.

A.6 EFFLUENTS RELEASED

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the CCSF as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX B Active Liquid Waste Treatment Center

B.1 Operations

The Active Liquid Waste Treatment Center (ALWTC) in Building 200 is operated under the WL Site Licence [1], in accordance with the requirements of the ALWTC Facility Authorization [52] while facilitating and harmonizing the decommissioning activities as prescribed in the established work plan. During 2020, the ALWTC was monitored and operated by Site and Nuclear Operations Branch personnel.

In 2017, new LLLWTS began operation in Buildings 100 and 300. All of the Building 100 low level liquid waste is now being tested, treated and controlled release to the river in the Building 100 LLLWTS and likewise in Building 300. All of the collection tanks in Building 200 were then isolated and taken out of service. The Building 200 sumps have also been taken out of service and any water collected from the sumps and associated piping is put into drums for processing. Decommissioning of the Low-Level Liquid Waste (LLLW) and Intermediate-Level Liquid Waste (ILLW) systems in Building 200 are underway.

Passive evaporation from Tank 807 ILLW is no longer conducted, nor is any ILLW stored in Building 200. The contents of Tank 807 was pumped into road-transportable containers in 2013, and the first shipment of this liquid was sent to an offsite processing facility for volume reduction. The remaining liquid is stored in road-transportable containers (5,400 L) in a Quonset in the WMA. Plans are underway to purchase and install a LLLW and ILLW waste processing facility in LLW Bunker 6 at the WMA, and then process the stored liquid waste onsite.

In 2020 October, the last of the operating systems in Building 200 were shut down and isolated (ventilation and compressed air systems). The building was rendered cold and dark and demolition of the building started later in October. At the end of 2020 November, the demolition of Building 200 was halted and placed into a safe state due to a safety shutdown by CNL of the Whiteshell Site. The building remained in this state for the remainder of 2020. Demolition of Building 200 will be completed in 2021.

Routine operations in the ALWTC were carried out by four operating staff from the Site and Nuclear Operations Branch.

There were no changes in the staffing or organization for the operating staff responsible for the ALWTC in 2020. There was a change in Facility Authority as communicated to the CNSC [53].

All operating procedures and other associated procedures for Building 200 have also been cancelled. In 2020, the facility continued to maintain the minimum staffing requirements outlined in the ALWTC Facility Authorization [52]. Staffing was maintained at levels to provide the needed operational and safety support.

In October 2020, CNL notified the CNSC that the ALWTC, Building 200 is being demolished and requested that the Facility Authorization [52] and the Safety Analysis Report [54] associated with the ALWTC be removed from the Whiteshell Laboratories LCH [12]. CNSC granted this request in December [55].

B.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [14]. Building 200 was turned over to decommissioning near the end of 2017 to begin the decommissioning of the building. Decommissioning of the LLLW systems was completed in 2019. All the laundry, decontamination, WR-1 and

Building 300 LLLW collection systems in Building 200 have been removed except for the collection tanks. The removal of the ILLW system was completed in 2020. The demolition of the building is approximately 50% complete at the end of 2020.

B.3 Equipment Performance, Planned Maintenance Testing and Inspections

The Facility operated satisfactorily in 2020.

As required by Section 8 of the Facility Authorization [52], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests and inspections were completed. Monthly housekeeping and fire prevention inspections were completed.

Low-Level Liquid Waste System

The low-level liquid waste system is shut down and decommissioned.

Medium-Level Liquid Waste System

The medium-level liquid waste (intermediate-level liquid waste) system is no longer in use and is decommissioned.

Ventilation System

Routine Poly-Alpha-Olefin testing of the exhaust High Efficiency Particulate Air (HEPA) filter was carried out satisfactorily in 2020 May. All filters had acceptable penetrations of less than 0.03%. The November testing was not required because the ventilation had been shut down and demolition of the building started.

B.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the ALWTC in 2020.

There were no liquid radioactive and/or hazardous wastes generated in the ALWTC as part of routine operations.

Decommissioning of low-level and intermediate-level liquid systems generated 1 m^3 of liquid waste for 2020.

B.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the ALWTC as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX C Shielded Facilities

C.1 Operations

The WL Shielded Facilities (SF) operates under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [56]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shut down and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of HEPA filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

There were no changes in the staffing for the operating staff responsible for the SF in 2020. There were no organizational changes. In 2020, the SF continued to maintain the minimum staffing requirements outlined in the SF Facility Authorization [56]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the SF in 2020. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

C.2 FACILITY CHANGES

All facility changes were performed as per the approved Engineering Change Control procedure [14].

C.3 Equipment Performance, Planned Maintenance Testing and Inspections

As required by Section 8 of the Facility Authorization [56], all routine maintenance for safety related systems was carried out as per the facility maintenance plan, and all equipment tests and inspections were complete. Monthly housekeeping and fire prevention inspections were completed.

Ventilation System

Maintenance activities requiring part of the ventilation system to be taken down occurred without incident.

The annual routine Poly-Alpha-Olefin testing of the HCF HEPA filters were successfully conducted except for Cell 13 as it required filters changes. Cell 13 was taken out of service until the filters can be replaced.

C.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of the volume of any volume of radioactive solid and/or liquid waste generated in the SF in 2020.

Low-Level Solid Waste

In 2020, the SF generated 10.8 m^3 of compactable low-level radioactive solid waste and 0.1 m^3 of non-compactable waste.

The Waste Handling Area processed 162.0 m^3 of low-level radioactive solid waste which was reduced to 15 m^3. A portion of this waste was generated in the SF, and the remainder came from all of the nuclear facilities and decommissioning projects at WL where waste is being generated.

Table 63 lists the annual low-level solid waste generated in the SF for 2020 and the previous four years.

Table 63: Solid Wastes Generated

Total Volume	2016	2017	2018	2019	2020
Low-Level Solid Waste (m^3)	47.7	0.4	73.3	64.3	10.9
Medium-Level Solid Waste (m^3)	0	0	0	0	0

Medium-Level Solid Waste

In 2020 the SF generated no medium-level (intermediate-level) radioactive solid waste. Table 63 lists the annual medium-level solid waste generated for 2020 and the previous four years.

Low-Level Liquid Waste System

In 2020, 99 m^3 of low-level liquid waste was processed through the Building 300 low-level liquid waste system (see Appendix E).

Medium-Level Liquid Waste System

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2020, there was one transfer of 0.12 m^3 medium-level liquid waste to transportable totes that is being stored for future disposition.

Table 64 lists the annual aqueous waste generated for 2020 and also for the previous four years.

Table 64: Building 300 Liquid Waste Volumes

Year	Low-Level Waste System[a]		Medium-Level Waste System[b]
	Total Volume (m^3)	Activity	Total Volume (m^3)
2016	195.4	0.039GBq β 0.006GBq γ 0.004GBq α	0
2017	164.0	0.073GBq β 0.007GBq γ 0.003GBq α	0
2018	123.0	0.016GBq β 0.006GBq γ 0.003GBq α	0
2019	186.5	0.035GBq β 0.008GBq γ 0.0027GBq α	1.2
2020	99	0.046GBq β 0.001GBq γ 0.008GBq α	0.12

a Total volume for Building 300 (Sumps)
b Total volume can be attributed to the SF

C.5 EFFLUENTS RELEASED

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

Liquid radioactive and/or hazardous effluents were discharged from the SF as part of routine operations.

APPENDIX D Waste Management Area

D.1 Operations

The Waste Management Area (WMA) operated under the WL Site Licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [57]. During 2020, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2020, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, WMA Operator and two WMA based utility workers, with support from other Site and Nuclear Operations personnel and Environmental Monitoring personnel as required.

There were no changes in the staffing or organization for the operating staff responsible for the WMA in 2020. There was a change in Facility Authority as communicated to the CNSC [53].

In 2020, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [57]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the WMA in 2020. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

D.1.1 Inventory Additions And Deletions

Changes in inventory are reported in Table 65 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.2 Low-Level Solid Waste

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. Some of the inventory of stored waste in WMA was sent to CRL for storage pending future disposal. The stored volume of waste is listed in Table 65.

D.1.3 Industrial Waste

There were no additions of industrial chemical waste during 2020.

Table 65: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2019 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433, and Building 923	19,293.86	2,147.87	330.59
Additions for 2020	Building 923, SSC, Building 431 to 433	32.33	16.97	0.00
Removals for 2020	Building 923 SSC LLW Bunker 6 B411 B514	112.50 14.00 182.00 198.80 20.40	0.16 52.70 48.50 85.90 10.20	0.00 0.00 0.01 0.00 0.00
Total Accumulation as of 2020 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433, Building 923 and SSC	18,798.84	1,967.38	330.58

D.2 Compliance Monitoring

D.2.1 Monitoring And Surface Water

Surface Water

Figure 11 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

A recorded amount of precipitation of 441 mm occurred in 2020, which was less than the 646 mm recorded in 2019. The majority of the precipitation was rainfall in July (90mm) and August (111mm) of 2020. The low precipitation is reflective of a drought year in the area.

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

- If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.
- If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, as was the case last year, all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable

Concentration (MAC) established by Health Canada [34]. If uranium is detected, the result is evaluated against the MAC for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity at ditch sample Locations 1 to 7 (Table 66) all remained well below 10 Bq/L. Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. Most beta activity levels in the ditch water remained below the drinking water screening level of 1 Bq/L and below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137 [58]. Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. In several measurements there were exceedances of the Canadian Drinking Water [34] standard of 1.0 Bq/L (Table 66), however no increasing trend was noted and all values for beta had returned below 1.0 Bq/L by the final measurements of the year on 2020 August 31.

The alpha activity levels in the surface water are presented in Table 67, and were below the trigger level of 0.5 Bq/L, except for the measurements on 2020 June 8 and 10. This represents one set of samples taken over those two days. Uranium values recorded from those samples ranged from 2.62 ppb at Location 1 to 29.40 ppb at Location 6. Uranium results are presented in Table 68.

There was no flow at Locations 19 A, B and C in this year. In past years, the uranium values recorded at these locations are believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation. This rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018. The Lac du Bonnet Batholith granite is noted to have naturally occurring uranium.

As shown in Table 69, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [34] at all locations. Tritium was measured at a maximum of 600.6 Bq/L at Location 3, with all other results through the year lower than that value. Location 3 receives surface water from a swale that leads north from the location alongside ILW Bunkers 1-4, and overland drainage from the south trenches, including Trench 7, which is known to contain tritium containing waste. Tritium detected at Location 3 would contribute to that seen in Locations 4, 5 and 7. In 2020, no flow occurred at and thus no measurements were made at Locations 19 A, B and C. The elevated readings that existed in this area in previous years likely resulted from migration of tritium in the clay columns from WR-1 stored in Trench 23. Trench 23 is nearest Location 19C. Locations 19 A, B and C were originally chosen for sampling for the potential migration of cesium-137 due to the presence of the Cesium Pond soil pile. Although the Cesium Pond soil has been removed, CNL will continue to monitor locations 19 A, B and C due to the elevated levels of tritium.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [59], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is elevated immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 4.5 Bq/L in 2020). Although the amount measured in Locations 1 to 7 are above that noted at the Control location, the levels are much lower than the Maximum Acceptable Concentration in drinking water for tritium (7000 Bq/L).

From the 2020 April 01 and 02 samples, Carbon 14 was noted with a value of 14.3 Bq/L in the east ditch of the WMA (Location 13), which is an order of magnitude less than the Canadian Drinking Water Guideline of

200 Bq/L [34]. Other values measured at Location 13 were 1.3 Bq/L on April 07, 2.5 Bq/L on June 08, 1.9 Bq/L on July 14 and 1.4 Bq/L on August 31, and 1.8 Bq/L at Location 10. Location 10 is to the east of the WMA and is unaffected by surface water flow from the WMA. A potential source for the C-14 at Location 13 may be from residue from barrels previously held in the area of Trench 1 and 2 while awaiting incineration in the now decommissioned Building 514 incinerator on the east side of the WMA. It may also relate to potential surface clay fissuring from the dry summers in 2019 and 2020. The reading from 2020 April may represent mobilization from initial meltwater. Further measurements will be taken in 2021 as ditch water flows permit.

Table 66, Table 67, and Table 68 present the WMA surface-water sampling data. The data represents continuing documentation of a spill incident that occurred in 1979 near ILW Bunker 3, at the reference sample point (Location 3) in the southeast section of the WMA, as shown in Figure 11 and Figure 12. In 2017, sampling Location 3 was reconfigured to allow preparations for future bunker and standpipe remediation, but the location was dry this year due to dry summer. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater is below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of 1.27×10^{7} Bq/L [60]. These tables, and Table 69, have been expanded to include the historical monitoring at Ditch Locations 19 A, B and C.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. There was no flow recorded in the north WMA ditch in 2020 (Locations 19 A, B and C) (Figure 12). Table 70 reflects this circumstance and shows that previous years indicated no migration of Cs-137 to these ditches.

As Trench 16 has a known quantity of Technetium-99 (Tc-99), ditch water measurements were made in 2020 to determine if the radioisotope was present. Sample Location 13, nearest Trench 16, gave an average value of 1.66 Bq/L from three readings (April 01/02, April 07 and July 14). Other sample locations provided similar low values of Tc-99 (Table 71) suggesting values are at the limit of detection. The Tc-99 limit for drinking water is 200 Bq/L [58].

Table 66: Gross Beta Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2020									
Locations	01 and 02 Apr	07 Apr	27 Apr	05 May	14 May	08 and 10 Jun	18 Jun	22 Jun	14 Jul	31 Aug
1	0.17	0.21	IF	IF	0.10	0.11	0.19	IF	IF	0.10
2	0.14	0.26	IF	IF	0.06	0.12	0.13	IF	0.20	0.17
3	IF	0.61	IF	IF	IF	3.30	IF	IF	IF	IF
4	IF	1.38	IF	IF	IF	1.40	IF	IF	IF	IF
5	IF	0.34	IF	IF	IF	0.95	0.26	IF	IF	0.87
6	0.23	0.21	IF	IF	IF	0.95	IF	IF	IF	0.48
7	0.52	0.47	0.18	0.18	0.82	2.26	1.01	0.92	1.04	0.99
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.22	0.27	0.17	0.05	0.08	0.06	0.09	0.10	0.08	0.08

Historical Beta Data (Average[b] Bq/L)						
Sample Point	2015	2016	2017	2018	2019	2020
3	2.13	1.23	1.62	1.24	IF	1.96
19 A	0.53	0.40	0.69	0.36	0.44[c]	IF
19 B	0.63	0.52	0.72	0.24	0.43[c]	IF
19 C	0.70	0.39	0.58	0.38	IF	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow
NA Not available

Table 67: Gross Alpha Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
1	0.05	0.05	IF	0.10	IF	0.05	0.11	IF	IF	0.10
2	0.06	0.10	IF	0.15	IF	0.05	0.05	IF	0.42	0.16
3	IF	0.07	IF	IF	IF	0.05	IF	IF	IF	IF
4	IF	0.05	IF	IF	IF	0.80	IF	IF	IF	IF
5	IF	0.09	IF	0.40	IF	0.80	0.30	IF	IF	0.21
6	0.14	0.08	0.15	0.40	IF	0.80	IF	IF	IF	0.24
7	0.13	0.07	0.09	0.22	0.15	0.40	0.14	0.21	0.13	0.16
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.05	IF	0.05	0.05	0.05	0.05	0.15	0.12	0.04	0.04

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
3	0.25	0.64	0.28	0.31	IF	0.06
19 A	0.23	0.34	0.53	0.92	0.26[c]	IF
19 B	0.39	0.36	0.74	0.24	0.51[c]	IF
19 C	0.41	0.40	1.05	0.39	IF	IF

a The reference nuclide for total alpha is total Uranium
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow
NA Not available

Table 68: Uranium of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
1	0.28	0.16	0.67	IF	1.65	2.62	1.00	IF	IF	3.24
2	0.64	0.35	1.07	IF	2.59	4.14	1.70	IF	0.49	4.39
3	IF	3.11	IF	IF	IF	17.00	IF	IF	IF	IF
4	IF	3.90	IF	IF	IF	25.00	IF	IF	IF	IF
5	IF	2.06	5.48	IF	IF	24.50	12.30	IF	IF	12.30
6	2.57	1.71	5.53	IF	IF	29.40	IF	IF	IF	8.66
7	3.96	2.68	8.54	8.41	11.50	12.10	8.21	10.50	2.40	7.18
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	0.39	0.58	0.33	0.71	0.63	1.33	1.12	1.35	1.23	0.48

Historical Uranium Data (Average[a] ppb)						
Sample Point	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
3	NR	ND	NR	21	IF	10.06
19 A	NR	NR	24	52[a]	13[b]	IF
19 B	NR	NR	39	NR	16[b]	IF
19 C	NR	NR	67	47[a]	IF	IF

a Arithmetic average of samples collected
b Based on single sample analyses
NR Analysis not required
IF Insufficient flow, water was stagnant in the ditch
ND Not detected
NA Not available

Table 69: Tritium Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
1	3.97	3.89	IF		3.40	4.00	3.90			4.30
2	4.04	4.25	IF		3.40	4.40	3.90		4.20	4.50
3	IF	95.14	IF			600.60				
4	IF	155.00	IF			362.20				
5	IF	46.34	IF			187.90	4.00			31.40
6	76.04	47.26	IF			62.10				114.10
7	81.26	74.37	92.71	135.90	132.90	52.70	119.50	141.70	36.10	136.90
19 A	IF	IF	IF							
19 B	IF	IF	IF							
19 C	IF	IF	IF							
Background	4.10	4.19	3.34	3.00	3.90	4.60	5.20	5.00	4.60	5.60

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
3	751	228	1335[b]	178	IF	348
19 A	1025	2324	5535	459	543[b]	IF
19 B	1206	4001	8123	325[b]	777[b]	IF
19 C	1216	4203	9610	405	IF	IF

a Arithmetic average of samples collected
b Single data point
IF Insufficient flow
NA Not available
NR Analysis not required

Table 70: Cesium-137 Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample	Sampling Data (Total Cesium-137 Bq/L) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
19 A	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 B	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
19 C	IF	IF	IF	IF	IF	IF	IF	IF	IF	IF
Background	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

Historical Cs-137 Data (Average[a] Bq/L)						
Sample Point	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
19 A	ND	ND	ND	ND	<1[b]	IF
19 B	ND	ND	ND	ND	<1[b]	IF
19 C	ND	ND	ND	ND	IF	IF

a Arithmetic average of sample collected
b Single data point
IF Insufficient flow
ND Not detected

Table 71: Technetium-99 Results from Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Technetium-99 Bq/L) in 2020									
Locations	**01 and 02 Apr**	**07 Apr**	**27 Apr**	**05 May**	**14 May**	**08 and 10 Jun**	**18 Jun**	**22 Jun**	**14 Jul**	**31 Aug**
1	1.72	1.71	1.53	IF	1.79	1.83	1.69	IF	IF	1.35
2	1.66	1.66	1.50	IF	1.81	1.65	1.56		1.41	1.34
3	1.55	1.55	IF	IF	IF	1.49	IF	IF	IF	IF
4	1.56	1.56	IF	IF	IF	1.58	IF	IF	IF	IF
5	1.53	1.53	1.63	IF	IF	1.60	1.50	IF	1.49	1.43
6	1.73	1.73	1.43	IF	IF	1.49	IF	IF	IF	1.48
7	1.62	1.62	1.49	1.71	1.65	1.60	1.49	1.42	IF	1.39
10	1.61	1.61	1.51	1.61	1.65	1.65	1.54	1.49	1.39	1.42
13	1.67	1.67	IF	IF	IF	IF	IF	IF	1.65	IF

IF Insufficient flow
ND Not detected

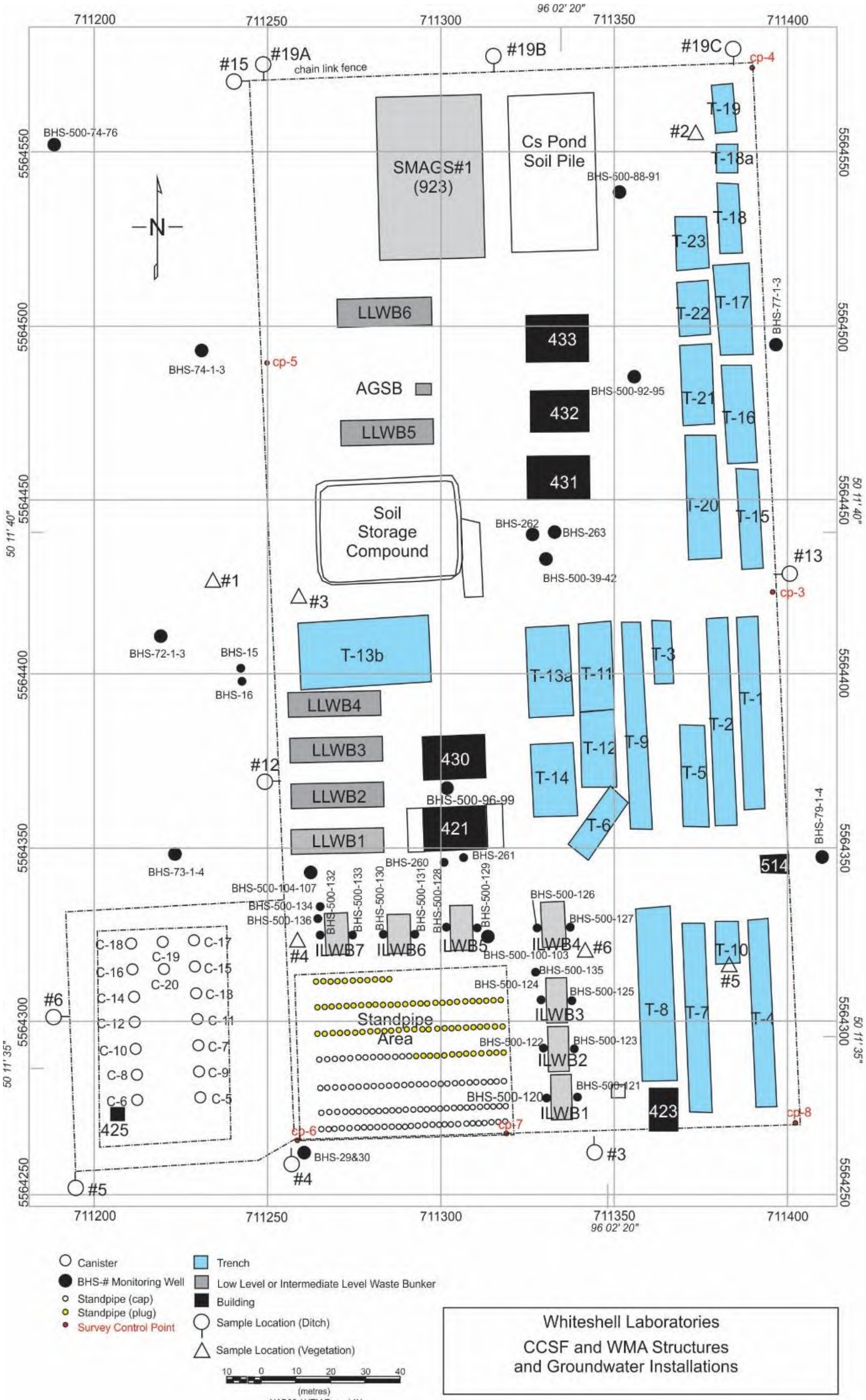

Figure 12: Ground Water Sample Points

Intermediate - Level Waste Bunkers Near Field Wells

A series of shallow near field wells were installed adjacent to the Intermediate - Level Waste bunkers in the WMA in 2015 (Figure 11). Groundwater samples were taken from the wells and from water in the Intermediate - Level Waste Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile but will bond with sand, and tritium is the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2020, Sr-90 was noted to be a maximum of 25 Bq/L adjacent to ILW Bunker 1, and < 13 Bq/L adjacent to ILW Bunker 3. For all other locations, the Sr-90 and Cs-137 levels were minor or negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 72) from the Intermediate - Level Waste Bunkers, and Sr-90 (Table 73) and tritium levels (Table 74) that are orders of magnitude below the levels observed in the water in the adjacent Intermediate - Level Waste Bunkers. At ILW Bunker 3, the tritium results remain high, with a second year of increasing values at BHS-500-124.

A series of water measurements was made as a confirmatory check in 2020 for the presence of base neutral chemicals (e.g., benzenes, ethylenes) and PCBs. These measurements indicated these chemicals were not present in the water around the bunkers.

Table 72: Cesium 137 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2016	2017	2018	2019	2020
ILW Bunker 1	31762					
BHS 500-120	-	ND	<1	<1	<1	<1
BHS 500-121	-	0.03	<1	<1	<1	<1
ILW Bunker 2	1170					
BHS 500-122	-	0.02	<1	<1	<1	<1
BHS 500-123	-	0.04	<1	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	0.33	<1	<1	<1	<1
BHS 500-125	-	0.05	<1	<1	<1	<1
BHS 500-135	-	ND	<1	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	0.05	<1	<1	<1	<1
BHS 500-127	-	0.04	<1	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	0.07	<1	<1	<1	<1
BHS 500-129	-	0.10	<1	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	0.08	<1	<1	<1	<1
BHS 500-131	-	0.90	<1	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	0.07	<1	<1	<1	<1
BHS 500-133	-	0.08	<1	<1	<1	<1
BHS 500-136	-	0.07	<1	<1	<1	<1

a Bunker values from 2015 samples
ND Not detected

Table 73: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate - level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2016	2017	2018	2019	2020
ILW Bunker 1	98300					
BHS 500-120	-	1.60	32	15.30	22.10	24.9
BHS 500-121	-	0.30	1.31	4.44	2.92	5.19
ILW Bunker 2	865					
BHS 500-122	-	0.50	0.25	0.21	0.14	0.5
BHS 500-123	-	0.70	1.27	2.55	1.59	1.84
ILW Bunker 3	26950					
BHS 500-124	-	0.60	5.70	11.3	6.58	12.6
BHS 500-125	-	0.70	<0.20	<0.10	<0.10	<0.10
BHS 500-135	-	0.50	0.72	0.74	1.32	0.84
ILW Bunker 4	2485					
BHS 500-126	-	0.60	0.33	0.24	0.30	0.21
BHS 500-127	-	0.80	<0.20	0.28	0.35	0.24
ILW Bunker 5	3850					
BHS 500-128	-	1.47	<0.20	<0.10	<0.10	<0.10
BHS 500-129	-	1.50	<0.20	<0.10	<0.10	<0.10
ILW Bunker 6	157500					
BHS 500-130	-	0.48	<0.20	<0.10	<0.10	<0.10
BHS 500-131	-	0.54	<0.20	<0.10	<0.10	<0.10
ILW Bunker 7	3335					
BHS 500-132	-	0.50	<0.20	<0.10	<0.10	<0.10
BHS 500-133	-	0.53	<0.20	<0.10	<0.10	<0.10
BHS 500-136	-	0.60	<0.20	<0.10	<0.10	<0.10

a Bunker values from 2015 samples
ND Not detected

Table 74: Tritium Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2016	2017	2018	2019	2020
ILW Bunker 1	42000					
BHS 500-120	-	16	70	279	258	410
BHS 500-121	-	1097	765	2788	2355	1509
ILW Bunker 2	6100					
BHS 500-122	-	836	1877	475	4274	3587
BHS 500-123	-	2974	1876	2554	2834	1640
ILW Bunker 3	4600000					
BHS 500-124	-	97567	158564	83604	128534	179094
BHS 500-125	-	3299	2956	2512	39	2484
BHS 500-135	-	3532	2404	3536	47	2737
ILW Bunker 4	41000					
BHS 500-126	-	49	69	24	39	225
BHS 500-127	-	21	76	< 4	47	37
ILW Bunker 5	5500000					
BHS 500-128	-	2785	2981	2674	2655	2793
BHS 500-129	-	11364	10700	9100	9633	9601
ILW Bunker 6	210000					
BHS 500-130	-	32	310	29	5	37
BHS 500-131	-	12	22	19	5	38
ILW Bunker 7	970000					
BHS 500-132	-	40	49	131	100	NR
BHS 500-133	-	11	16	<4	6	158
BHS 500-136	-	28	36	78	72	58

a Bunker values from 2015 samples
ND Not detected

Water Table Wells and Deep Wells

Water samples were collected from wells in and around the WMA (Figure 12) in the spring and fall of 2020. The gross alpha and gross beta results are summarized in Table 75. The beta activity levels in the clay, clay till and basal zone wells remained below the drinking water screening level of 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs 137 (10 Bq/L) [34]. The average alpha activity in the samples collected from the Basal zone wells was below the screening level.

Uranium concentrations in the basal zone wells ranged from 0 to 0.99 Bq/L. The concentrations in the Clay zone wells ranged from 0.23 to 1.41 Bq/L, and in the clay till from 0 to 1.37 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [61], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (7.56 Bq/L) and clay-till (21.31 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA.

In 2020, sampling of wells for DDT was conducted in wells within and surrounding the WMA as a confirmatory check. No DDT was detected.

Table 75: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2016 Avg. (Bq/L)	2017 Avg. (Bq/L)	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2020 Avg. (Bq/L)	2020 Avg. Range (Bq/L)
Total Beta [a]						
Clay	0.67	0.35	0.29	0.42	0.26	0.05 to 0.57
Clay Till	0.54	0.36	0.25	0.26	0.30	0.14 to 0.54
Basal	0.39	0.16	0.13	0.34	0.11	0.05 to 0.37
Total Alpha [b]						
Clay	1.05	1.01	1.03	0.87	0.52	0.11 to 1.00
Clay Till	0.60	0.77	0.72	0.75	0.80	0.05 to 2.20
Basal	0.18	0.10	0.12	0.22	0.14	0.05 to 0.60
Total Uranium [c]						
Clay	0.86	0.90	0.88	0.86	0.70	0.23 to 1.41
Clay Till	0.55	0.52	0.62	0.60	0.71	0.00 to 1.37
Basal	0.01	0.01	0.04	0.01	0.06	0.00 to 0.99
Total Tritium						
Clay	11.86	11.60	11.36	8.07	7.56	3.34 to 31.97
Clay Till	12.04	13.36	13.51	14.07	21.31	3.37 to 83.26
Basal	5.32	4.08	4.63	5.66	3.48	3.07 to 4.05

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value calculated from the concentration of uranium in the water sample

High-Level Liquid Waste Tray Water

Monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. This is sampled in the summer months. The sample results indicated no leakage has occurred from the tanks. The data are summarized in Table 76. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 76: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2016 Avg (Bq/L)	2017 Avg (Bq/L)	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2020 Avg (Bq/L)	2020 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	11.9	13.8	13.8	12.1	11.2	4.1 to 16.7
Total Alpha [b]						
Tank Tray Water	< 0.6	0.65	0.69	1.5	0.95	0.13 to 1.5

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13Bq/L of the gross beta activity is due to K-40.

b The reference nuclide for total alpha is Pu-239

D.2.1.1 Radiation Field Measurements

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2020 radiation field measurements were similar to those in 2019. The data is summarized in Table 77.

Table 77: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2016 Avg	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2020 Range
Spring Survey						
South Fence	0.3	0.2	0.2	0.2	0.3	0.2-0.5
West Fence	0.5	0.4	0.4	0.4	0.3	0.1-0.6
North Fence	0.4	0.2	0.2	0.2	0.4	0.2-0.5
East Fence	0.3	0.3	0.3	0.3	0.2	0.1-0.4
Fall Survey						
South Fence	0.2	0.2	0.2	0.2	0.4	0.3-0.4
West Fence	0.4	0.4	0.4	0.5	0.3	0.2-0.6
North Fence	0.2	0.2	0.2	0.2	0.3	0.1-0.5
East Fence	0.3	0.3	0.3	0.4	0.3	0.2-0.5

D.2.1.2 Vegetation

In 2020, vegetation samples were collected at monitoring locations within the WMA (Figure 12), and at a control location unaffected by WL operations. The gross beta results are summarized in Table 78. In 2020, as since 2017, the samples were only collected in the late summer-fall as it was determined that the uptake occurs over the summer, so the fall measurements presented since 2017 are more conservative than previous years. Potassium (K)-40 represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. The average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90).

Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 78: Waste Management Area Vegetation Monitoring Data

WMA Sample Locations	Average Gross Beta[a] (Bq/kg)				
	2016 Avg	2017 Avg	2018 Avg	2019 Avg	2020 Avg
North-East Area[d]	488	NA	672	450	196
Mid-West Area	578	1619	411	155	173
South-West Area	575	275	414	NA	296
South-East Area	751	460	409	441	230
Control Sample[b]	632	379	187	210	162
Background Sample[c]	592	419	324	317	203
East of ILW Bunkers 3 and 4	488	NA	672	450	NA

a The reference nuclide for beta is Sr-90
b Adjacent to the WMA outside of the fence boundary
c Ambient Radiation monitor Stations Background Samples
d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area. Only a single set of vegetation samples was taken as of 2017 as uptake occurs over the summer. Range is no longer included because of this change.

D.3 Facility Changes

All facility changes are performed as per the approved Engineering Change Control procedure [14].

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2020 with most of the physical preparatory work done in starting fabrication of extraction equipment off site. A pad to the east of the north access road within the WMA was constructed. The pad will provide a location for seacans containing waste to be stored awaiting processing, characterization and packaging for off-site shipment. This was required to allow Building 923 (SMAGS) to be converted to use a Cask Loading Facility. Waste from SMAGS has been removed from the building, a limited amount of that removed waste was held in Quonsets through 2020 due to restrictions in work crews and shipments related to the COVID-19 pandemic.

The WR-1 Phase 1 decommissioning waste material was stored in Buildings 432 and 433 in the WMA. Approximately 96% of the WR-1 Phase 1 decommissioning waste stored in Buildings 432 and 433 was processed by the end of 2016. Nine oversized crates remain in Building 433, and five asbestos containing crates that moved to Building 430 were returned to Building 433 and remained there as of the end of 2020.

The marine container used for storing sealed sources that was transferred from Building 430 in the WMA to the Standpipes Protected Area to meet revised security regulations from the CNSC in 2015, remained in place through 2020. Sources are still held pending future dispositioning.

Low Level Waste Bunker #6 has largely been emptied of waste, with most being packaged for offsite shipment and removed from the site. Some waste was removed and returned to the bunker pending completion of characterization work through 2020 due to restrictions in work crews and shipments related to the COVID-19 Pandemic. Planning to convert Low Level Waste Bunker #6 to process Intermediate-Level Liquid Waste began in 2020.

Construction was completed on an access structure on the east side of Low Level Waste Bunker #5 to facilitate decommissioning of the bunker starting with waste retrieval operations planned initially in 2020, with work now planned for 2021 due to reduced operations as a result of the COVID-19 Pandemic and the fieldwork pause in November.

A Waste Transshipment Area outside the northern perimeter to allow for holding shipments of waste that are ready to be shipped, began modifications to increase its surface area and to allow access to the planned road along there west exterior of the WMA. The road to access transformers and generators to support extraction equipment was surveyed, with construction now planned for 2021.

D.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2020, the bunkers and other structures in the WMA remained fit for service. Waste stored in SMAGS was removed in 2020. Medium-Level Waste Bunker 4 did not have new waste placed in 2020 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues. Medium-Level Waste Bunker 7 is ~85% full. The percentage full values are estimates only. Road transportable totes of liquid waste remain in the heated Building 430 pending future processing. Building 431 contains historic waste and is used as temporary storage for waste repackaging-characterization operations. Building 432 and Building 433 contain various historic wastes and wastes held in various stages of repacking operations. A small seepage of an oily substance was noted at the central gasket, near the base of the LLW Bunker 1 wall. The substance was sampled and found to contain oil and likely degraded liquid organic. The volume was small and the area was cleaned up. Seepage only occurred during hot weather, and as weather cooled the seepage stopped. The area will continue to be monitored. The bunker is slated for remediation of its waste in the next few years.

The Soil Storage Compound is empty of stored waste soil bags. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018. No caulking was done in 2020.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.2.1 under “Intermediate - Level Waste Bunkers Near Field Wells”, and indicates limited migration of tritium beside the ILW bunkers, in particular ILW Bunker 3. There is no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have only found limited levels of contaminants, below drinking water guidelines, suggesting the waste storage structures and natural barriers of low permeability clay soil and upwards groundwater flow are performing as expected.

As required by Section 8 of the Facility Authorization [57], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests and inspections were completed. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [16], and is further discussed in Section 6.

D.5 Wastes Generated

As a result of routine operations solid radioactive waste and liquid radioactive waste were generated in the WMA.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the WMA in 2020.

There was 2.5 m^3 of solid compactable wastes and no solid non-compactable wastes generated in this facility during 2020 from operational activities.

In 2020, approximately 1069 L of water was removed from ILW Bunker 6; no other storage facilities and collection sumps at the WMA required pumping.

D.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the WMA as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection. There are no liquid effluents generated from this facility.

The incinerator was decommissioned in 2018. There are no other radiological airborne releases from this facility.

APPENDIX E Auxiliary Operation Facilities

E.1 Operations

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2020. There were no organizational changes. There was a change in Facility Authority as communicated to the CNSC [53].

No program changes were made for the auxiliary facilities in 2020. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contained experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops were located in the South High Bay.

The research program in the Stage 6 (RD-14M) area was completed in 2018, and operational shutdown was started. The operational shutdown, decontamination, and decommissioning of the remainder of the building was completed in 2015. The demolition of Stages 4 and 7 was completed in 2016. The demolition of Stage 6 was completed in 2019.

During 2020, WL Site and Nuclear Operation's staff and user groups in Building 300 carried out routine operations which included:

- Non-radiological laundry activities.
- Respirator fit test / maintenance activities.
- Ongoing CNL Nuclear Engineering & Systems Analysis R&D activities.
- Cleanup activities associated with decommissioning.
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

In support of decommissioning work conducted in 2020, the Sample Management Office, and Environmental labs and offices, were relocated from Building 402 to Building 300.

Health and Safety Facilities (Buildings 402 and 305)

Building 402 has three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

During 2017 the private business tenant left Building 305, and the area was repurposed. A licensed gamma cell belonging to the former tenant remained, and in 2019 the gamma cell was moved from Building 305 to the source container located inside the Protected Area of the Waste Management Area (WMA) for storage until a more permanent disposition path is determined.

In 2020, routine operations were carried out and supervised by Site and Nuclear Operations personnel. Operational cleanout of Buildings 402 and 305 were started in preparation for decommissioning/demolition.

E.2 Facility Changes

All facility changes were performed using the Engineering Change Control procedure [14]. The Sample Management Office, and Environmental labs and offices, were relocated from Building 402 to Building 300.

E.3 Equipment Performance, Planned Maintenance Testing and Inspections

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed.

E.4 Wastes Generated

There were minimal amounts of radioactive and/or hazardous wastes generated in the facilities as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the facilities in 2020.

Building 300 generated 0.3 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2020.

Building 402 generated 0.2 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2020.

After processing at the Waste Handling Area, all waste was shipped to the WMA for storage.

See Table 79 for a summary of solid wastes for the last five years.

Table 79: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2016*	2017	2018	2019	2020
Building 300 (m^3)	203.3	14.7	4.5	0.4	0.3
Building 402 (m^3)	3.4	2.8	1	0.7	0.2
Building 411 (m^3)	74.9	355.1	7.6**	0.2**	0.0

* Volume prior to compaction, all compactable waste is consolidated at the Waste Handling Area.

** Legacy waste processed in 2018 for Building 411 that was decommissioned in 2017.

There was no liquid radioactive and/or hazardous waste generated in 2020 in this facility.

Research and Development (Building 300) Low-Level Liquid Waste System

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in Building 300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2020, 99 m^3 of low-level liquid was processed through the Building 300 LLLWTS Table 80 shows the historical volumes of LLLW processed through the Building 300 LLLWTS and also the total volume of Building 300 and Building 100 LLLW processed.

Table 80 - Historical Records of Low-Level Liquid Waste Processed

	2016	2017	2018	2019	2020
Total Combined Low-Level Waste Liquid Processed (m^3)[a]	230	172.3[b]	131.5[c]	189.3[c]	107
Low-Level Waste Liquid Processed in Building 300 (m^3)[d]	195	46	123	186.5	99

a All low-level liquid waste processed in Active Liquid Waste Treatment Centre for 2014-2016. This total includes laundry and decontamination and ALWTC facilities for 2014 and 2015. For 2016 the total is Building 100 and Building 300 and ALWTC. After 2017 all low-level liquid waste is processed in Building 100 and Building 300.

b This includes 126 m^3 of low-level liquid waste that was processed through the Active Liquid Waste Treatment Centre in Building 200.

c All Low-Level Liquid Waste processed through the low-level liquid waste treatment systems in Building 100 and Building 300.

d Building 300 LLLWTS came online in 2017 July.

The total activities given below are the combination of the Shielded Facilities, Building 300, and Building 100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the Building 300 and Building 100 LLLWTS during 2020 was 0.01 GBq, compared with 0.01 GBq released during 2019. The maximum release in a month during the year was 0.001 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.0011 GBq for 2020 compared with 0.0027 GBq released during 2019. The maximum release in a month during the year was 1.9E-04 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Am-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 81 provides a summary of the total activity released for both the Building 100 and Building 300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [30]. These values were revised in 2016.

Table 81 – Building 100 and Building 300 LLLWTS Radioactive Releases

Radionuclide	Total 2020 Effluent (GBq)	Annual Release Limit[a] (GBq/a)	Total 2020 Effluent as a % of Annual Release Limit	Peak Release	
				Max. Monthly Release (GBq)	% of[b] Monthly DRL
Total (Total-Beta Analysis) [c]	0.01	–	–	0.001	–
Sr-90	$2.23x\ 10^{-3}$	1.56×10^{2}	$1.47x\ 10^{-3}$	3.16×10^{-4}	2.72×10^{-3}
Cs-137	$4.55x\ 10^{-3}$	1.39×10^{2}	$3.27x\ 10^{-3}$	7.44×10^{-4}	6.41×10^{-3}
Total Alpha (As Pu-239 Equivalent) [d]	1.06×10^{-3}	1.33×10^{1}	$7.96x\ 10^{-3}$	1.89x 10-4	1.70×10^{-3}
Historical Data Total Effluent (GBq)					
	2016[e]	2017[e]	2018[e]	2019[e]	2020[e]
Total (Total-Beta Analysis) [c]	0.04	0.04	0.02	0.01	0.01

a The annual release limit is calculated by multiplying the DRL by 12.

b DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [30].

c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.

d DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11×10^{1} GBq/month [30].

e Year's 2014 to 2016 effluent was all processed in ALWTC. 2017 effluent was processed in ALWTC and Building 300 LLWTS. From 2018 on, all effluent was processed in Buildings 300 and 100 LLWTS.

E.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in Building 300 Room B-33.

Any liquid and/or gaseous releases from the facilities are provided and discussed in Section 9, Environmental Protection.

APPENDIX F WR-1 Facility

F.1 Operations

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [62]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [63]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [62].

In 2020, the LLLW system processed a total of 7.9 m^3 of liquid waste.

Routine operations in the WR-1 facility, as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [62], were carried out by the five (four and one trainee) Site and Nuclear Operations Technologists assigned to Building 100.

In 2018 approximately 20 m^3 of low concentration (3.4E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained. Investigation is also ongoing to determine what the impact would be if this water is left in situ as part of the proposed in situ disposal of WR-1.

In 2020, the Building 100 continued to maintain the minimum staffing requirements outlined in the Facility Authorization [62]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for WR-1 in 2020. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

F.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [14].

F.3 Equipment Performance, Planned Maintenance Testing and Inspections

During 2020, the operations status of WR-1 remained unchanged. There were no changes to the reactor’s equipment, and all facility maintenance was done as per the facility maintenance plan.

During 2020, all planned activities for systems required to be operated, tested and inspected were carried out as per the approved facility maintenance plan. Monthly housekeeping and fire prevention inspections were completed. There was some ventilation characterization work carried out in WR-1 in 2020 in support of future decommissioning activities. These were done in areas where ventilation ducts will need to be removed and packaged as waste regardless of which decommission plan is executed for WR-1.

F.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in WR-1 as part of routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of any volume of radioactive solid and/or liquid waste generated in WR-1 in 2020.

Solid Radioactive and/or Hazardous Wastes

Solid radioactive and/or hazardous waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

During 2020, 0.8 m^3 of low-level radioactive compactable waste and 9.2 m^3 non-compactible waste were generated from Building 100/WR-1 operations and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

Liquid Radioactive and/or Hazardous Wastes

Liquid radioactive and no hazardous waste was generated in the facility as part of routine operations.

During 2020, 7.9 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Section WL in Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the facility as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

APPENDIX G Non-Nuclear Facilities

G.1 Operations

The WL non-nuclear facilities status and changes for 2020 are as noted in Table 82.

Table 82: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
304	Waste Clearance Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
306	Waste Clearance Facility	Removed in 2016	None	None	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Operational	None	None	All Site/Visitors	No change
408	Stores	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Operational	None	None	Security and Common Services	No change
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
415	Warm Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Operational	None	None	Transportation, Security and Stores	No change
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Removed in 2020 l	None	None	Facilities	Building removed,, End-State Report to be completed
426	Quonset: Cold Storage	Operational	None	None	Utility	No change
427	Cold Mechanical Storage	Removed in 2016	None	None	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Operational	None	None	Maintenance	No change
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
540	Modular Office Complex	Operational	None	New	Facilities	Modular Trailer office complex installed in parking lot
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	Relocated from Building 402 to near Building 300 Shielded Facilities. Temporarily out of Operation
597	Portable Boiler Building 1	Out of Operation	None	None	Powerhouse Operators and Maintenance	Taken out of Service due to shutdown of Building 200

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hydro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

[a] Security personnel perform regular patrols of all site buildings

There were no policy, program or procedural changes for the non-nuclear facilities in 2020. There were no changes in organization in 2020, the Section Head left the company, and the Senior Operator assumed the role on a delegate basis. The two Operator trainees became full Operators.

G.2 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [14].

In 2020, three non-nuclear facilities, Buildings 303, 304 and 424 were decommissioned. The final End-State Decommissioning Report will be prepared when all the other non-nuclear buildings on the South-side and North-side have been decommissioned.

G.3 Equipment Performance, Planned Maintenance Testing and Inspections

Systems and equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2020, as noted in Table 82.

Routine maintenance was carried out, and equipment tests and inspection were completed in 2020 with no significant results, as noted in Table 82.

G.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the non-nuclear facilities as part of routine operations.

G.5 Effluents Released

There were 1.21E+09 L and 3.08E+07 L of effluent released from buildings Building 422 (Outfall Monitoring Station) and Building 907 (Sewage Lift Station and Lagoons) respectively.

Landfill Dugout Water Monitoring

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2020, the precipitation was low over the year (441 mm) and the dugouts had low water levels during the summer sampling period. The location of the dugouts are shown in Figure 13. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

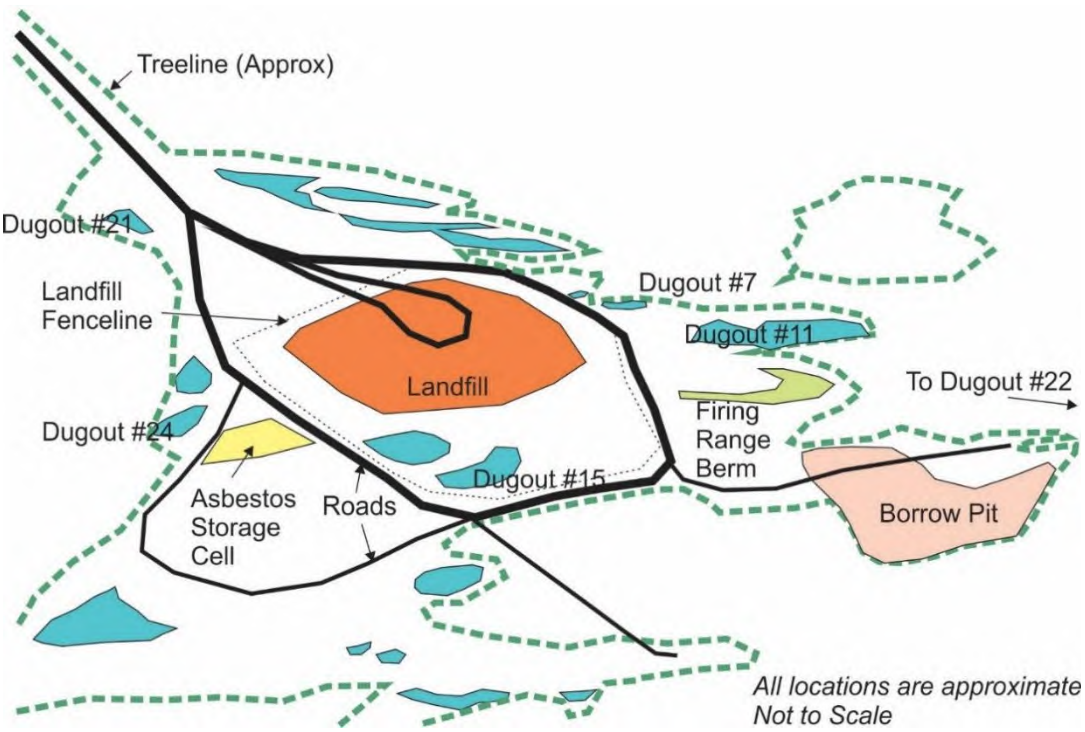

Figure 13: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Table 83 and Table 84 respectively. All alpha results for 2020 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. All beta results for 2020 were near the detection limits, and are below the drinking water screening level of 1.0 Bq/L. Both alpha and beta results for 2020 are consistent with previous results obtained from 2015 to 2019.

Table 83: Gross Alpha Results from the Landfill Dugouts

Sample	Gross Alpha (Bq/L)					
Location	2015	2016	2017	2018	2019	2020
Dugout #7	< 0.11	< 0.14	< 0.17	< 0.17	0.07	<0.05
Dugout #11	< 0.10	< 0.10	< 0.14	< 0.14	< 0.05	<0.05
Dugout #15	< 0.16	0.16	0.10	0.10	0.28	<0.05
Dugout #21	< 0.12	0.16	0.07	0.07	Dry	<0.05
Dugout #22	< 0.13	< 0.11	< 0.14	< 0.14	0.11	<0.05
Dugout #24	< 0.16	< 0.18	< 0.19	< 0.19	0.29	<0.05

Table 84: Gross Beta Results from the Landfill Dugouts

Sample	Gross Beta (Bq/L)					
Location	2015	2016	2017	2018	2019	2020
Dugout #7	0.17	0.19	0.17	0.17	0.11	0.07
Dugout #11	0.09	0.07	0.02	< 0.10	< 0.05	< 0.05
Dugout #15	0.40	0.35	< 0.07	< 0.07	0.12	0.16
Dugout #21	< 0.12	0.12	< 0.05	< 0.05	Dry	< 0.05
Dugout #22	< 0.13	< 0.06	< 0.13	0.13	< 0.05	0.05
Dugout #24	0.39	0.26	0.08	< 0.08	0.25	0.06

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a small amount was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there in 2020. The higher tritium level in Dugout 15 was 54 Bq/L, approximately one-quarter that measured in 2019 (212 Bq/L). All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2020 that contain < 4 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 85.

Table 85: Results from the Landfill Dugouts

Sample	Tritium (Bq/L)					
Location	2015	2016	2017	2018	2019	2020
Dugout #7	< 4	< 4	< 4	< 4	< 3	< 4
Dugout #11	< 4	< 4	< 4	< 4	< 4	18
Dugout #15	41	98	82	105	212	54
Dugout #21	< 4	< 4	NA	< 4	Dry	< 3
Dugout #22	< 4	< 4	< 4	< 4	< 4	< 3
Dugout #24	< 4	5.5	< 4	76	< 4	< 4

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill had been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing conducted in 2018 included Sr-90 and Tc-99, two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. In 2019, only Sr-90 was tested, and was found to be at the detection limit. In 2020, both Sr-90 and Tc-99 were again measured (Table 86). Sr-90 was at the detection limit and Tc-99 was not detected. The water from these dugouts and wells is not used for human consumption. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99.

Table 86: Sr-90 and Tc-99 Results from the landfill Dugouts in 2020

Sample Location	(Bq/L)	
	Sr-90	**Tc-99**
Dugout #7	< 0.10	ND
Dugout #11	< 0.10	ND
Dugout #15	< 0.10	ND
Dugout #21	< 0.10	ND
Dugout #22	< 0.10	ND
Dugout #24	< 0.10	ND

ND – Non Detect

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia (N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron were detected in in Dugout #15, a continuation of results from 2017 onwards (Table 87). The value in 2020 returned to under the Drinking Water Guideline for Boron (5,000 ug/L).

Table 87: Boron Results from the Landfill Dugout #15

Sample Location	(uq/L)			
	2017	**2018**	**2019**	**2020**
Dugout #15	1630	5460	8460	2040

Molybdenum decreased to detection limits in 2020 in Dugout #21; it had been measured as above 74 ppb in 2019 from 145 ppb in 2018. In 2020, Manganese was found to be at or higher than drinking water guidelines of 50 ug/L in Dugout #15 (232 ug); in 2019 it had been measured at 96 ug/L. No other parameters were detected and/or at concentrations of concern.

Groundwater results will be discussed in the annual Environmental Monitoring report [26]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [28].

Landfill Dugout Sediment Monitoring

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, as such no sediment sampling was conducted in 2020.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program [28].

Landfill Radiological Monitoring

Annual radiological monitoring of the landfill surface is performed as a confirmatory measure. The results show readings consistent with background levels at the landfill fence line. Table 88 provides a five year listing of survey results at the top of the landfill. In 2019, metal waste collection containers were sited on top of the landfill to collect inactive waste for offsite shipment. For some years monitoring was performed at the base of the pile, and more recently monitoring was performed around the perimeter of the fenced area of the landfill.

Table 88: Landfill Radiological Monitoring

Sample Location	(μR/h)				
	2016	**2017**	**2018**	**2019**	**2020**
Landfill Top Surface	10-15	10-16	8 - 10	6 -12	6 - 12[2]
Landfill Base	< 20	< 20	NR	5 - 8[1]	5 - 8[1]

NR – Not recorded

[1] Taken at the fence line instead of base of landfill

[2] Metal waste collection bins sited at top of landfill

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Annual Compliance Monitoring Report

Whiteshell Laboratories Annual Compliance Monitoring Report for 2021

WL-514300-ACMR-2021

Revision 1

Prepared by:	R. Swartz Manager, Licensing & Quality Management	2022/06/08 Date
Reviewed by:	S. Cotnam Senior Director, Compliance – Chief Regulatory Officer	2022/06/08 Date
Approved by:	J. Gilbert Head, WL Closure Project	2022/06/08 Date

UNRESTRICTED

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
1	2022/06/08	Issued as “Approved for Use”. Minor changes due to noted missing Environmental data in Revision 0 for the Outfall for 2021 October-December.	R. Swartz	S. Cotnam	J. Gilbert
0	2022/04/28	Issued as “Approved for Use”.	R. Swartz	S. Cotnam	J. Gilbert
D2	2022/04/04	Issued for “Review and Comment”.	R. Swartz	S. Cotnam J. Gilbert S. Brewer C. Gallagher	
D1	2022/03/07	Issued for “Review and Comment”.	A. Stelko R. Swartz	B. Scott A. Coulas R. Swartz A. Rehman A. Caron N. Deighton S. McLean Z. Barnicoat S. Khan J. deRuiter D. Fillion V. Golovko J. Hayter L. Rasmussen R. Bilinsky P. Vilks J. Betteridge A. Bilton C. Oversby T. Rosentreter C. McGregor J. Reynolds S. Mynhardt C. Clark J. Turcotte D. Koopman M. MacKay	

				A. Mahabir J. Martino T. Reimer	

EXECUTIVE SUMMARY

This annual compliance monitoring report for the 2021 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 and CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* as a summary report of annual compliance monitoring and operational performance.

Canadian Nuclear Laboratories (CNL) would like to acknowledge Canada's Indigenous Peoples and their traditional territories upon which CNL carries out its work. CNL also wishes to confirm its commitment to being an active participant in Canada's journey towards healing and reconciliation.

This annual compliance report provides CNL 2021 performance data for WL and is organized by 14 Safety and Control Areas (SCAs)[1], as well as a report on each of the WL nuclear and non-nuclear facilities.

The following provides overall performance highlights for 2021 activities:

- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2021 were below their respective Derived Release Limits (DRL).
- Demolition of Building 200, the former Active Liquid Waste Treatment Centre (ALWTC), is complete, and Building 402/305, the former Health and Safety Facilities, is partly demolished.
- The WL site maintained safe and compliant performance under COVID-19 Pandemic conditions and protocols.

Below is a summary of the annual compliance report for calendar year 2021.

- **SCA - Management System**: WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning. After having no Canadian Nuclear Safety Commission (CNSC) inspections in 2020, four inspections were carried out in 2021.
- **SCA - Human Performance Management**: A significant effort towards training individuals in human performance related areas continued as a result of the fieldwork pause in 2020 November. Another outcome of the fieldwork pause was the development and delivery of the initial Annual General Employee Training which goes

1 The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas.

over site and project updates, as well as review of policies and procedures. This will be updated and delivered annually to all employees.

- **SCA - Operating Performance**: WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of “events”. The total number of internal event reports raised continues to show a strong reporting culture. There were six CNSC reportable events in 2021.
- **SCA - Safety Analysis**: Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL’s nuclear facilities, helping meet health, safety, security, environmental and regulatory requirements. Safety analyses continue to be developed for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and Cask Loading facilities being constructed in the Waste Management Area.
- **SCA - Physical Design**: The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba. The new revised WL Pressure Boundary Quality Assurance Plan was accepted by Inspection and Technical Services Manitoba and a new Certificate of Authorization was issued.
- **SCA - Fitness for Service**: The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. Regular preventative or corrective maintenance and testing of WL’s safety-related systems were carried out to ensure the systems were fit-for-service. Missed maintenance of safety-related systems was reported to CNSC, and a corrective action plan was developed that will fix the issues and prevent recurrence.
- **SCA - Radiation Protection**: No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 0.6 mSv and collective doses remained below 50 person-mSv (19.0 person-mSv) for 2021. Members of the public received no measureable radiation doses.
- **SCA - Conventional Health and Safety**: Implementation of CNL’s Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture. Safety advisories are regularly issued to staff about imminent issues that could impact their safety. There were no lost-time injuries at WL in 2021.
- **SCA - Environmental Protection**: The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment. Radiological emissions were 0.00019% of the Derived Release Limit (DRL) for air emissions and 0.45% of the DRL for liquids. The monitoring program confirms that the WL site is operating in a manner that protects workers, the

public, and the environment. WL maintained their ISO-14001 registration, and are compliant to a number of CSA environmental standards.

- **SCA - Emergency Management and Fire Protection**: The Emergency Management program at WL continued to be focussed on supporting COVID-19 planning and coordination efforts, providing procedures and guidance to enable work to continue safely in this dynamic situation. A third party Fire Protection Audit was conducted, and resolution to findings will be tracked through the corrective action program.
- **SCA - Waste Management**: WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 924 m^3 of radioactive waste to Chalk River Laboratories (CRL), and 271 m^3 (37,145 kg) of recycled waste shipped off-site. The WL Site Overview Detailed Decommissioning Plan was revised and accepted by CNSC.
- **SCA – Security**: The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for high-security sites. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC.
- **SCA - Safeguards**: There were no issues identified with International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL. The IAEA also provided human surveillance and IAEA seal verification, removal and reapplication during canister inspection activities.
- **SCA - Packaging and Transport**: There were 68 radioactive transport packages making up 53 loads that were safely and successfully sent off-site, including approximately 921 m^3 of low-level waste and 3 m^3 of intermediate-level waste shipped to CRL.
- **Other matters of regulatory interest**: Two virtual meetings of the WL Public Liaison Committee took place. Numerous public information sessions and Indigenous engagements (mainly virtual) were held on the Whiteshell Reactor 1 (WR-1) in-situ decommissioning and overall activities of the WL Closure Project, including four Webinars.
- **Facilities** (operating nuclear facilities, permanently shut down facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: the Active Liquid Waste Treatment Centre, Building 200, completed demolition, and significant progress was made in demolition of the Health and Safety Facilities, Building 402/305.

CNL is committed to achieve high standards of operational safety and security. The information and data presented in this report support the conclusion that safe and secure performance was achieved at the Whiteshell Laboratories site, while enhancements were implemented to further improve results.

ACKNOWLEDGEMENT

The “Author” of this document would like to thank the many Whiteshell Laboratories authors and reviewers from the various Functional Support Areas and Facilities for their production of the individual sections of the report.

CNL’s Continued COVID Pandemic Response

For a detailed description of CNL’s robust mitigation initiatives and controls to protect its employees, contractors, visitors and Site operations from the COVID pandemic, see the Executive Summary in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories*.

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TABLES

INTRODUCTION

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the eastern bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL. This work transitioned to Canadian Nuclear Laboratories (CNL) who are carrying out the work to achieve site closure on behalf of the site owner, AECL.

Activities are now underway to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see the Decommissioning Strategies Section below).

Name:	Whiteshell Laboratories
Location:	*1 Ara Mooradian Way* *Pinawa, Manitoba* *R0E 1L0*

Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook (LCH) for Whiteshell Laboratories,* herein referred to as “Licence Conditions Handbook” [2], and section 3 Annual Compliance Monitoring Report of CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2021 January 01 to December 31.

This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to 14 Safety and Control Areas as they are applied across all of CNL.

The intent of this report is to provide sufficient detail to demonstrate how Whiteshell Laboratories programs are meeting the regulatory requirements as specified in the licence [1] and the LCH for Whiteshell Laboratories [2].

Facilities Included in this Report

Appendices Appendix A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities included in this report are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and Building 305), and WR-1 Reactor.

Summary of Licensed Activities

There are no new licenced activities.

Decommissioning Strategies

As discussed since 2015, work is underway to complete decommissioning of the entire WL site (current schedule is to be complete in 2027). This includes leaving in-situ the selected WMA trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this proposed change. The Environmental Impact Statement supporting this is in progress.

Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [5], advising that as an agent of Her Majesty in Right of Canada, AECL's liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee remains valid and in effect, as per the communication issued on 2020 August 25 [6].

1 Management System

1.1 Management System Program

Whiteshell Laboratories adheres to the Corporate Management System. See Section 1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL Quality Assurance Plan [7] supports the CNL Management System Manual [8] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to CSA N286-12 [9] and N286.6-98 [10].

1.2 Audits, Inspections and Self-Assessments

As per the requirements of the Management System [8], both Safety Control Areas and Facilities conduct various audits, inspections, and self-assessments to ensure that the management system is functioning according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate actions taken to resolve them.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Corrective Action Program.

1.2.1 Audits

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL-wide Audits for the reporting year 2021.

1.2.1.1 External Audits

The external audits conducted at Whiteshell Laboratories are summarized in the table below.

Table 1: External Audits

Title	Type of Audit	No. of Non-Compliances Raised	No. of Non-Compliances Completed
SAI Global Recertification Audit of the WL Environmental Management System	14000:2015	0	Not applicable
PLC Fire Safety Solutions Audit of the Fire Protection Program	CSA N393	31	0

For the Fire Protection Program audit, the non-compliances related mostly to missing documentation for inspection, testing and maintenance activities. The audit report was received late in 2021, and a corrective action plan is to be submitted to CNSC staff in early 2022.

1.2.1.2 Internal Quality Audits

There were no internal audits completed by the Quality Audits and Processes branch specific to Whiteshell Laboratories in 2021.

1.2.2 Inspections

CNSC Inspections

The following CNSC Inspections were conducted at Whiteshell Laboratories.

Table 2: CNSC Inspections for 2021

Inspection No.	Area Inspected	No. of NNC[a]s	No. of NNC[a]s Completed
CNL-WL-2021-01	Human Performance Management	2	2
CNL-WL-2021-02	Management System	6	6
CNL-WL-2021-03	General	3	0
CNL-WL-NSD-T2-2021-001	Security	7	0

a NNC – Notice of Non-Compliance

Inspections by Other Regulatory Bodies

A Physical Inventory Verification (PIV) inspection was carried out by the IAEA on 2021 May 26. This inspection was a sampling of accessible items containing Special Fissionable Material. A Design Information Verification inspection was carried out by the IAEA on 2021 May 25-27. This inspection verified the information provided in the Design Information Questionnaire.

Transport Canada conducted a virtual Transport of Dangerous Goods (TDG) inspection at WL in 2021 and did not find any non-conformances.

1.2.3 Self-Assessments

In 2021, there were 18 self-assessments conducted at Whiteshell Laboratories covering various aspects of the management system, including both safety and control areas, and various facilities.

Table 3: List of Self-Assessment Conducted at Whiteshell Laboratories in 2021

Title	Facility/Department
Effectiveness of Industrial Hygiene Instrumentation	WL Occupational Safety and Health (OSH)
Workload on the SMO	WL Environmental Management (EM)
WL Integrated Work Control	WL Site and Nuclear Operations
TDG Requirements	WL Waste Management

Movement of Radioactive and Non-Radioactive Materials	WL Waste Management
Registration and control of radiation sources	WL Radiation Protection (RP)
WL RP Program Compliance Review	WL RP
WL-510400-OI-366-01 - WL Lock Out Tag Out (LOTO)	WL Site and Nuclear Operations
900-510400-MCP-032 - Work Permit	WL Site and Nuclear Operations
WL EM QA Plan WL-514200-QAP-001 to 17025, Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Risk Assessment Process	WL EM
Compliance to ISO/IEC 17025:2017 Improvement	WL EM
WL Radiation Dose Reporting to NEW Workers for 2020 Doses	WL RP
Manager Dose Control Points and RP Training Designation Annual Reviews for 2021	WL RP
REGDOC 2.12.1, High Security Sites: Nuclear Response Force Section 7	WL Emergency Services
REGDOC 2.10.1 Section 2.2.1, Emergency Response Organization and Staffing	WL ES
Impairment Notification and Compensatory Measures	WL ES

1.3 Management Reviews

The Quality Assurance Program/Management System Review for 2018/19 and 2019/20 was completed. The review identified 6 actions, all of which are completed.

2 Human Performance Management

2.1 Human Performance Program

Whiteshell Laboratories adheres to the Corporate Human Performance (HU) Program. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.1.1 Program Improvements and Accomplishments

The effectiveness of the HU program at WL has been enhanced through the following improvements:

- Following the 10 week fieldwork pause in 2020 November to address an adverse trend in human performance, WL gradually increased fieldwork throughout 2021 February. WL executed an extensive Corrective Action Plan, which included comprehensive reviews and updates to procedures and a significant investment in employee training. Improvements implemented included increased supervisor presence in the field, in depth review of proper use of tools and equipment, procedure awareness and compliance, sharing of lessons learned, and better pre- and post-job briefs. WL also performed several self-assessments through the integrated assessment plan and implemented new work control metrics.
- In 2021 May, Performance Assurance reintroduced the two-level rigorous review of ImpAct records by re-instating the Management Screening Team (MST) weekly meeting. MST's mandate is to provide management level review and oversight of the ImpAct record and ensure it has sufficient and accurate information to let the Management Review Meeting (MRM) team conduct their review. The MST assesses and recommends the significance level, cause determination effort, cause statement and the Responsible Manager. MRM provides Director level (and above) oversight for the ImpAct Corrective Action Program. The MRM team confirms, or modifies as appropriate, decisions made by the MST.
- In 2021 August, a three day TapRooT® Essentials Course was delivered to nine (9) WL Employees. The virtual sessions were taught by an external root cause analysis and investigation expert who guided immersive learning activities using interactive presentation technology, group exercises, and two-way interaction. TapRooT® is a powerful tool in conducting investigations and has already been used to augment CNL's current cause analysis techniques.
- WL enlisted the support of the recently formed CNL Strike Team, comprised of experts from across CNL, to conduct a causal analysis for a discovered adverse condition regarding the WL Preventative Maintenance program (see ERM-21-3009 in Table 5). Unlike the usual Apparent Cause Analysis or Root Cause Analysis processes, the Strike Team's causal analysis used a Facts Issues Causes Actions table. Doing the investigation in this manner allowed the team to develop the causal analysis and corrective actions in

a concise and timely manner. This tool will be beneficial for future investigations that may need to be conducted.

2.2 Training programs

Whiteshell Laboratories adheres to the Corporate Training and Development Functional Support Area. See Section 2 of the Annual Compliance *Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.2.1 Program Improvements and Accomplishments

The effectiveness of WL Training Program has been enhanced through the following improvements:

- Revisions to the content for the New Employee/Contractor Orientation to reflect current policies and procedures for working on site.
- WL introduced the Integrated Work Control Core 5 Elements course, which provides contractors with training that combines the 5 core courses delivered during the safety stand down: Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls.
- Development of the initial Annual General Employee Training to review site and project updates, as well as policies and procedures. This will be updated and delivered annually to all employees.
- Updates and improvements to the content and media for the Radiation Group 4 Training delivered to all employees and contractors coming to site.
- Major revisions to the Delivering Practical Training course. Content now includes adult learning and learning principles content. This course is required for any employee who conducts on-the-job training and functional checkouts for skills assessments.
- Redevelopment of the Waste Management & Fundamentals courses to include updates to policies and procedures in our Waste Management Program.
- Revisions to the content and materials for Vehicle Spotter Training. Delivery to all staff who are required to have spotter training.
- Development of the ‘Training Matrix tool’ which allows managers and supervisors to quickly look up the training status of their teams.

2.2.2 Systematic Approach to Training

CNL maintains a list of positions and roles requiring Systematic Approach to Training (SAT) training programs in compliance with REGDOC-2.2.2, Personnel Training [11].

Training and Development evaluated the training programs for listed positions and roles at WL against the main elements of SAT. The results led to initial individual action plans which are being managed and further evaluated by the Curriculum Review Committees. Additional corrective actions and program improvements will be identified and managed by the

Curriculum Review Committees going forward. Since the initial analysis of the listed positions, dedicated Training and Development personnel have been hired and assigned to support WL in the completion of the action items identified. Curriculum Review Committees for the WL WMA and Shielded Facilities have been established and progress on the actions is underway.

2.2.3 Required Training

Some WL listed positions and roles require additional training documentation development to achieve full SAT-compliance. Current workers are qualified based on existing training programs combined with their years of experience in the role. Existing training programs include classroom training, practical training, computer-based training, and mentor style training. These experienced workers will assist as Subject Matter Experts (SMEs), in the development of training documentation that is required to achieve full SAT-compliance.

All Whiteshell Laboratories personnel, both employees and contractors, are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work under the licence [1]. Section 2 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories [4] provides the 2021 CNL Employee and Manager/Supervisor required training. Table 4 provides a list of federally/provincially legislated training courses that appear in position-specific training plans at Whiteshell Laboratories.

Table 4: Whiteshell Laboratories Operating Staff Training in 2021

Course Code	Course Title	No. of Attendees
OSH-1001-Online	Crane (Safe Indoor Hoist) – Theory	44
OSH-1002-Online	Lift Truck Operation – Theory	40
OSH-1003-Online	Aerial Work Platform – Theory	59
OSH-1004-Online	Lock Out / Tag Out Exam	28
OSH-1004-Virtual	Lock Out / Tag Out (Virtual)	28
OSH-1005-Online	Working at Heights – Theory	84
OSH-1006	Confined Space Entry	14
OSH-1006-Online	Confined Space Exam	15
OSH-1006-Virtual	Confined Space Entry (Virtual)	25
OSH-1007	Asbestos Module 6E	51
OSH-1033-Online	Ladder Safety	27
OSH-1034-Online	Hazard Prevention Program	31
OSH-1042-Online	WHMIS – 2015	40
OSH-1046-Online	Heat Stress	7
OSH-3001-E	Crane – Safe Indoor Hoist – Practical – Jib Crane	3
OSH-3001-F	Crane – Safe Indoor Hoist – Practical – Bridge Crane	3

OSH-3001-J	Crane – Safe Indoor Hoist – Practical Gantry Crane	2
OSH-3001-K	Crane – Safe Indoor Hoist – Practical	1
OSH-3001-L	Crane – Safe Indoor Hoist Only	13
OSH-3001-MULTI	Crane – Safe Indoor Hoist – Practical – All Equipment Codes	8
OSH-3002-C	Lift Truck Practical – Counter Balance	18
OSH-3002-MULTI	Lift Truck Operation – Practical/All Equipment Codes	4
OSH-3003-B	Aerial Work Platform Practical – Articulating Boom 60 ft (or less)	21
OSH-3003-C	Aerial Work Platform Practical – Rough Terrain Scissor Lift	27
OSH-3003-D	Aerial Work Platform Practical – Scissor Lift	25
OSH-3003-E	Aerial Work Platform Practical – Single Person Up-Up	1
OSH-3003-Multi	Aerial Platform – Practical (All Equipment Codes)	34
OSH-3005	Working at Heights – Practical	88
HU-1036-Online	Pre job Brief	12

2.2.4 Contractor Training

Before accessing the Whiteshell Laboratories, contractors are required to complete the following training:

- Contractor Safety Orientation
- Radiation Protection Group 4
- Integrated Work Control Core 5 Elements (Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls)
- CNL COVID Awareness

WL utilizes the contract terms and conditions, in addition verifying and approving the contractor company’s safety programs and training records, to ensure contractors are qualified to work at WL.

WL oversees contractors’ work in the field and all WL work control protocols apply.

2.2.5 Training Evaluations Summary

In 2021 WL continued to utilize trainee feedback forms to capture learner input as part of training program improvement and maintenance activities. Also, there were 16 documented Observation and Coaching sessions related to training events. These evaluations are reviewed weekly by Training and Development staff and training program improvements are managed through applicable training change processes.

3 Operating Performance

3.1 Operating Program

Whiteshell Laboratories adheres to the Operating and Decommissioning Functional Support Areas. See Section 3.1 and Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review board and other internal assessment activities such as self-assessments and audits (see Section 1.2).

3.1.1 Operations / Decommissioning Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [12] for Whiteshell Laboratories are given in Appendix A through F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [13] processes.

Relevant modifications to WL facilities are given in Appendix A through G.

3.2 Reporting Requirements

3.2.1 Reportable Events to CNSC

In 2021, there were 6 events that occurred at Whiteshell Laboratories that were deemed reportable to the CNSC. They are listed in Table 5.

Table 5: Reportable Events to the CNSC at Whiteshell Laboratories in 2021

Event No.	Title	SCA	Facility (if applicable)
ERM-21-3585	WL Injury - Medical Aid - Slip, Trip, Fall (Leg Injury)	Operating Performance	WL Building 300 (Research and Development)
ERM-21-3009	WL Reportable Event – Missed maintenance of safety related systems as per the Shielded Facilities Facility Authorization	Operating Performance	WL Shielded Facilities

HSSE-21-1772	WL - Radiation Source Found in Area Radiation Monitor Removed from B305 Electron Accelerator	Radiation Protection	WL Building 402 (Health and Safety)
ERM-21-1732	WL Environmental Protection: Hydraulic Leak at the Building 200 Demolition site involving a contractor's Hyster 550 Fork Lift (Rental Unit)	Environmental Protection	WL Building 200 (Active Liquid Waste Treatment Centre)
ERM-21-1651	WL Reportable Event - Building 402 Fire Protection System Impairment	Fire Protection	WL Building 402 (Health and Safety)
ERM-21-1036	WL - Incomplete Inventory Results in Misclassification of Shipment	Packaging and Transport	

3.2.2 Reportable Events to Other Regulators

Reports to other regulatory agencies consisted of:

- 1 Hazardous Occurrence Investigation Reports (HOIR) was made to Employment and Social Development Canada (see Section 8.1.3 for further details)
- 2 reports made to Environment and Climate Change Canada (see Section 9.5.2.4 for further details).

3.2.3 Trending of Events Related to Operational Activities

As events at Whiteshell Laboratories occur, they are recorded in the Improvement Action (ImpAct[2]) system. This information is regularly reviewed and analyzed to identify any trends. To identify trends Event Code based trend reports are also prepared to analyse ImpAct data on monthly bases. Monthly site wide and WL specific trend reports are prepared by CRL Performance Assurance and shared with WL. WL specific trends are also specified in the monthly Contractor Assurance System scorecard.

The following trends were identified and raised as ImpActs:

- ERM-21-1299, WL TREND – No Purchase Order in Place Prior to Commitments of Contract Service Providers Coming to Site
- ERM-21-3088, WL TREND - Misuse of WHMIS (Workplace Hazardous Materials Information System) when labelling or storing hazardous waste.
- ERM-21-3132, WL TREND – Increased Vehicle Accident Incident Reports (VAIR), Equipment and/or Passenger Vehicles on site and in main parking lot at WL.
- HSSE-21-3283, WL TREND – Barrier Crossings.

[2] ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

The use of the ImpAct process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

In 2021, a total of 424 ImpActs were raised by CNL employees at WL.

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

The following table summarizes ImpActs raised over the past 5 years by Significance Level[3].

Table 6: Number of ImpActs raised at Whiteshell Laboratories

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2017	5	0	0	42	448	496
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609
2020	13	0	3	58	276	350
2021	5	0	2	81	336	424

a Level 0 will be assigned if the ImpAct is deemed to be a “non- problem” and a recommendation to close the Impact will be given.

3.2.4 Notification of Conflicts or Inconsistencies

In 2021, there were no conflicts or inconsistencies identified between licence conditions, codes or standards, operations, programs, methods, or regulatory documents referenced in the Whiteshell Laboratories Licence [1] or *Licence Conditions Handbook* [2].

3 Significance Level: Levels assigned to an event (SL1 being most significant, SL4 being least significant) based on the actual or potential result in safety, environmental, or business consequences.

4 Safety Analysis

4.1 Safety Analysis Program

Whiteshell Laboratories adheres to the Corporate Safety Analysis Functional Support Area. See Section 4.1 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories for details [4].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, three facilities have SARs and Facility Authorizations: Shielded Facilities (SF), WMA and Concrete Canister Storage Facility (CCSF). The ALWTC SAR and Facility Authorization documents were previously obsoleted in 2020 [14]. Assessments are in progress to determine if the SF and WMA SARs need to be revised. The CCSF SAR is being updated to address upcoming fuel retrieval activities.

A SAR is being prepared for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and conversion of the SMAGS building to a Cask Loading Facility. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC before these facilities are operated.

4.2 Nuclear Criticality Safety Program

Whiteshell Laboratories adheres to the Corporate Nuclear Criticality Functional Support Area. See Section 4.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

As the Nuclear Criticality Safety Program is a companywide program, enhancements and improvements made were intended to target all sites including WL and are identified in [4].

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSDs) for the Waste Management Area (CSD-27), the Cask Loading Facility (formerly the Whiteshell Laboratories SMAGS Building B923) (CSD-73) were conditionally accepted and the Intermediate-Level Liquid Waste Processing Centre (CSD-74), Concrete Canister Storage Facility (CSD 11), and the Fuel Basket Transfer Flask (CSD-54) are in progress to allow retrieval of waste from the WMA and CCSF. The remaining WL CSDs have not been updated during this review period.

5 Physical Design

5.1 Design Program

Whiteshell Laboratories adheres to the Corporate Design Functional Support Area. See Section 5.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Design Authority and Design Engineering Functional Support Area maintains and controls the design basis for all design activities performed at WL.

In 2021 March, the Certificate of Authorization was renewed with Engineers Geoscientists Manitoba. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of The Engineering and Geoscientific Professions Act.

5.1.1 Safety Related Structures Systems and Components

In 2021, the Design Authority and Design Engineering Program ensured that any structures, systems and components important to safety met and maintained their design basis, and any changes made were controlled through the Engineering Change Control Process [13].

5.2 Pressure Boundary Program

Whiteshell Laboratories adheres to the Corporate Pressure Boundary Functional Support Area. See Section 5.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Pressure Boundary Functional Support Area applies to design, procurement, fabrication, installation, examination, testing, repair, modification, construction and maintenance of pressure retaining systems and components performed by CNL at WL.

The *WL Pressure Boundary (PB) Quality Assurance (QA) Plan* [15] details the specific scopes of pressure boundary work carried out at WL, as permitted by the Certificates of Authorization issued by Inspection and Technical Services (ITS) Manitoba, describes the controls, authorities, and responsibilities applicable at the WL site, and is consistent with CNL's PB Program requirements.

The revised *PB QA Plan* [15] was accepted by ITS and a new Certificate of Authorization was issued on 2021 August 10. The new certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Plan until expiry in 2024 August.

The CNSC has previously been notified of revisions to the *PB QA Plan* [15], as per the *Licence Conditions Handbook.*

6 Fitness for Service

6.1 Fitness for Service Program

Whiteshell Laboratories adheres to a Fitness for Service Program through its Maintenance Functional Support Area. See Section 6.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Site and Nuclear Operations Branch provides monitoring and operation of building's processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedure reviews are conducted on a five year cycle. Currently the Operating Procedures are under review; some of these procedures have reached the five-year timeline for review and those are being prioritized for review and updating. As facilities are decommissioned procedures related to those buildings or processes are obsoleted. Procedures to operate the facilities in order to enable decommissioning efforts are prepared as required.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service, WL staff ensure that critical systems, structures and components related to the safe decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities ensures that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the facility's Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to

assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plan are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed as they are identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed and is being implemented that will fix the issues and prevent recurrence. The effectiveness of the corrective action plan will be investigated upon completion of the actions.

6.1.3 Condition of Structures

Waste storage structures include the WMA bunkers and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [16] was developed in 2007 and continues to be implemented to confirm the ongoing fitness-for-service of the concrete storage facilities (termed "bunkers") at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done, to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site, they will be removed from the inspection process. The 2021 annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [16].

Although the SMAGS building (Building 923) is not a bunker it has been included in the bunker inspection. Building 923 is being converted to the Cask Loading Facility, and during this conversion and subsequent re-commissioning for its new purpose, it will not store waste. A repair, conducted in 2016, to the north wall of Building 923 that extended into the core of the slab, remained stable through 2021 with no new crack expressions (the walls of Building 923 are pre-cast concrete slabs). All other repair items for the bunkers and Building 923 were minor in nature and were tracked through the WL work request system.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however existing cracks and pour pockets were regularly checked for changes. Requests for patching were placed in 2021, and several canisters will require more extensive patching of pour pockets that have gradually become more noticeable over time, however no increased radiation field was noted.

Environmental monitoring was conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers, SMAGS or concrete canisters.

7 Radiation Protection

7.1 Radiation Protection Program

Whiteshell Laboratories adheres to the Corporate Radiation Protection Functional Support Area. See Section 7 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories uses the Chalk River Laboratories (CRL) licensed Dosimetry Service Provider for external and internal dosimetry for site/facility staff and contractors.

Whiteshell Laboratories staff and contractors who work at the WL site are assigned Thermoluminescent Dosimeters (TLDs) to monitor for external radiation exposures.

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2021 included:

- Radiological hazard and precaution sheets were reviewed and updated as required to remove statements such as “at the Surveyor’s discretion” or “as directed by RP Surveyor”.
- Enhanced personal protective clothing and equipment requirements were implemented for work in Radiological Safety Zone 2 and 3 work areas.
- Guidelines were developed and implemented for field RP staff for consistent completion of radioactive material transit/storage tags.
- Radiological surveys completed in WL nuclear facilities to confirm absence or identify unknown and unmarked historical or legacy contaminated materials and areas.
- Facility review completed for the adequacy of radioactive material storage areas.
- Field compliance check list developed and implemented for use by field RP staff during facility housekeeping inspections.
- Guidelines provided for RP staff when knee pads or other additional measures are needed to prevent inadvertent knee contaminations when working in contaminated environments.
- New CNL RP program requirement for formal registration of long term radioactive material storage areas was implemented for any new storage areas, and work started on registration of pre-existing facility storage areas.
- WL site procedure developed for the dose monitoring program for WL workers, contractors and visitors.

WL RP performance metrics are measured and tracked weekly through WL Closure Project status reports and quarterly through the WL Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies and

opportunities for improvement, establish and effectively implement corrective and preventative action plans.

7.1.2 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2021, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to TLD badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition. Table 7 summarizes maximum daily recorded doses and dose rates for PAD work in 2021 and the previous four years, and a summary of PAD alarms. In 2021, the maximum PAD recorded daily dose received by a worker was 0.22 mSv and the highest dose rate measured in the year was 3.1 mSv/h. These were associated with planned exposures associated with decommissioning activities in the Building 200 ALWTC, and removal and packaging hot cell roughing filters in the WL Shielded Facilities. There were no PAD dose alarms and 78 PAD dose rate alarms in 2021. The distribution of PAD dose rate alarms over the past 5 years is summarized in Table 8.

There was an increase in the number of low level dose rate alarms in 2021 due to increased decommissioning and operations activities in the WMA associated with the removal, characterization and packaging of low level radioactive waste from waste storage buildings. These low level dose rate alarms helped alert workers of dose rate areas they did not need to be working in, and thus helped to maintain low doses to workers.

Table 7: Personal Alarming Dosimeter Summary

	2017	2018	2019	2020	2021
PAD – Maximum Daily Dose (mSv)	0.17	0.24	0.42	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.10

Table 8: Distribution of Number of PAD Dose Rate Alarms 2017-2021

Year	Dose Rate Alarm Set Point (mSv/h)							
	≤0.10	>0.10 - <0.25	0.25 - < 0.50	0.50 - < 1.0	1.0 – < 2.5	2.5 - < 5.0	5.0 - < 10	≥ 10
2021	11	20	22	16	7	2	0	0
2020	10	2	1	5	9	1	1	0
2019	9	0	2	12	4	2	0	0
2018	22	0	13	5	31	3	0	0
2017	22	3	26	2	5	0	0	0

At the beginning of 2021, managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by managers and supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified. At the end of 2021, there were no individuals with an assigned DCP higher than 2 mSv, 28 individuals with an assigned DCP of 2, and the remainder of workers with a DCP of 1 mSv. No worker dose exceeded their assigned DCP in 2021.

7.1.3 Contamination Control

Regular contamination surveys of workplaces, material transfers, and personnel exiting nuclear facilities and controlled areas, are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls, and to warn of abnormal or unplanned airborne contamination conditions.

Table 9 shows the number of personnel, workplace and material contamination events identified in 2021 and over the past five years. None of the contamination events in 2021 resulted in a recordable whole-body, skin or internal dose.

Material contaminations increased from 1 in 2020 to 11 in 2021. This increase was due to historical surplus equipment being found with low level contamination during operational cleanup activities (8), building decommissioning waste disposition (1), and as a result of operational activities (2). There were no worker skin or clothing contaminations in 2021.

In 2021, there were no airborne contamination exposure events and no radioactive material spills.

The following table outlines contamination events that occurred at Whiteshell Laboratories in 2021:

Table 9: Contamination Events

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	Personal Clothing[a]	Radiological Work Clothing[b]	Total	Surface[c,d]	Vehicle / Materials [b, c]
2017/18 FY	0	0	1	1	3	
2018/19 FY	1	0	5	6	6	0
2019 CY	3	0	4	7	2	4
2020 CY	2	0	3	5	1	1
2021 CY	0	0	0	0	1	11

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area.
b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area.
c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas
d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2021, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2021 December 31, the total number of registered sealed or contained sources at WL, was 53. One Cesium (Cs)-137 source was added to the registry, and one mixed Cs-137 liquid standard and one Cs-137 gamma irradiator were removed from the registry. The liquid standard was evaporated and dispositioned as radioactive waste. The Cs-137 calibrator was transported back to the manufacturer.

7.2 Dosimetry

7.2.1 Interpretation of Reported Dose Quantities

WL uses the CRL licensed Dosimetry Service Provider for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory document REGDOC 2.7.2, *Dosimetry*, Volume II [17] requires external exposure measurements to meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective

dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[4].

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a committed effective dose from occupational intakes exceeding 1 mSv per year.

7.2.2 Radiation Doses to Personnel

Table 10 to Table 13 summarize the monitored radiation doses at the WL site for 2021. Doses are summarized for employees, contractors and visitors and are subdivided into Nuclear Energy Worker (NEW) and non-NEW status. Doses in the tables of this report do not include doses received by WL employees and contractors working at sites other than WL. Two visitors had NEW status that were associated with prior NEW requirements and visits within CNL as a whole, these two instances were CNSC and IAEA staff.

In 2021, there were no exceptions for individual monitoring of non-CNL employees and visitors at WL, other than drivers of delivery trucks and building demolition debris haulers in radiological Supervised Areas.

There were no operations of exposure devices in 2021 which required employees or contractors to be placed on a two-week dosimetry period, and there were no formal dose calculations required during 2021 for local area skin contamination.

No neutron dosimeters were assigned to employees during 2021.

In 2021, 180 individuals underwent internal bioassay, which involved urinalysis and/or whole-body counting. Eleven individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective dose estimates were necessary as a result of any bioassay sampling in 2021.

In May of 2021 the building (B402) that housed the WL Whole Body Counter (WBC) began decommissioning and demolition and a new building (B543) is currently being commissioned to house the WBC. It is anticipated that the new facility will be ready for occupancy sometime in the spring of 2022. During this outage, workers who normally participate in annual or bi-annual WBCs were evaluated against the site's current radiological activities to determine which

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4 Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.2).

workers required alternative monitoring. Workers with reasonable potential for an intake which warranted alternate monitoring were placed on a gamma spectrometry in urine analysis (provided by CRL Dosimetry Services) which provides similar minimum detectable doses to the WBC analysis. Additional random (biased toward likelihood of an intake) urine bioassay monitoring of workers who did not meet the alternative monitoring criteria is being undertaken until the new facility is ready.

Table 10: Effective Dose for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	393	100	292	1	-	-	-	-	0.57	0.06	0.05	17.98
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
Totals		861	546	314	1	0	0	0	0				18.99

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 11: Distribution of Equivalent Dose to the Skin for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv) 0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00	Individual Dose (mSv) Max	Ø Avg[a]	Avg All[b]	Collective Dose (p·mSv)
			Number of Persons										
NEW	Employee	393	99	287	7	-	-	-	-	0.94	0.08	0.06	22.46
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
Totals		861	545	309	7	0	0	0	0				23.47

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 12: Distribution of Equivalent Dose to the Hands and Feet for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	**Employee**	16	4	8	1	3	-	-	-	1.86	0.61	0.45	7.26
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor[c]	0	-	-	-	-	-	-	-	-	-	-	-
Non-NEW	**Employee**	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Totals		16	4	8	1	3	0	0	0				7.26

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.

b Average of all measured doses that include the zero dose value, rounded to two decimal places.

c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 13: Summary of Dose Components Received as a Result of Licensed Activities for 2021 [a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	393	17.98	0.57	0.06	0.05	393	22.46	0.94	0.08	0.06	16	7.26	1.86	0.61	0.45
	Contractor	77	0.74	0.19	0.04	0.01	77	0.74	0.19	0.04	0.01	0	-	-	-	-
	Visitor[c]	2	0.00	0.00	-	0.00	2	0.00	0.00	-	0.00	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	148	0.17	0.11	0.06	0.00	148	0.17	0.11	0.06	0.00	0	-	-	-	-
	Visitor	241	0.10	0.10	0.10	0.00	241	0.10	0.10	0.10	0.00	0	-	-	-	-
Total		**861**	**18.99**				**861**	**23.47**				**16**	**7.26**			

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor[d]	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Total		0	0.00				0.00					0	0.00			

a All quantities are measured in mSv unless otherwise noted.
b Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
c Average of all measured doses that include the zero dose value, rounded to two decimal places.
d Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

7.2.2.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2021 was 0.57 mSv and the site collective dose was 18.99 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the current five-year dosimetry period from 2021 to 2025 at WL was 0.57 mSv.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2021 was 0.94 mSv and the site collective dose was 23.47 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2021 was 1.86 mSv and the site collective dose was 7.26 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2021, the maximum individual effective dose from the time the pregnancy was declared to the end of the pregnancy term was 0.05 mSv.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2021, the maximum individual effective dose to a non-NEW at WL was 0.11 mSv.

Table 14 provides a summary of radiation doses by worker group in 2021. The majority of radiation doses were received by RP, Nuclear Operations and Trades staff.

7.2.2.2 Radiation Dose Changes or Trends

Table 15 shows external whole body dose received from 2017 to 2021, and Figure 1 displays the maximum individual and collective dose from 2001-2021.

Worker doses decreased in 2021 with the completion of higher dose extensive decommissioning activities in Building 200 (ALWTC) in 2020. The site collective dose decreased from 33 p-mSv in 2020 to 19 p-mSv in 2021. The number of workers receiving occupational doses above 0.2 mSv in a calendar year decreased from 25 workers in 2020 to 11 workers 2021. This a significant decrease compared to a maximum number of 42 workers in 2017. There were no workers receiving an annual radiation dose above 1 mSv in 2021.

Main contribution to radiation dose in 2021 was radioactive tanks removal during B200 demolition activities, and operational replacement of hot cell roughing filters. There was increased waste handling in 2021 with the start of the removal, characterization and packaging of low level radioactive waste packages from storage facilities in the WMA. However, these activities had only a small contribution to site worker doses.

7.2.3 Program Exceedances

During 2021, radiation dose to all persons working at WL were below the WL dose Action Levels [2] and the respective CNSC regulatory limits [18]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 14: Summary of Worker Group Radiation Doses at WL for 2021

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	p·mSv	p·mSv	p·mSv
Nuclear Facilities:						
SF Staff (HCF and IFTF)[c]	5	0.18	0.49	0.91	0.92	1.83
WR1 and ALWTC Staff	5	0.07	0.14	0.37	0.37	0
WMA and CCSF Staff[c]	6	0.07	0.21	0.39	0.39	0
Support Workgroups:						
Radiation Protection Staff [d]	41	0.11	0.43	4.43	6.02	1.06
Trades Staff [e]	48	0.09	0.57	4.31	6.35	4.37
All Remaining Staff:						
Other Staff [f]	513	0.02	0.19	8.48	9.32	0
WL Site[g]:	618	0.03	0.57	18.89	23.37	7.26

a Includes photon and neutron; there were no tritium committed effective doses for 2021.

b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.

c SF= Shielded Facilities; HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; ALWTC= Active Liquid Waste Treatment Center; WMA= Waste Management Area; CCSF= Concrete Canister Storage Facilities; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.

d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.

e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL

site in general.

f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.

g WL Site includes 393 CNL staff (WL and staff visiting from other CNL sites) and 225 contractors working at the WL site during 2021. This tally does not include visitor doses.

Table 15: WL External Whole-Body Dose Performance 2017 to 2021

Performance Metric	2017	2018	2019	2020	2021
Site Collective Worker Dose (p-mSv)	19.9	40.2	49.6	33.4	18.9
Max Individual Worker Dose (mSv)	1.41	1.65	3.09	2.97	0.57
Number of Workers > 0.2 mSv in a year	42	39	38	25	11
Number of Workers > 1 mSv in a year	1	12	14	8	0
PAD[a] – Maximum Daily Dose (mSv)	0.17	0.24	0.40	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.1

a Personal Alarming dosimeter.

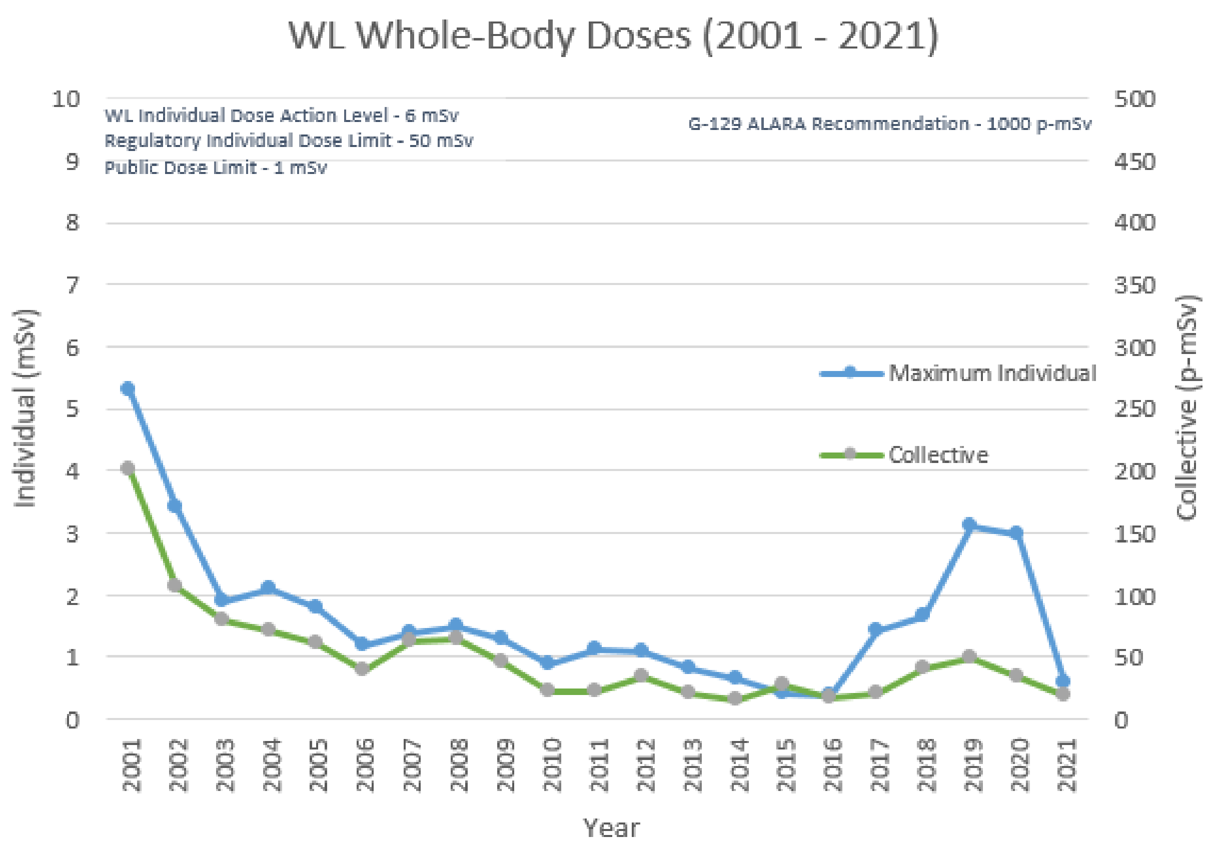


Figure 1: Whole-Body Effective Doses (2001 – 2021)

8 Conventional Health and Safety

8.1 Conventional Health and Safety Program

Whiteshell Laboratories adheres to the Corporate Conventional Health and Safety Functional Support Area. See Section 8 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives are continuing or began in 2021:

- To support project work, WL OSH purchased noise dosimeters, a sound calibrator, Jerome Mercury detector and Colorimetric Badges for chemical detection.
- OSH presence in the field continued at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to WL's internal safety success.
- Contractors continued to be "pre-qualified" prior to bidding on WL contracts. The pre-qualification process involves reviewing safety statistics and the safety programs of the potential bidders.
- WL continued to participate in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- There were 11 internal Safety Advisories and 2 Learning Advisories sent to WL site employees. The bulletins are intended to inform WL employees about imminent issues that could impact their safety. WL continued to be proactive in the approach to safety.
- Near Miss reporting (a known industry best practice) continued with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 16).
- Near Miss reporting at WL always includes an investigation/fact finding session. The majority of Near Miss reports also generate an ImpAct. Whether an ImpAct is generated or not, the possibility of a human error trap being involved in the Near Miss incident is always considered, evaluated and followed up as appropriate.
- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.
- Promoted the Stop/Pause protocol.

Table 16: Summary of WL Near Miss Reporting

Year	2017	2018	2019	2020	2021
Near Miss Reported	60	53	46	10	26

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis.

In 2021, the WL Site Safety and Health Committee received 93 inquiries out of which 6 remained open and in progress. There was one inquiry carried over from 2020. The Site Safety and Health Committee acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 61 site health and safety inspections completed in 2021.

8.1.3 HOIRs and Lost-Time Injuries

There was one hazardous occurrences at Whiteshell Laboratories that was reported to Employment and Social Development Canada in 2021. CNSC staff received a copy of this notification, as per the requirements of the CNSC REGDOC-3.1.2 [3].

The following is a summary of injury rate data for the last 5 years.

Table 17: Summary of Whiteshell Laboratories Injury Rate Data

	2017	2018	2019	2020	2021
Whiteshell Laboratories					
Person Hours Worked	706,000	688,000	642,000	584,030	684000
Lost-Time Injuries	3	1	0	1	0
Working Days Lost	27	5	0	2	0
Frequency[a]	0.85	0.25	0	0.34	0
Severity[b]	7.76	1.45	0	0.68	0
Whiteshell Laboratories Contractors[c]					
Lost Time Injuries	1	0	0	0	0
Working Days Lost	0[d]	0	0	0	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

c The Number of Person Hours worked are not divulged by Contractors. As such, Frequency and Severity rates cannot be calculated.

d Number of days lost is unknown as the contractor terminated the employee.

The Recordable Lost Time Injury rate over the last five years at WL in Manitoba is significantly lower than local lost-time injury rates for construction (3.7) and manufacturing (2.4), as per the data from the Workers Compensation Board of Manitoba found in *The Manitoba Workplace Injury and Illness Statistics Report 2010-2019* (safemanitoba.com).

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2021.

9 Environmental Protection

9.1 Environmental Protection Program

WL adheres to the Corporate Environmental Protection (EnvP) Functional Support Area. See Section 9 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

WL has an integrated Environmental Protection Program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program, and the Groundwater Monitoring Program. The WL Environmental Protection Program is designed to implement the requirements of:

- CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [19],
- CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [20],
- CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [21],
- CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [22],
- CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [23], and
- ISO 14001:2015, *Environmental Management Systems* [24].

The integrated Environmental Protection Program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

This report will focus and discuss the implementation of the WL Effluent Verification Monitoring Plan [25]. This plan defines the methodologies and protocols followed in performing the effluent verification monitoring required in CSA N288.5-11 [20].

The WL site has maintained its ISO 14001 [24] registration in 2021 with initial registration in 2010.

The CNSC has previously been notified of revisions to *Environmental Protection documents* [26], as per the *Licence Conditions Handbook.*

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control programs as required by CSA N288.5 [20]. General quality assurance objectives for CNL's

Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [27] for analytical laboratories.

Whiteshell Laboratories' Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 3247 quality verification tests during 2021 on WL's radiochemical counting equipment. Of these tests, 99.6% fully complied with acceptance criteria. The results of these tests are shown Table 18.

Table 18: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	1188	4	99.7
Total Beta (Instrumentation)	1188	5	99.6
Gamma (Instrumentation)	647	0	100.00
Tritium	224	4	98.2
2021 Total	**3247**	**13**	**99.6**

In 2021, the WL Effluent verification program continued performing regular field Quality Verification testing on the Outfall, Lagoon, and Ditch effluent sampling (Table 19). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

Table 19: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	N/A	N/A	4	100%
Conductivity	4	<LDML	4	100%
Total Organic Carbon	4	< LMDL	4	100%
Phenols	4	< LMDL	4	100%
TSS	4	<LMDL	4	50%
Phosphorus	4	<LMDL	4	75%
Oil and Grease	4	< LMDL	4	100%
Mercury	4	<LDML	4	75%
Chromium	4	< LMDL	4	25%
Copper	4	0.222 mg/L	4	25%
Magnesium	4	< LMDL	4	100%
Iron	4	< LMDL	4	50%
Lead	4	0.0033 mg/L	4	25%
Nickel	4	< LMDL	4	50%
Potassium	4	< LMDL	4	75%
Sodium	4	< LMDL	4	100%
Strontium	4	< LMDL	4	100%
Uranium	4	< LMDL	4	75%
Zinc	4	0.010	4	50%
Bromodichloromethane	4	0.002 mg/L	4	100%
Chloroform	4	0.096 mg/L	4	100%
Toluene	4	0.044 mg/L	4	100%
Radiological Parameters:				
Gross Alpha	N/A	N/A	1	100%
Gross Beta	N/A	N/A	1	0%
Cesium-137	N/A	N/A	1	100%
Americium-241	N/A	N/A	1	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Potassium-40	N/A	N/A	1	100%
Lead-214	N/A	N/A	1	100%
Beryllium-7	N/A	N/A	1	100%
Strontium-90	N/A	N/A	1	100%
Plutonium-238	N/A	N/A	2	100%
Plutonium-239/240	N/A	N/A	2	100%
Sewage Lagoon				
No Samples collected in 2021				
Ditches				
Non-Radiological Parameters:				
pH	N/A	N/A	2	100%
Conductivity	1	2.1 uS/cm	2	100%
Phenols	1	<LDML	2	100%
TSS	1	<LDML	2	50%
Phosphorus	1	< LMDL	2	100%
Oil and Grease	1	< LMDL	2	100%
Mercury	1	< LMDL	2	50%
Chromium	1	< LMDL	2	100%
Copper	1	0.434 mg/L	2	100%
Iron	1	< LMDL	2	100%
Lead	1	0.007 mg/L	2	100%
Nickel	1	0.0006 mg/L	2	100%
Zinc	1	0.043 mg/L	2	100%
Radiological Parameters:				
Gross Alpha	1	< LMDL	2	50%
Gross Beta	1	< LMDL	2	50%
Tritium	1	< LMDL	2	100%
Cesium-137	1	< LMDL	2	100%
Americium-241	1	< LMDL	2	100%
Cobalt-60	1	< LMDL	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Radium-228	1	< LMDL	2	100%
Europium-154	1	< LMDL	2	100%
Lead-210	1	< LMDL	2	100%
Thorium-228	1	< LMDL	2	100%
Thorium-230	1	< LMDL	2	100%
Thorium-234	1	< LMDL	2	100%
Uranium-235	1	< LMDL	2	100%
Radium-226	1	< LMDL	2	100%
Actinium-228	1	< LMDL	2	100%
Potassium -40	1	< LMDL	2	100%
2021 Total	**224**	**--**	**148**	**89%**

LMDL = Laboratory Method Detection Limit

It is important to note that not all of the radiological results for 2021 have been received from the contract laboratories carrying out the analysis of samples (see also Section 9.4.1.3.2). At the time of writing this report, results received to date indicate that out of the 148 duplicate quality verification tests, 132 of these tests meet the acceptance criteria (+/- 20% of the actual result) of the program, to yield an 89% pass rate. A larger number of duplicates failed this year, with the majority of the failures being related to the metal concentrations being observed at the Outfall monitoring station. CNL is attributing this increase in failures to the fact that the metal concentrations being observed in the effluent are near the detection limit. This leads to results with low concentrations and high variability being produced, which will increase the likelihood of a failure in the duplicates being observed. This is supported by the large number of results classified as not being detected, and the low concentrations of metals being observed at the Outfall as seen in Table 32. No further action by CNL is needed to address the failures.

Reviewing the travelling blank data, and comparing it to the field results, the environmental program has concluded that the water source being used for the travel blank is slightly contaminated with Copper, Lead, Zinc, Chloroform, and Bromodichloromethane. The traveling blank results for these parameters are not reflective of contamination being picked up while sampling in regards to these parameters.

In 2021, the WL Environmental Management group took part in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses, were offered through the Canadian Association for Laboratory Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 20 and Table 21. There were four unacceptable test results out of thirty for the Environmental Research Associates inter-laboratory comparison studies, resulting in an 87% pass rate. The four unacceptable test results related to the gross alpha and gross beta analysis of water samples. The WL radiochemical counting laboratory is working on determining the cause of the problem, and until the cause has been identified, all quantitative analyses of this nature are being contracted out to a third party laboratory. The laboratory is in the process of ruling out possible factors. The areas the laboratory are currently reviewing includes the process for evaporation and ashing samples being utilized to prepare samples. The previously used method was required to change due to equipment limitations in the new environmental laboratories. The standard stock solutions that are used for the creation of the calibration curves used in this analysis may have also been compromised.

For the Proficiency Testing Canada inter-laboratory comparison studies, a 100% pass rate was achieved.

Table 20: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2021

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Air Filter Radionuclides	Americium-241	(pCi/Filter)	60.2	64.20	43.0 – 80.3	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	1030	898.76	668 - 1260	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	163	173.30	134- 214	Acceptable
MRAD-34	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	1220	1310.15	1040- 1550	Acceptable
MRAD-34	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	771	926.67	632- 1180	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	96.1	105.09	50.2-158	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	62.6	58.64	38.0-94.6	Acceptable
MRAD-34	Water Radionuclides	Americium-241	pCi/L	157	154.80	108-201	Acceptable
MRAD-34	Water Radionuclides	Cesium-134	pCi/L	1610	1369.04	1220-1770	Acceptable
MRAD-34	Water Radionuclides	Cesium-137	pCi/L	578	558.65	495-657	Acceptable
MRAD-34	Water Radionuclides	Cobalt-60	pCi/L	2180	2089.33	1880-2500	Acceptable
MRAD-34	Water Radionuclides	Zinc-65	pCi/L	1720	1765.19	1530 - 2170	Acceptable
MRAD-34	Water Gross Alpha/Beta	Gross Alpha	pCi/L	62.2	12.09	22.7 – 85.8	Not Acceptable
MRAD-34	Water Gross Alpha/Beta	Gross Beta	pCi/L	103	169.83	51.5 - 142	Not Acceptable

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Water Tritium	Tritium	pCi/L	22800	21216	17200-27800	Acceptable
MRAD-35	Air Filter Radionuclides	Americium-241	(pCi/Filter)	27.7	27.75	19.8-36.9	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	241	196.60	156-296	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	187	184.8	154-245	Acceptable
MRAD-35	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	310	310.75	264-394	Acceptable
MRAD-35	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	366	401.32	559	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	77.6	91.00	40.5-128	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	80.6	74.22	48.9-122	Acceptable
MRAD-35	Water Radionuclides	Americium-241	pCi/L	63.7	62.63	43.7-81.5	Acceptable
MRAD-35	Water Radionuclides	Cesium-134	pCi/L	649	558.51	490-714	Acceptable
MRAD-35	Water Radionuclides	Cesium-137	pCi/L	2170	2026.11	1860-2470	Acceptable
MRAD-35	Water Radionuclides	Cobalt-60	pCi/L	964	936.39	831-1110	Acceptable
MRAD-35	Water Radionuclides	Zinc-65	pCi/L	394	408.92	351-497	Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Alpha	pCi/L	93.9	27.66	34.3-129	Not Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Beta	pCi/L	97.0	142.66	48.5-133	Not Acceptable
MRAD-35	Water Tritium	Tritium	pCi/L	12800	12528.93	9650-15600	Acceptable

* MRAD: Multi-Media Radiochemistry

Table 21: Proficiency Testing Canada Accreditation Inter-Laboratory Comparison Program CNL WL - 2021

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2021	CO1A-1	Conductivity	(µS/cm)	741	740	99	Acceptable
	CO1A-2	Conductivity	(µS/cm)	1160	1153		
	CO1A-3	Conductivity	(µS/cm)	374	376		
	CO1A-4	Conductivity	(µS/cm)	523	522		
March -2021	CO4A-1	TSS	(mg/L)	15	16	97	Acceptable
	CO4A-2	TSS	(mg/L)	64	66		
	CO4A-3	TSS	(mg/L)	128	130		
	CO4A-4	TSS	(mg/L)	203	203		
March -2021	C15-1	pH	(pH units)	4.89	4.87	95	Acceptable
	C15-2	pH	(pH units)	6.58	6.54		
	C15-3	pH	(pH units)	3.34	3.32		
	C15-4	pH	(pH units)	9	8.95		
October-2021	CO1A-1	Conductivity	(µS/cm)	676	695	91	Acceptable
	CO1A-2	Conductivity	(µS/cm)	454	469		
	CO1A-3	Conductivity	(µS/cm)	412	428		
	CO1A-4	Conductivity	(µS/cm)	707	719		
October-2021	CO4A-1	TSS	(mg/L)	22	16	86	Acceptable
	CO4A-2	TSS	(mg/L)	136	134		
	CO4A-3	TSS	(mg/L)	185	178		
	CO4A-4	TSS	(mg/L)	53	52		
October-2021	C15-1	pH	(pH units)	4.9	4.89	96	Acceptable
	C15-2	pH	(pH units)	7.72	7.77		
	C15-3	pH	(pH units)	2.82	2.80		
	C15-4	pH	(pH units)	8.52	8.55		

9.3 Supplementary Studies

In 2020, the WL site began to do temporary enhanced monitoring on the effluent verification ditches for the year. The enhanced monitoring is being done to confirm the absence of a number of radiological and non-radiological parameters. The enhanced monitoring involved doing an open scan for Volatile Organic Carbons, semi-volatile organic carbons, and an expansion of the metals and gamma isotopes list currently being used to monitor the ditches.

Whiteshell is reviewing the data, and is deciding whether there is a need to add any of these parameters to the effluent verification monitoring program going forward. This study was on going in 2021, and will be continued into 2022 due to the limited number of ditch sampling events that occurred in 2021.

9.4 Effluent Monitoring - Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [28] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, *Environmental Monitoring in 2021 at Whiteshell Laboratories* [29] and *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

9.4.1 Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

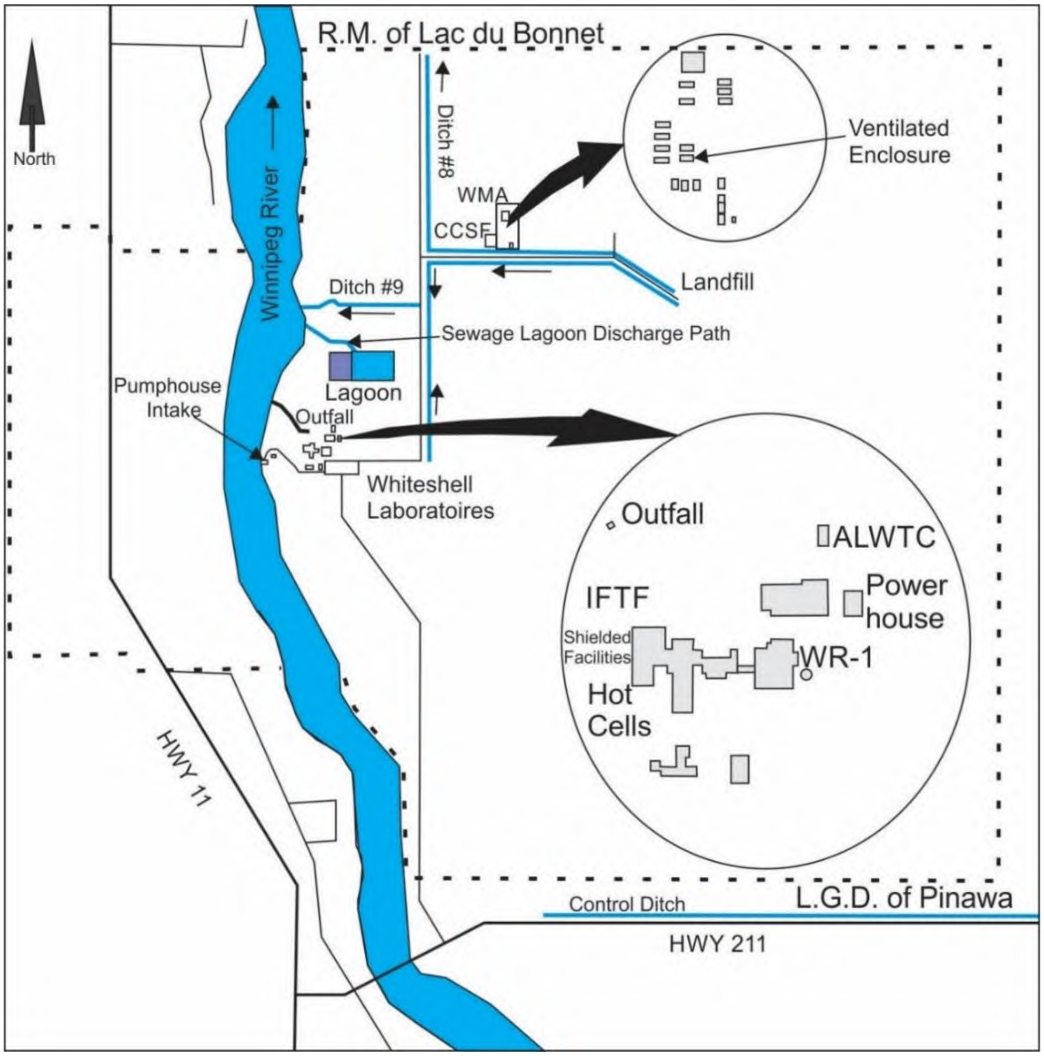


Figure 2: Effluent Monitoring Locations

Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable DRLs [30]. The DRLs in use at WL came into effect on 2021 January 31. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction

and analysis of individual beta emitting radionuclides, such as Strontium (Sr)-90, complemented by examination of historical data.

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in CSA N288.1-08 [31]. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [32]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[5] that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3.2, the increase in 2019 to 2021 liquid effluents is due to an increase in detection limit values for Am-241 and Plutonium (Pu)-239/240. When the activities of radionuclide contaminants are not detected it is standard practice to report detection limit values as if they were observed concentrations. For example, Pu isotope activities were always detection level values and Am-241 and Cs-137 activities are very close to detection levels.

[5] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).

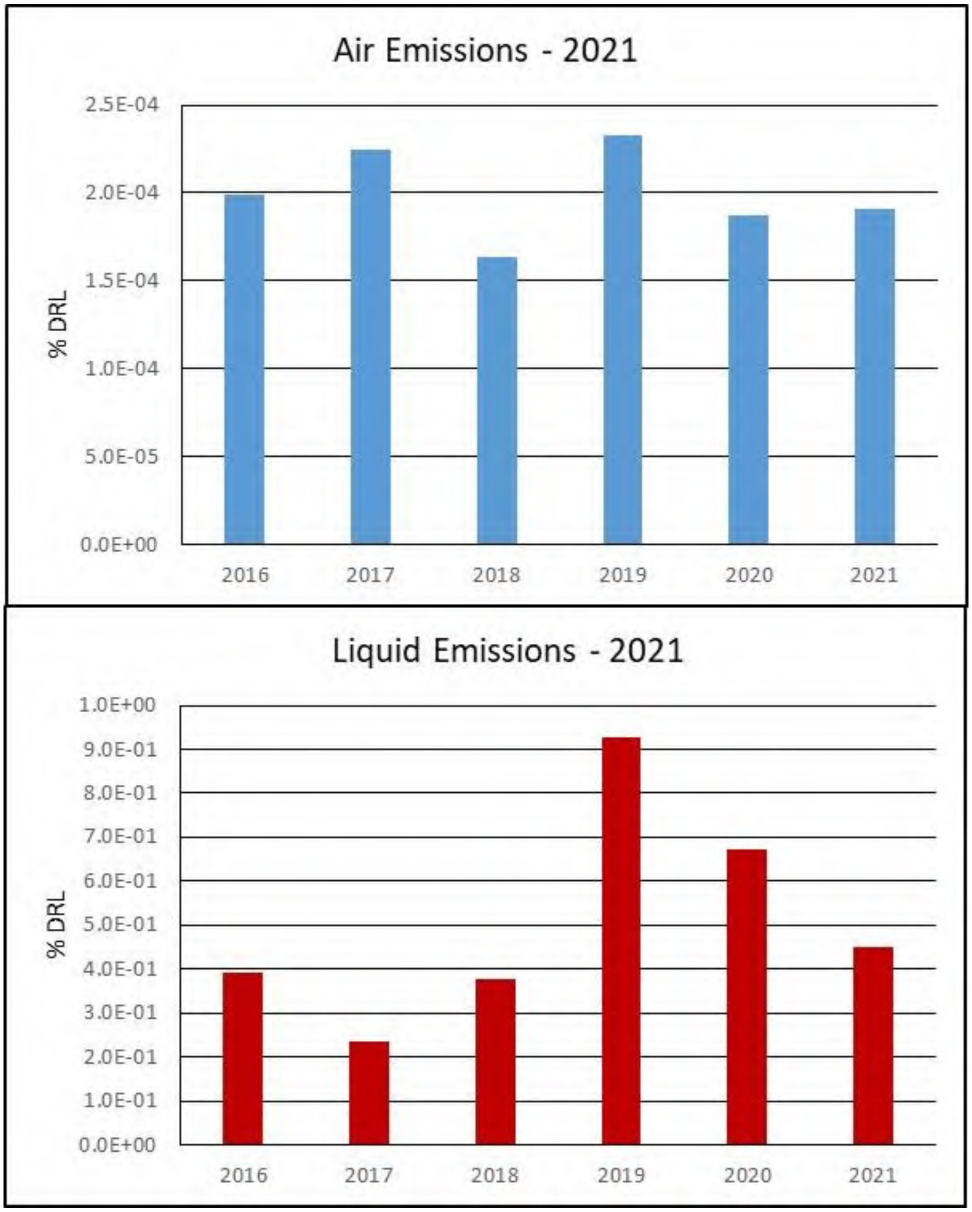


Figure 3: Trends for Airborne and Liquid Emissions form WL for 2016 to 2021

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Administrative and Action Levels[6] as specified in Reference [33]. The Action Levels were calculated based on current CNSC guidance to meet CSA N288.8 [23] and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

9.4.1.2 Airborne Effluents Monitoring

9.4.1.2.1 Monitoring Points, Schedules and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. These activities include waste compaction in the Waste Handling Area, located in the Immobilized Fuel Testing Facility (IFTF), and decommissioning activities in the ALWTC. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)
- ALWTC (Building 200)

Air effluents from Buildings 100 and 300 were sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 22. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. Any proposals on modifications to the monitoring program will be communicated to CNSC staff. In 2020, Building 200 (ALWTC) was prepared for demolition and the ventilation system was shut down in 2020 October. Monitoring of stack effluents for Building 200 ceased after 2020 October 13, and the building was demolished in 2021. Therefore the reported air emissions in 2021 do not include emissions from Building 200, which is no longer included in the monitoring schedule (Table 22).

[6] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

Table 22: Radiological Air Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
Building 100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
Building 300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
Building 300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured but passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water Bubbler for tritium.

W Weekly

N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The WL maintenance planning team performs the measurements for the stack flows and the RP team measures the Sampler flow. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [30]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (Sr-90 for gross beta and Pu-239 and Pu-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 23 and Figure 3 for the years 2016 to 2021. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also includes tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. The reader should be aware that the values for 2021 in Table 23 represent averages that include detection limit values where nothing has actually been detected. The releases from the Reactor Building include gross beta and tritium values that are always above detection, and gross alpha numbers that are often detection limits. The gross alpha releases from the HCF are normally detection levels and the gross beta are often, but not always detection levels. The gross alpha values from the IFTF are always detection limits and the gross beta are a mixture of detects and non-detects.

Airborne emissions remain a small fraction of the release limit. The result for 2021 (0.00019% of the DRL) is similar to 2020, and slightly lower than the average for the last five years. Total site gross alpha in 2021 is lower than in 2020 and the last five years average. It remains near detection limit values. The gross beta emissions are slightly more than in 2020 and similar to the last five-year average. In 2021, the air emissions from all facilities were below Administrative Levels and regulatory Action Levels. In 2021, Building 200 no longer contributed to air emissions. The average values of the previous five years shows that Building 200 had contributed 16 percent of the total alpha air emissions and 8 percent of the total beta air emissions.

Tritium emissions from the WR-1 stack were higher than in 2020 and slightly less than the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative level (1.52E+10 Bq/week) for the facility and well below the Action Level (7.62E+10 Bq/week) and DRL (1.65E+15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence.

Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Building 100, and work in the Shielded Facilities and Concrete Canister Storage Facility. Outdoor Workplace Air Sampler monitoring was performed for Building 200 demolition. Environmental airborne dust monitoring was performed close to the east, north,

west and south boundaries of the WL campus during building demolitions. The results of the 2021 dust monitoring are described in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

Table 23: Radionuclides in Air Effluents from WL Facilities – 2016 to 2021

Location/Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2016 (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	2019 (Bq/wk)	2020 (Bq/wk)	Five-Year Average		2021		2021 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building													
Gross Alpha[b]	1.73E+09	1.71E+04	4.16E+02	3.82E+02	2.65E+02	2.89E+02	3.07E+02	3.32E+02	1.92E-05	4.16E+02	2.40E-05	1.29E+03	7.45E-05
Gross Beta[b]	6.79E+09	1.68E+05	1.91E+03	1.83E+03	1.07E+03	1.95E+03	1.62E+03	1.67E+03	2.47E-05	2.34E+03	3.45E-05	7.36E+03	1.08E-04
Tritium	1.65E+15	7.62E+10	6.24E+08	9.68E+08	2.51E+08	6.43E+08	2.51E+08	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
ALWTC													
Gross Alpha	1.73E+09	1.00E+04	2.25E+02	2.37E+02	3.13E+02	3.12E+02	3.80E+02	2.93E+02	1.70E-05	N/A	N/A	N/A	N/A
Gross Beta	6.79E+09	2.02E+04	2.33E+02	2.92E+02	3.24E+02	4.54E+02	4.59E+02	3.52E+02	5.19E-06	N/A	N/A	N/A	N/A
HCF													
Gross Alpha	1.73E+09	1.58E+04	6.00E+02	6.00E+02	6.00E+02	6.10E+02	6.00E+02	6.02E+02	3.48E-05	6.19E+02	3.58E-05	1.59E+03	9.18E-05
Gross Beta	6.79E+09	6.82E+04	1.05E+03	1.15E+03	1.04E+03	2.05E+03	8.43E+02	1.23E+03	1.81E-05	1.07E+03	1.58E-05	1.29E+04	1.91E-04
IFTF													
Gross Alpha	1.73E+09	1.48E+04	5.78E+02	5.78E+02	5.78E+02	5.78E+02	6.37E+02	5.90E+02	3.41E-05	5.78E+02	3.34E-05	5.78E+02	3.34E-05
Gross Beta	6.79E+09	3.76E+05	8.92E+02	1.04E+03	8.41E+02	1.84E+03	1.18E+03	1.16E+03	1.70E-05	1.08E+03	1.58E-05	2.22E+03	3.26E-05
Total Tritium (as %DRL)			3.78E-05	5.87E-05	1.52E-05	3.90E-05	1.52E-05	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
Total Alpha (as %DRL)			1.05E-04	1.04E-04	1.02E-04	1.03E-04	1.11E-04	1.82E+03	1.05E-04	1.61E+03	9.32E-05	3.46E+03	2.00E-04
Total Beta (as %DRL)			5.90E-05	6.23E-05	4.73E-05	9.21E-05	6.04E-05	4.41E+03	6.50E-05	4.49E+03	6.61E-05	2.25E+04	3.32E-04
Total (%DRL)			**2.02E-04**	**2.25E-04**	**1.64E-04**	**2.33E-04**	**1.87E-04**	**2.03E-04**		**1.91E-04**		**5.99E-04**	

a The DRL's shown are for members of the public at the WL boundary as described in reference [30].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A – Not applicable

9.4.1.3 Liquid Effluent Monitoring

9.4.1.3.1 Monitoring Points, Schedules and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the Outfall, the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the process water outflow (Outfall), which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways, around buildings through the weeping tile system, cooling water used in process and experimental facilities, and discharges from the Low Level Liquid Waste treatment systems tanks based in Building 100 and Building 300. The ALWTC was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 24.

Table 24: Radiological Liquid Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	Frequency	Method	Beta Screen	Gross Beta	Gross Alpha	Tritium	Gamma Spec (liquid)	Gamma Spec (ash)	Sr-90 (ash)	U-238 Pu-239/240 Pu-238	C-14
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wc	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, up to twice a year for the Lagoon.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2021 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2021 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers in 2018, which reduced the contribution from the washing of footwear. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is now directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4 L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 32 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (Am-241, Cs-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for Pu-239/240, Pu-238 and Pu-241 isotopic analyses. Monitoring for Carbon (C-14) and tritium in Outfall samples was initiated in 2020 because they are known to exist in WR-1, and decommissioning activities have a potential for releasing these isotopes. The activities of tritium and C-14 at the Outfall continued to be below the lower limits of detection.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. The minimum residence time for the lagoon is equal to the amount of time the secondary cell is isolated from the primary cell, to allow for biodegradation and settling. This is typically around 45 days. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail later). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon's north side. In 2021, the lagoon was not discharged at all because there was enough freeboard that a discharge was not necessary.

Whenever there is a discharge, the outflow of the Lagoon is continuously sampled during the discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium, and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at the Ditch 7 and Ditch 8 sampling locations, are also released to the Winnipeg River from the two ditches indicated in Figure 2. Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (395 mm) in 2021 was less than in 2020 (441 mm), and in 2019 (646 mm). The winter of 2021 was very dry. The spring precipitation was normal, but the early summer was unusually dry. Normal amounts of precipitation were observed for August, October and November. Due to the low

precipitation, ditches were only sampled six times during March, April, May and June. The August and October precipitation was captured by the dry ground and there was no moving water in the ditches to be sampled any time after June.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[7]. The samples are analyzed for gross alpha, gross beta, gamma spec and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are submitted for radio strontium analysis. Uranium activities are calculated from uranium concentrations obtained from total metals analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [30]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cs-137 for beta activity and Pu-239 and Pu-240 for alpha activity. With the introduction of total uranium (U) and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

9.4.1.3.2 Monitoring Results

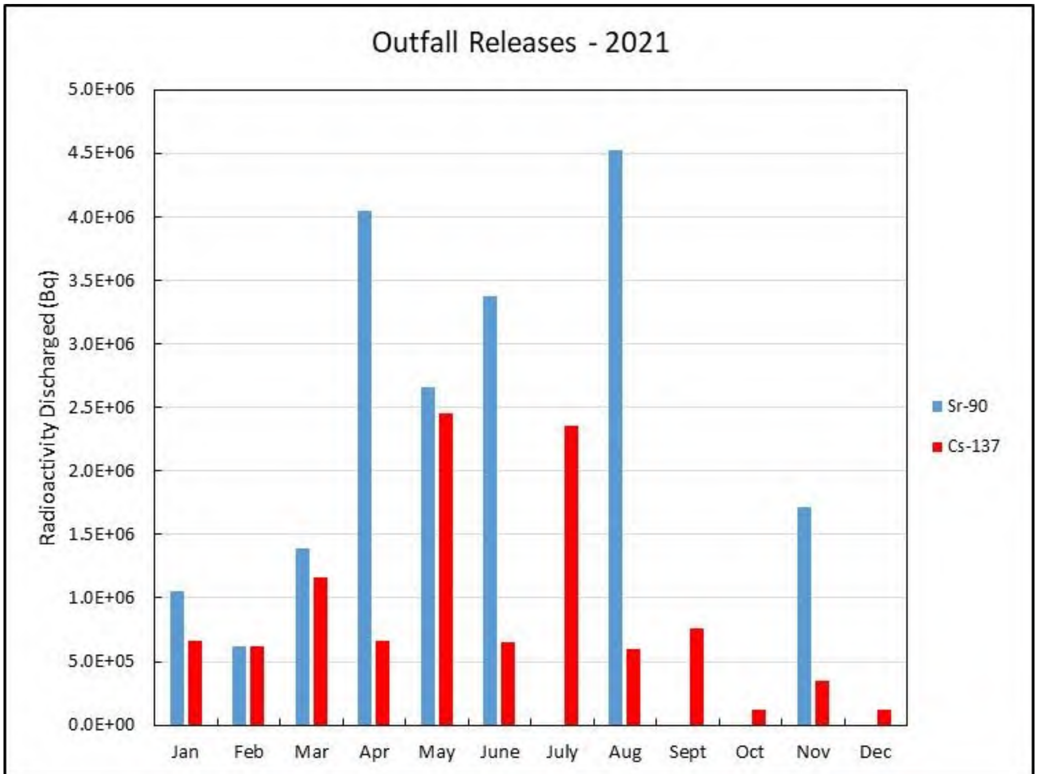
The liquid emission results are summarized in Table 26 and Figure 3 for the years 2016 to 2021. Average monthly emissions, in Becquerels, are shown for gross alpha, gross beta, total U (including U-234, U-235, and U-238), Am-241, Sr-90 and Cs-137 for the releases from the Outfall and the Lagoon. The monitoring of tritium from the Outfall began in 2019. In addition, quarterly activities of Pu-239/240 and Pu-238 were reported for Outfall effluents. A plot of the monthly Cs-137 and Sr 90 releases as Bq from the Outfall in 2021 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of Sr-90 and Cs-137 from the tanks in 2021 were 1.13E+06 Bq and 4.01E+06 Bq, respectively. These releases were only a fraction of the total Sr-90 (1.9E+07 Bq) and Cs-137 (1.0E+07 Bq) releases from the Outfall. There was little correlation between the patterns of releases from the tanks with the pattern of releases from the Outfall because the tank releases were only a small fraction of the total releases. The additional Sr-90 and Cs-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical

[7] The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

site contamination events and historical radioactivity disposition in the storm drain line from Building 200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970's, although more likely from the Building 200 drain line. The high Sr-90 and Cs-137 releases from the Outfall during April, May and August correlate with higher rainfall during these months. The periods of high precipitation are believed to flush contamination into the Outfall from storm drains and previously contaminated process piping.

Note, all monthly releases from the Outfall were well below the administrative release level[8]. Releases of gross alpha were less than the 2020 releases and the five year average. Gross beta releases in 2021 were also less than the 2020 releases and the five year average. Sr-90 releases in 2021 were lower than in 2020 and the five year average. The Cs-137 releases were less than the 2020 releases and the five year averages. Am-241 releases were similar to 2020 releases. The total uranium releases were slightly lower than in 2020. The relatively constant emissions of gross alpha, gross beta, Sr-90 and Cs-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Pu-239/240 and Pu-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.27). In 2021, Outfall water was also analyzed for the presence of C-14, which could be introduced by the discharge tanks from Building 100. C-14 was below detection levels (varying from 0.99 to 1.26 Bq/L) in Outfall samples. Given that the DRL for C-14 is 1.06E+08 Bq/month, the detection limit of 1.26 Bq/L would correspond to a %DRL value of 0.18. Measurements of C-14 in site intake water from Building 902 were also below detection values.

[8] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the ALARA process.



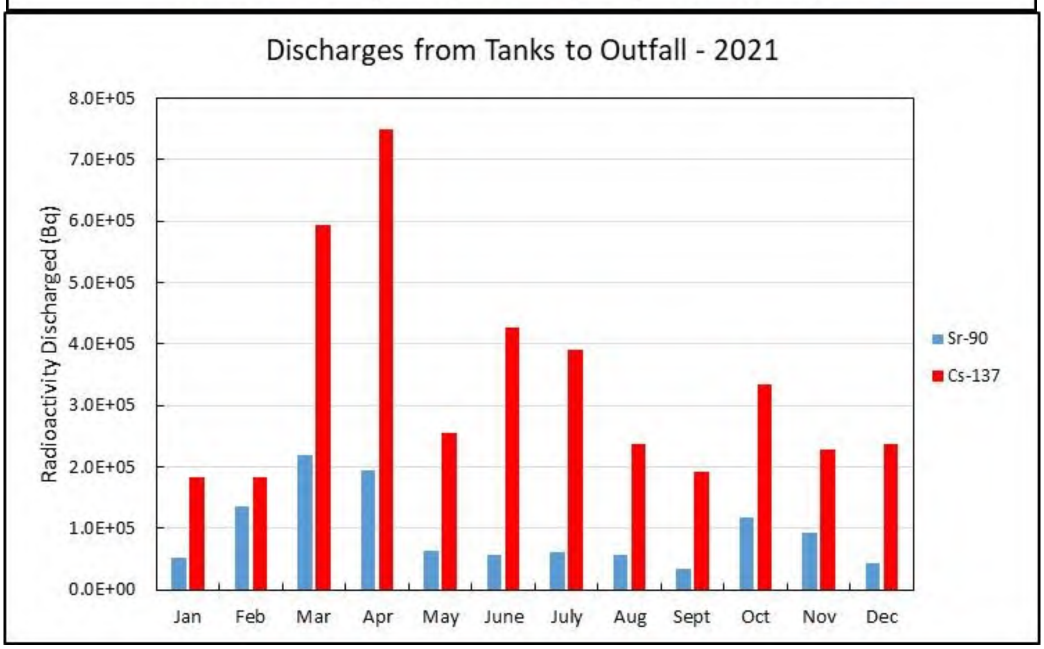


Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2021

As stated above there were no Lagoon discharges in 2021 and so there are no results to report. In 2021 the lagoons did not contribute to the total liquid discharges from the site.

The averaged results for the two drainage ditches and control sample are shown in Table 25. The reported errors are the standard deviations of parameter values indicating their variability between different sampling events.

Table 25: Annual mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2016 to 2021

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Five-Year Average**	**2021[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.12	0.14	0.52	0.19	0.12	0.22	0.13 ± 0.04
Gross Alpha	0.50	0.07	0.17	0.11	0.18	0.15	0.10	0.14	0.05 ± 0.02
Tritium	7 000	3	4.4	4.8	5.3	5.5	4.3	4.9	4.6 ± 0.5
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.09	0.13	0.32	0.20	0.11	0.17	0.24 ± 0.34
Gross Alpha	0.50	0.07	0.09	0.09	0.16	0.20	0.06	0.12	0.07 ± 0.03
Tritium	7 000	3.00	17.4	21.1	9	10	6.5	13	4.7 ± 0.4
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.10	0.15	0.14	0.19	0.11	0.14	0.17 ± 0.13
Gross Alpha	0.50	0.07	0.11	0.10	0.22	0.114	0.07	0.12	0.05 ± 0.01
Tritium	7 000	4	4.8	4.67	<4	<4	4.7	4.4	4.4 ± 0.4

a Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. LLD is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.
b LLD = Lower Limit of Detection.
c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2021, the gross beta activities in Ditches 8 and 9 were higher than in 2020. The 2021 gross alpha activities were lower in Ditch 8 and slightly higher in Ditch 9 compared to 2020. The average gross beta values were similar to the control sample collected off of Highway 211, given the variability in their values. The gross alpha values were similar to the control ditch. The control sample is unaffected by CNL's operations. Compliance with the *Guidelines for Canadian Drinking Water Quality* [34] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [35] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring

uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amount measured in drainage Ditch 8 (4.6±0.5 Bq/L) and Ditch 9 (4.7±0.4 Bq/L) were not significantly different from that noted at the control location (4.4±0.9 Bq/L). A number of ditches close to WMA are known to contain tritium. In 2021, the amount of tritium reaching the Ditch 8 and 9 locations was not significant. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [34].

Table 26 summarizes the data for releases of liquid effluents[9] for the years 2016 to 2021. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2021 was 0.45% of the DRL, which is lower than 2020 and the five-year average (0.51%). The main reason for the higher 2019, 2020 and 2021 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release from the Outfall in 2021 was Pu-239/240 at 0.29% of the DRL. There were no lagoon discharges in 2021.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

[9] The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [34] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 26: Radionuclides in Liquid Effluents from WL – 2016 to 2021

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2016 (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	2019 (Bq/mo)	2020 (Bq/mo)	Five-Year Average		2021		2021 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.43E+08	2.43E+06	2.20E+06	2.86E+06	4.23E+06	3.99E+06	3.14E+06	2.71E-01	2.33E+06	-	5.31E+06	-
Uranium-total	1.25E+10	N/A	N/A	1.24E+06	9.13E+05	1.05E+06	9.65E+05	N/A		9.28E+05	7.42E-03	1.26E+06	1.01E-02
Plutonium-239/240	1.11E+09	N/A	N/A	5.76E+05	1.89E+06	3.19E+06	2.32E+06	N/A		1.86E+06	1.67E-01	2.98E+06	2.68E-01
Plutonium-238	1.16E+09	N/A	N/A	7.24E+05	1.53E+06	4.05E+06	1.99E+06	N/A		1.86E+06	1.61E-01	2.54E+06	2.19E-01
Americium-241	1.04E+09	N/A	N/A	1.49E+05	1.07E+05	1.06E+06	9.76E+05	N/A		9.76E+05	9.38E-02	3.66E+06	3.52E-01
Gross Beta[b]	-	5.00E+08	1.43E+07	2.06E+07	1.36E+07	2.06E+07	1.98E+07	1.78E+07	-	1.26E+07	-	2.44E+07	-
Strontium-90	1.30E+10	N/A	2.50E+06	4.83E+06	2.39E+06	3.11E+06	2.41E+06	3.05E+06	2.35E-02	1.62E+06	1.24E-02	4.53E+06	3.48E-02
Cesium-137	1.16E+10	N/A	1.31E+06	1.51E+06	1.26E+06	1.14E+06	1.03E+06	1.25E+06	1.08E-02	8.63E+05	7.44E-03	2.45E+06	2.11E-02
Tritium	6.80E+13					3.76E+08	4.09E+08	N/A		3.48E+08	5.64E-04	7.05E+08	1.04E-03
LAGOON													
Gross Alpha[a]	1.11E+09	5.84E+07	7.22E+05	1.03E+06	3.92E+05	6.17E+05	1.57E+06	8.65E+05	7.46E-02	N/A		N/A	
Uranium-total	1.25E+10	N/A	N/A	1.66E+05	5.49E+04	1.92E+05	1.19E+05	NA		N/A		N/A	
Americium-241	1.04E+09	N/A	N/A	2.76E+05	2.44E+05	6.17E+05	5.22E+05	NA		N/A		N/A	
Pu-239/240[a]	1.11E+09	N/A	N/A	4.22E+05	4.52E+04	7.28E+05	9.67E+05	NA		N/A		N/A	
Gross Beta	-	1.50E+08	5.76E+06	4.14E+06	2.53E+06	8.00E+06	1.04E+07	6.17E+06	-	N/A		N/A	
Strontium-90	1.30E+10	N/A	1.16E+06	7.26E+05	2.82E+05	1.85E+06	2.35E+06	1.27E+06	9.79E-03	N/A		N/A	
Cesium-137	1.16E+10	N/A	5.05E+04	6.43E+04	2.44E+02	6.17E+05	5.22E+05	2.51E+05	2.16E-03	N/A		N/A	
TOTAL as %DRL	**-**	**-**	**3.24E-01**	**2.61E-01**	**3.79E-01**	**9.27E-01**	**6.71E-01**		**5.10E-01**		**4.49E-01**		**9.06E-01**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 and Cs-137 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 27: Effluents Monitoring Equipment Unavailability – 2021

	Unavailability Criteria[a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. In Building 100 there was one instance when the stack pump went down for a long weekend, resulting in 112.5 hours of unplanned loss of air monitoring. In the Shielded Facilities there were three instances of planned loss of monitoring because class III power was shut down for electrical equipment inspections. The total planned loss of monitoring, affecting the Hot Cells and IFTF was 6.5 hours. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities, this amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. There was one instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability was calculated as per procedure. In each instance, an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 23 and Table 26 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2016 to 2021. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2021 were below CNL’s Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [30]. All air emissions were below CNL’s Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2021 continue to be very low, averaging 0.00019% of the DRL, which is similar to 2020 and lower than in 2019.

Radioactivity in the WL liquid releases for 2021 was 0.45% of the DRL which is lower than in 2020 (0.67%) and the last five-year average (0.51%). The main reason for the higher 2019 to 2020 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Pu-239/240, at detection limit values, was the primary contributor to the Outfall, averaging 0.17% of the DRL. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2021 release results, as well as the previous years' trends, indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement on hazardous substances monitoring of liquid and airborne effluents for the WL site for 2021. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [28].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedule, and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Sewage Lagoon (referred to as the Lagoon) at point of discharge to the Lagoon drainage ditch, the Process Outfall (referred to as the Outfall), the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low-Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are used as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial Highway 211. More details for each monitoring area are provided in the sections that follow.

Referring to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 28 lists the non-radiological parameters monitored at the inlet and effluent streams sampled, and the sampling schedule that is followed. The WL monitoring program follows the

protocols from the Ontario Ministry of Environment [36] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups. These are described in Table 29, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment (SRI). The LMDL and SRI were decided following protocol. The WL monitoring program also meets the requirements set out in the Federal Wastewater Systems Effluent Regulations [37], and the standards from CSA N288.5-11, *Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [20].

Table 28: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS Tanks	
						Building 300-LLLWTS	Building 100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	Quarterly[c]	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
5b	Total Organic Carbon	Monthly	-	Discharge	-	-	-
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9a	Magnesium	Monthly	-	Discharge	-	-	-
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
-	Potassium	Monthly	-	Discharge	-	-	-
9	Strontium	Monthly	-	Discharge	-	-	-
9a	Uranium	Monthly	-	Discharge	-	-	-
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
16	Bromodichloromethane	Monthly	-	Discharge	-	-	-
16	Chloroform	Monthly	-	Discharge	-	-	-
17	Toluene	Monthly	-	Discharge	-	-	-
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.

b The Monthly = grab sample taken once within each month.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

In 2021, there was no discharging of the Lagoon.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were six events in 2021.

Whenever a tank was discharged at either of the Low Level Liquid Waste Treatment System's (LLLWTS), the effluent was sampled.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [36]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system supplies a justifiable set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into Analytical Test Groups, listed in Table 29. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses, and result reporting.

Table 29: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.001
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.050
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
5b	Total Organic Carbon	High Temperature Combustion	mg/L	-	-	-	0.5
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9a	Magnesium	ICP	mg/L	--	--	--	0.05
9	Nickel	ICP	mg/L	0.02	--	--	0.001
-	Potassium	ICP	mg/L	--	--	--	0.05
9	Strontium	ICP	mg/L	--	--	--	0.001
9a	Uranium	ICP	mg/L	--	--	--	0.0001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0019
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
16	Bromodichloromethane	GC-MS	mg/L	--	--	--	0.0005
16	Chloroform	GC-MS	mg/L	--	--	--	0.0005
17	Toluene	GC-MS	mg/L	--	--	--	0.0004
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.

b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a common estimate of bacterial counts, especially for sewage effluent.

c RMDL = Regulation Method Detection Limit

d The LMDL = Laboratory Method Detection Limit (“MDL” also used).

e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is found for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results because of equipment failure, maintenance/calibration outages or operator action requiring “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. There were no instances of non-radiological air monitoring unavailability. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities. This amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. One instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2021. These include an averages summary table and a comparison against the CNL’s Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2021 are presented in Table 30 through Table 34. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [36]. The next three give the CNL monthly guideline concentration, LMDL (Table 29) and units for each measurement. The next six columns provide comparison of the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven

columns have a summary of the results for the 2021 monitoring period (explained further below).

WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 29.

Within the 2021 results section, the number of samples included in the average ("# Spl.") is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled "ND's") gives the number of samples in which the analyte was not detected and was therefore deemed a "zero" result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables found at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number allows some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 31 through Table 34, yearly average values for parameters marked with an asterisk show that a monthly guideline was exceeded for at least one month during the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected in Table 36, and compared to the previous five years).

Table 30: Averages Summary for Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2021							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)
3	pH	6 to 9	N/A	pH	7.03	7.42	7.41	7.43	7.17	7.29	12	0	6.73	8.11	7.66	5.84	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	9.0	9.0	12	0	6.9	9.7	8.4	10.1	25000
6	Phosphorus	1.0	0.003	mg/L	0.040	0.026	0.020	0.017	0.014	0.023	12	0	0.010	0.019	0.014	21.4	46
7	Conductivity	N/A	2.0	µS/cm	104	93.0	107	107	98	102	12	0	97	110	101	4.26	N/A
8	TSS	25	1.0	mg/L	2.63	3.03	2.05	3.15	3.80	2.93	12	4	0	6.1	2.23	94.7	6205
9	Chromium	0.5	0.001	mg/L	0.0002	0	0.0001	0.0005	0.0006	0.0003	12	11	0	0.0062	0.0005	346	0.53
9	Copper	0.5	0.0005	mg/L	0.007	0.004	0.005	0.007	0.007	0.006	12	0	0.004	0.013	0.007	39.9	19
9a	Iron	1.0	0.01	mg/L	0.32	0.310	0.233	0.331	0.242	0.287	12	0	0.159	0.354	0.247	27.0	805
9	Lead	0.1	0.0002	mg/L	0.001	0.0002	0.0001	0.0001	0.0001	0.0003	12	5	0	0.0003	0.0001	89.2	0.65
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	3.62	3.62	12	0	3.34	4.13	3.70	47.7	11840
9	Nickel	0.5	0.001	mg/L	0.0008	0	0	0.0001	0.0002	0.0002	12	10	0	0.0272	0.0025	318	2.72
9	Potassium [f]	-	0.05	mg/L	-	-	-	-	0.823	0.823	12	0	0.735	0.859	0.810	5.27	2564
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	2.23	2.23	12	0	2.00	3.68	2.38	18.52	8190
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.023	0.023	12	0	0.022	0.025	0.024	3.81	75
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0000	0	12	8	0	0.0001	0.0000	148	0.10
9	Zinc	0.5	0.005	mg/L	0.0023	0	0	0	0.0022	0.0009	12	11	0	0.0072	0.0006	318	1.26
12	Mercury	1.0	0.002	µg/L	0.0016	0	0.0002	0	0.0016	0.0007	12	12	0	0	0	N/A	0
14	Phenolics	0.02	0.001	mg/L	0.0014	0.0017	0.0002	0.0007	0	0.0008	12	12	0	0	0	N/A	0
16	Bromodichloromethane [f]	-	0.0005	mg/L	-	-	-	-	0.0015	0.0015	12	3	0	0.0028	0.0017	68.79	4.33
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.068	0.068	12	0	0.001	0.120	0.053	75.71	139
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	12	12	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	0.4	0.1	0.1	0	0	0.1	12	12	0	0	0	N/A	0

					Monitoring Point: Site Intake														
					Averages from Previous Five Years[a]						Results for Year 2021								
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)		
--	Estimated Flow (total volume for year)			m^3	1.30E+06	1.21E+06	1.18E+06	1.01E+06	1.12E+06	1.16E+06	3.14E+06								

a Averages were calculated by setting to zero results reported as “< DL”.

b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A not applicable

Table 31: Averages Summary for Lagoon

					Monitoring Point: Lagoon												
					Averages from Previous Five Years						Results for Year 2021						
ATG	**Parameter**	**Monthly Guide[a]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[b]**	**NDs[c]**	**Min.**	**Max.**	**Vol. Wt. Avg.**	**RSTD[d] (%)**	**Load (kg)**
-	CBOD	25	2.0	mg/L	0	2.5	17.7	0	0	4.0	0	0	0	0	0	0	N/A
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.0099	0.0100	0.0097	0.0011	0.0010	0.0063	0	0	0	0	0	0	N/A
-	Total residual Chlorine	0.02	0.05	mg/L	0.035*	0.017	0.018	0.022	0.057	0.030	0	0	0	0	0	0	N/A
--	Total Coliform	N/A	3	MPNUe/100 mL	35	534	330	200	763	372	0	0	0	0	0	0	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	5	40	5	13.5	88	30	0	0	0	0	0	0	N/A
3	pH	6 to 9	N/A	pH	7.01	8.59	8.68	6.66	7.00	7.59	0	0	0	0	0	0	N/A
6	Phosphorus	1.0	0.003	mg/L	0.083	0.069	0.131	0.049	0.075	0.081	0	0	0	0	0	0	N/A
7	Conductivity	N/A	2.0	µS/cm	279	223	229	348	446	305	0	0	0	0	0	0	N/A
8	TSS	25	1.0	mg/L	1.92	4.807	3.8	1.2	3.9	3.1	0	0	0	0	0	0	N/A
9	Chromium	0.5	0.001	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0016	0.0021	0.0015	0.0007	0	0.0012	0	0	0	0	0	0	N/A
9a	Iron	1.0	0.01	mg/L	0.245	0.283	0.370	0.119	0.116	0.227	0	0	0	0	0	0	N/A
9	Lead	0.1	0.0002	mg/L	0	0.0001	0	0	0	0	0	0	0	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.0005	0.0015	0.0015	0.0011	0	0.0009	0	0	0	0	0	0	N/A
9	Zinc	0.5	0.005	mg/L	0.0003	0	0	0	0	0	0	0	0	0	0	0	N/A
12	Mercury	1.0	0.002	µg/L	0.0006	0	0	0	0	0.0001	0	0	0	0	0	0	N/A
4	Phenolics	0.02	0.001	mg/L	0.0015	0.0017	0.0033	0	0	0.0013	0	0	0	0	0	0	N/A
25	Oil & Grease	15	1.0	mg/L	0.45	0.78	0.856	0	0	0.4172	0	0	0	0	0	0	N/A
--	Estimated Flow (total volume for year)[f]			m^3	7.46E+04	4.72E+04	1.22E+04	3.83E+04	3.08E+04	4.06E+04	0						
--	Number of Batches Discharged			--	2	2	2	1	1	2	0						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

d RSTD = Relative Standard Deviation

e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.

f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: There were no discharges in 2021 of the Lagoon.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A = not applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 32: Averages Summary for Outfall

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	Parameter	Monthly Guide [b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.	RSTD[e] (%)	Load (kg)
3	pH	6 to 9	N/A	pH	7.50	7.81	7.76	7.67	7.50	7.65	52	0	6.79	8.30	7.66	4.67	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	13.4	13.4	51	0	7.4	21.0	10.2	31.5	12230
6	Phosphorus	1.0	0.003	mg/L	0.040	0.035	0.030	0.022	0.021	0.030	52	1	0	0.074	0.022	57.5	25.9
7	Conductivity	N/A	2.0	µS/cm	130	139	131	164	134	140	52	0	110	790	149	63.0	N/A
8	TSS	25	1.0	mg/L	2.35	2.97	1.5	4.2	5.4	3.3	52	3	0	18	5.3	74.6	6630
9	Chromium	0.5	0.001	mg/L	0.0001	0	0.0001	0.0006	0.0005	0.0003	52	43	0	0.0062	0.0003	307	0.035
9	Copper	0.5	0.0005	mg/L	0.006	0.006	0.005	0.005	0.010	0.006	52	0	0.002	0.016	0.007	67.6	8.44
9a	Iron	1.0	0.01	mg/L	0.316	0.262	0.186	0.218	0.302	0.257	52	0	0.107	1.300	0.271	65.7	322
9	Lead	0.1	0.0002	mg/L	0.0004	0.0003	0.0002	0.0002	0.0004	0.0003	52	17	0	0.0015	0.0003	102	0.303
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	5.46	5.46	52	0	3.82	8.05	5.18	16.4	6118
9	Nickel	0.5	0.001	mg/L	0.0009	0.0020	0.0006	0.0005	0.0007	0.0009	52	25	0	0.0273	0.0017	322	1.49
-	Potassium [f]	-	0.05	mg/L	-	-	-	-	1.111	1.11	52	0	0.85	2.25	1.10	25.7	1302
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	4.40	4.40	52	0	2.68	21.3	4.34	71.9	5086
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.033	0.033	52	0	0.026	0.044	0.034	10.5	39.3
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0004	0.0004	52	0	0.0002	0.0007	0.0004	27.0	0.461
9	Zinc	0.5	0.005	mg/L	0.003	0.001	0.001	0.004	0.006	0.003	52	15	0	0.026	0.006	84.3	7.88
12	Mercury	1.0	0.002	µg/L	0.001	0	0.0006	0.0009	0.0002	0.0005	52	47	0	0.0033	0.0003	314	0.0003
14	Phenolics	0.02	0.001	mg/L	0.0017	0.004	0.0001	0.0003	0.0000	0.0012	52	52	0	0	0	N/A	0
16	Bromodichloro methane [f]	-	0.0005	mg/L	-	-	-	-	0.0005	0.0005	52	52	0	0	0	N/A	0
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.0259	0.0259	52	9	0	0.019	0.0072	78.3	8.82
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	52	52	0	0	0	N/A	0

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
25	Oil & Grease	15	1.0	mg/L	0.82	0.19	0.10	0.02	0	0.226	52	50	0	6.80	0.15	627	188
--	Estimated Flow (total volume for year)			m^3	1.41E+06	1.13E+06	1.16E+06	1.25E+06	1.21E+06	1.23E+06	1.15E+06						

a All results below the LMDL, originally flagged as “< DL” when reported, are only estimates.

b Monthly Guide is from WL’s non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL,” result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A = Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Note: There were no monthly guideline exceeds for any monitored parameter.

Table 33: Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.50	7.88	7.81	7.73	7.64	7.71	5	0	7.5	8.00	7.81	2.39
6	Phosphorus	1.0	0.003	mg/L	0.049	0.071	0.045	0.043	0.135	0.069	5	0	0.031	0.059	0.041	27.2
7	Conductivity	N/A	2.0	µS/cm	571	445	690	586	451	549	5	0	330	700	454	33.4
8	TSS	25	1.0	mg/L	2.3	1.4	1.65	1.92	3.4	2.1	5	2	0	3.0	1.26	103
9	Chromium	0.5	0.001	mg/L	0.0004	0	0	0.0005	0.0002	0.0002	5	5	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.002	0.0015	0.0015	0.0013	0.0010	0.0015	5	0	0.0008	0.0019	0.0014	29.1
9a	Iron	1.0	0.01	mg/L	0.208	0.192	0.083	0.147	0.205	0.167	5	0	0.089	0.274	0.141	54.5
9	Lead	0.1	0.0002	mg/L	0.0002	0	0	0	0	0	5	5	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.005	0.004	0.003	0.003	0.003	0.004	5	0	0.002	0.004	0.003	25.8
9	Zinc	0.5	0.005	mg/L	0.004	0.002	0.001	0.001	0.001	0.002	5	1	0	0.006	0.004	58.4
12	Mercury	1.0	0.002	µg/L	0.0055	0	0.0020	0.0009	0.0014	0.0020	5	0	0.0029	0.0044	0.0037	18.0
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0070	0.0002	0.0006	0.0008	0.0022	5	4	0	0.0011	0.0002	223
25	Oil & Grease	15	1.0	mg/L	0.85	0.4	0.13	0.17	0.08	0.33	5	5	0	0	0	N/A

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					Monitoring Point: DITCH 9 (Westbound)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**#Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.05	7.67	7.69	7.58	7.32	7.46	6	0	7.23	8.08	7.57	22.0
6	Phosphorus	1.0	0.003	mg/L	0.053	0.045	0.042	0.004	0.039	0.037	6	1	0	0.440	0.097	174
7	Conductivity	N/A	2.0	µS/cm	193	214	538	400	224	314	6	0	200	600	300	50.3
8	TSS	25	1.0	mg/L	2.4	2.1	2.1	2.7	3.3	2.5	6	1	0	4.9	2.3	73.98
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0005	0.0004	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0008	0.0013	0.0021	0.0018	0.0018	0.0016	6	0	0.0014	0.0029	0.0019	29.8
9a	Iron	1.0	0.01	mg/L	0.575	0.326	0.315	0.250	0.558	0.405	6	0	0.251	0.710	0.382	44.1
9	Lead	0.1	0.0002	mg/L	0	0	0	0	0.0000	0.0000	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.003	0.003	0.004	0.003	6	0	0.002	0.006	0.003	95.8
9	Zinc	0.5	0.005	mg/L	0.006	0.002	0.004	0.003	0.006	0.004	6	0	0.004	0.061	0.015	153
12	Mercury	1.0	0.002	µg/L	0.0087	0	0.0021	0.0016	0.005	0.0035	6	0	0.0029	0.0410	0.0109	136
14	Phenolics	0.02	0.001	mg/L	0.0021	0.0086	0	0.0005	0.0002	0.0023	6	5	0	0.0011	0.0002	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0	0	0.1	0.24	6	5	0	1	0.2	245

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					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.22	7.76	7.83	7.72	7.54	7.61	6	0	7.27	8.07	7.76	4.02
6	Phosphorus	1.0	0.003	mg/L	0.148	0.083	0.065	0.104	0.071	0.094	6	0	0.03	0.14	0.06	65.8
7	Conductivity	N/A	2.0	µS/cm	347	380	939	579	385	526	6	0	280	550	415	26.0
8	TSS	25	1.0	mg/L	3.28	6.2	2.9	7.0	3.1	4.5	6	0	1.4	20	5.63	128
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0008	0.0001	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0005	0.0010	0.0015	0.0018	0.0009	0.0011	6	0	0.0009	0.0017	0.0013	21.3
9a	Iron	1.0	0.01	mg/L	0.714	0.594	0.674	0.762	0.464	0.642	6	0	0.357	0.769	0.509	37.9
9	Lead	0.1	0.0002	mg/L	0.0005	0.0002	0	0.0002	0.0000	0.0002	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.005	0.003	0.002	0.003	6	0	0.002	0.003	0.002	19.5
9	Zinc	0.5	0.005	mg/L	0.003	0	0.013	0.011	0.001	0.006	6	2	0	0.014	0.004	117
12	Mercury	1.0	0.002	µg/L	0.0127	0	0.0004	0.0007	0.0008	0.0029	6	0	0.0022	0.0040	0.0031	25.11
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0074	0.0001	0.0007	0.0006	0.0022	6	5	0	0.0022	0.0004	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0.3	0	0.01	0.28	6	6	0	0	0	N/A

a All results below the LMDL, originally flagged as “< DL” when reported, are only estimates.

b Averages were calculated by setting to zero results reported as “< W.”

c Monthly Guide is from CNL’s limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = “< W,” result = 0).

f RSTD = Relative Standard Deviation

N/A = not applicable

Table 34: Averages Summary for the Low-Level Liquid Waste Treatment Systems

					Monitoring Point: Building 100 & 300 LLLW Treatment Systems [a]												
					Averages from Previous Five Years[b]						Results for Year 2021						
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)	Load (kg)
3	pH	6 to 9	N/A	pH	7.50	7.52	7.39	7.54	7.69	7.53	33	0	2.58	8.01	7.55	12.5	N/A
6	Phosphorus	1.0	0.003	mg/L	0.145	0.370	0.327	0.554	0.503	0.380	33	0	0.011	2.00	0.810*	64.9	0.0719
7	Conductivity	N/A	2.0	µS/cm	326	267	348.84	352	473	353	33	0	240	1800	527	57.4	N/A
8	TSS	25	1.0	mg/L	4.38	14.67*	16.28*	8.25	15.0*	11.7	33	0	1.50	24.0	10.2	65.7	0.8968
9	Chromium	0.5	0.001	mg/L	0.0016	0.0007	0.0006	0.0009	0.0011	0.0010	33	25	0	0.0250	0.0021	255	0.0001
9	Copper	0.5	0.0005	mg/L	0.128	0.509*	0.516*	0.512	0.423*	0.418	33	0	0.011	1.660	0.333*	102	0.0296
9a	Iron	1.0	0.01	mg/L	9.37*	3.39*	1.660*	0.465	1.77*	3.33	33	0	0.42	6.05	1.57*	81.7	0.1379
9	Lead	0.1	0.0002	mg/L	0.006	0.014	0.0112	0.0057	0.0047	0.0083	33	0	0.0008	0.2020	0.0143	253	0.0013
9	Nickel	0.5	0.001	mg/L	0.0180	0.0066	0.0055	0.003	0.0040	0.0074	33	0	0.0037	0.0420	0.0117	85.1	0.0010
9	Zinc	0.5	0.005	mg/L	0.096	0.180	0.272	0.152	0.124	0.165	33	0	0.027	1.210	0.175*	151	0.0156
12	Mercury	1.0	0.002	µg/L	0.161	0.130	0.060	0.030	0.010	0.078	33	1	0	0.071	0.023	88.3	0.0000
14	Phenolics	0.02	0.001	mg/L	0.007	0.007	0.01*	0.005	0.005	0.007	33	7	0	0.010	0.004	82.8	0.0003
25	Oil & Grease	15	1.0	mg/L	0.60	0.73	0.88	0.59	0.70	0.70	33	30	0	2.50	0.18	326	0.0164
--	Estimated Flow (total volume for year)			m³	2.30E+02	1.72E+02	1.32E+02	1.89E+02	1.07E+02	1.66E+02	8.82E+01						
--	Number of batches discharged			--	14	24	50	68	40	39	33						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< DL."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).
f RSTD = Relative Standard Deviation
N/A = not applicable
Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

Discharges of effluent coming from the new low level liquid waste treatment systems are being combined, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. They are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 35 supplies a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2021 or at any time during the previous five years.

As with the average summary table provided, for each monitoring point, the first two columns in the table identify the Ministry of Environment ATG and parameter names. The next three columns give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns show the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

To assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 35: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2021		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	100	83	100	96.6	12	4	67
	8	TSS	25	1.0	mg/L	100	78	92	100	92	92.4	12	0	100
	9	Copper	0.5	0.0005	mg/L	100	67	33	42	58	60.0	12	2	83
	9a	Iron	1.0	0.010	mg/L	67	44	50	83	42	57.2	12	8	33
	9	Zinc	0.5	0.005	mg/L	100	100	100	100	100	100	12	1	92
	14	Phenolics	0.02	0.0010	mg/L	100	100	92	100	100	98.4	12	0	100

Notes:

- Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table.
- Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that parameter at the monitoring point. This year there were 9 months when one of four parameters (Iron, Copper, Phosphorous and Zinc from the LLLWTS had monthly values higher than CNL monthly guidelines. Figure 5 shows the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, Figure 8 and Figure 9 for each parameter, and the explanations for the observed high values can be found in Section 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is shown by a broken red line in the corresponding figures.

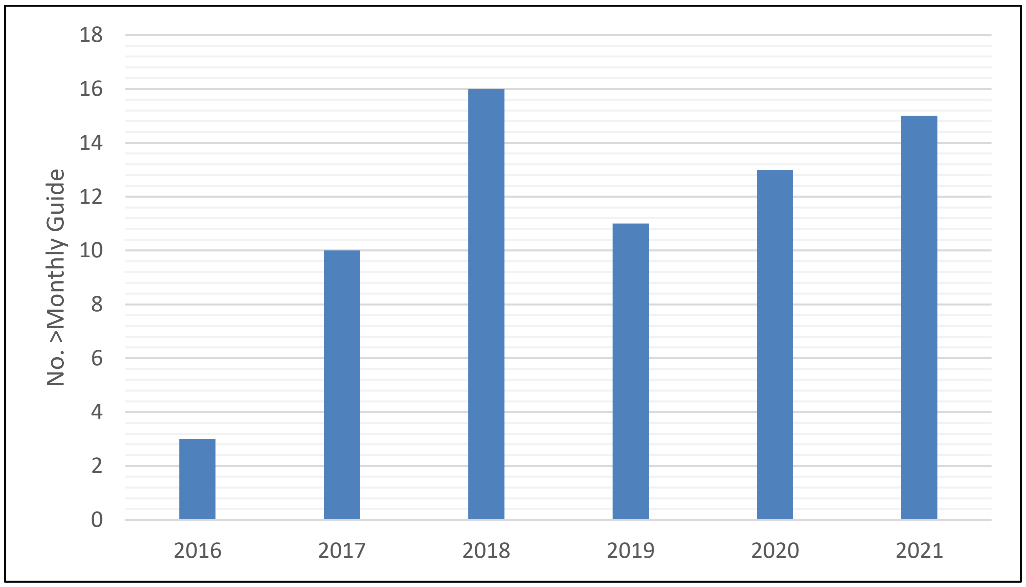

Figure 5: Non-Radiological Monitored Effluent Parameters Above Monthly Guidelines

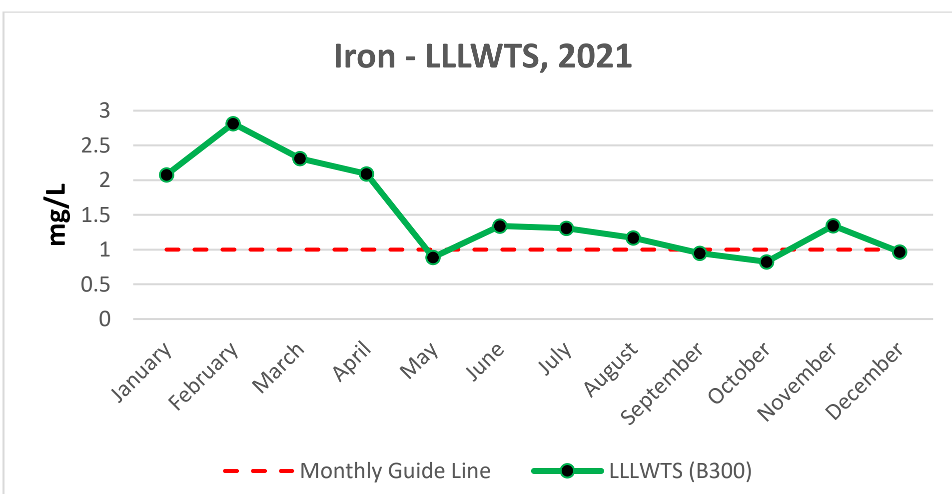

Figure 6: Monthly Average Iron Concentrations of Effluents from the Low-Level Liquid Waste

Treatment System for 2021

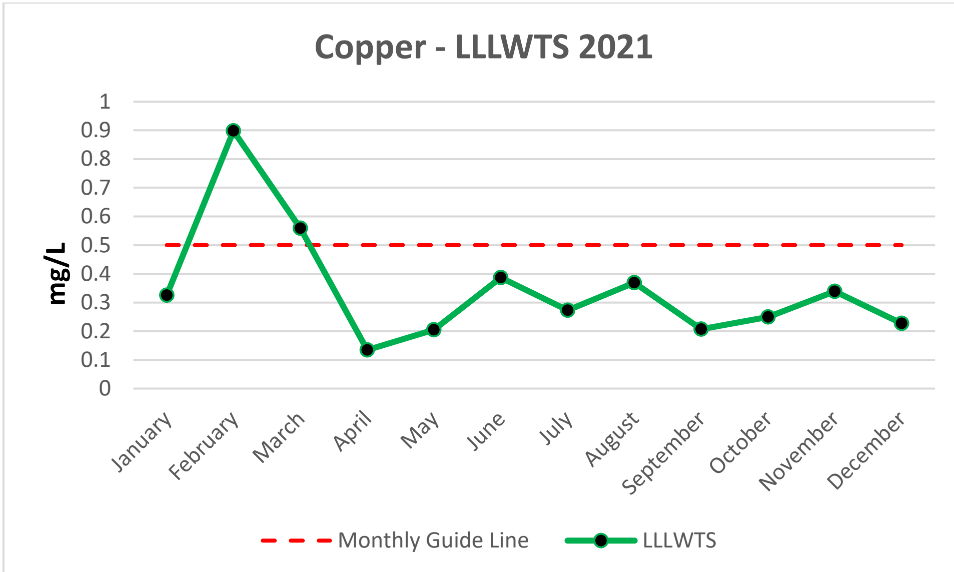

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

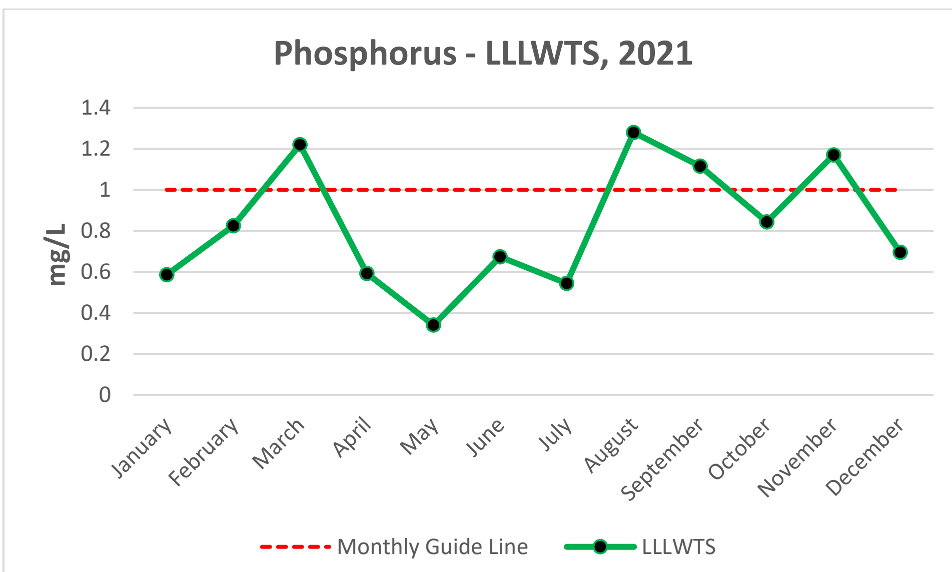

Figure 8: Monthly Average Phosphorus Concentration of Effluents from the Low-Level Liquid Waste Treatment Systems for 2021

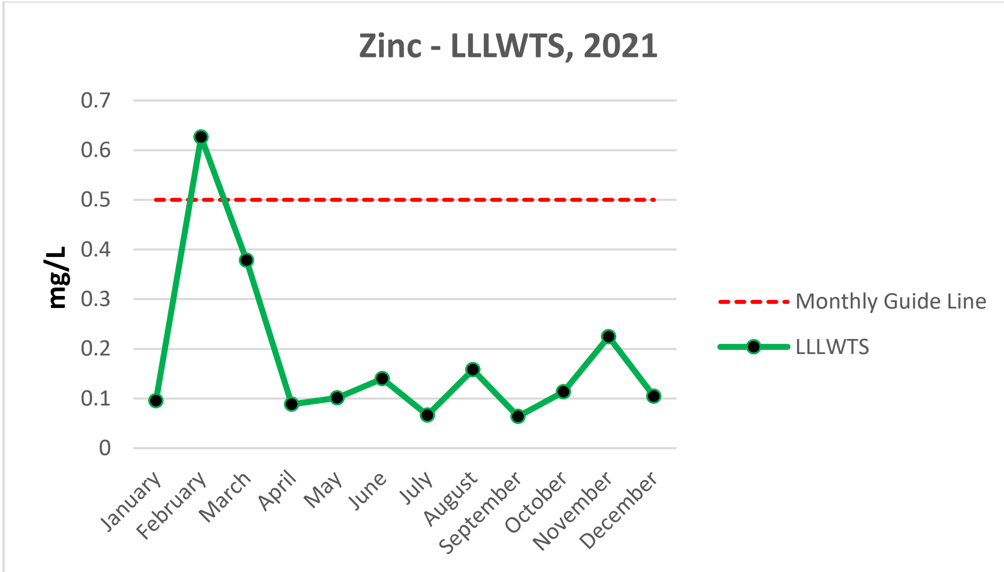

Figure 9: Monthly Average Zinc Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

9.5.1.4.4 Monitoring of Intake Water from the Winnipeg River

Except for bottled drinking water, all the water needed to run the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 30, where they are compared to available data for the previous five years. Figure 10 shows the estimated amount of water used monthly for 2021.

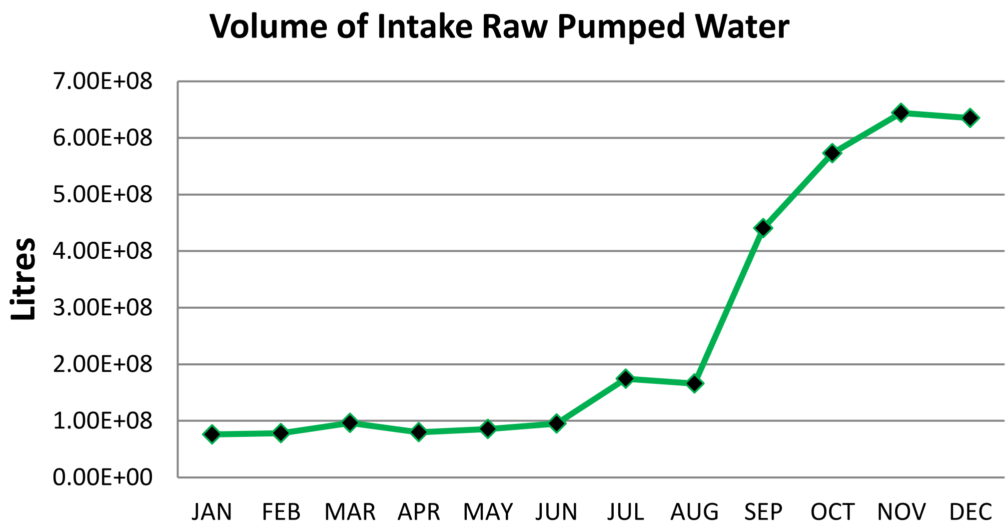

Figure 10: Monthly 2021 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2021 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 3.14E+06 m^3 of water was pumped from the river over the year.
- Compared to the five-year average, increased concentrations (> 10%) were seen for Chromium, Copper, Nickel, and Bromodichloromethane.
- Parameters that had their concentrations improve (> 10% decrease) this year compared to the average seen for the last five years are Phosphorus, TSS, Iron, Lead, Mercury, Phenolics, chloroform, and Oil & Grease.
- Water consumption for the site drastically increases during misting operations that are employed during building demolition. As these operation progress into sub-zero temperatures, a further increase is also observed, as a high flow of water is utilized to ensure the water lines do not freeze.

Intake water results can have a significant impact on the environmental performance of the WL site and they will continue to be monitored closely.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell was not discharged during 2021. With reduced personnel on site due to the COVID-19 pandemic, the occupancy of Building 540 (modular office complex) which

has its bio-waste diverted offsite, and the low level of precipitation observed in 2021, the lagoon had enough freeboard to allow the site to operate into 2022 without discharging.

The total amount of effluent discharged from the Lagoon in 2021 was 0 m^3.

If the lagoon was discharged, the Lagoon would be tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the cell occurs. During discharge, grab-samples would be collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters would be collected on a weekly basis during the discharge.

The vertical scale from which surface height is found was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

Volume (in L) = Height x [Width_Bottom x Length_Bottom
+ 0.5(Width-Width_Bottom) Length_Bottom
+ 0.5(Length-Length_Bottom) Width_Bottom
+ (1/3) (Width-Width_Bottom) (Length-Length_Bottom)]

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

Volume (in L) = 636 655*d + 206.886*d^2 + 0.02133*d^3 for depth “d” (in cm)

The position of the Lagoon’s water surface would be recorded once or twice daily while emptying. The daily flow would then be calculated from changes in the contained volume. This permits the calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in deciding meaningful average concentrations.

Discharging of the secondary cell is only allowed to proceed after initial testing. Once discharging begins, the pH is checked daily throughout the discharge period.

Table 31 summarizes the results of the fall discharge. Some notable points are:

- There was no effluent discharged from the lagoon in 2021.

9.5.1.4.5.2 Process Outfall

The Outfall monitoring station functioned as expected during 2021. The total discharge volume was 1.15 GL. This volume is lower than the previous five-year average of 1.23 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 52 samples of each parameter for the year.

Table 32 summarizes the results obtained, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were no instances of CNL's monthly guidelines being exceeded at the Outfall monitoring station.
- The only parameters that had a significant increase (> 10%) compared to the 5-year average were TSS, Copper, Nickel, and Zinc. The increased TSS loads are a reflection of the demolition activities occurring on site, while sediment controls are put in place to mitigate the impact, an increased load of sediments are entering the storm drain system. The increase in nickel and copper concentrations being observed are related to the elevated levels being observed at the intake this year. Zinc is being detected close to the detection limit, a slight increase seen in the concentrations is having a significant percentage increase being measured in the Outfall, especially since the 5-year average concentration is below the method detection limit.
- Compared to the five-year average, Phosphorus, bromodichlormethane, chloroform, Phenolics, and Oil and Grease concentration levels significantly decreased (>10%).
- Quarterly Acute Lethality Testing on the Outfall effluent was not successful in 2021, as CNL missed collecting samples for the second and third quarter of the calendar year. A corrective action plan has been developed to prevent reoccurrence.
- Acute Lethality Testing for the outfall effluent in first and fourth quarter showed no mortality on the rainbow trout tested.

Overall, there were no concerns about the effluent discharged from Outfall during 2021.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were six events from 2021 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the

flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparison is made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines this year. The measurement data are summarized in Table 33. The following are notable points for the 2021 ditches results:

- There were only six sampling events for the ditches. The sample events were also predominately influenced by the spring melt as four of the six events were related to water flows experienced during this period, in other years rain fall events made up the majority of the sampling events.
- Zinc and Mercury were the parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 8. The parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 9 were Phosphorus, Copper, Zinc, and Mercury. The control ditch had TSS and Copper being observed at significantly higher concentrations (>10%) than the previous five-year average.
- Metal concentrations detected are very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase being observed in Ditch 8 and Ditch 9.
- The five year average for phosphorus in ditch #9 was higher this year due to the reduced sampling. It is not uncommon for the spring melt to observe elevated phosphorus concentrations due to the decaying vegetation from the fall, but the phosphorus concentrations throughout the summer during rainfall events are typically lower and would drive the average down.
- All concentrations remain well below the CNL's monthly guideline limit and pose no concern.
- All parameters measured in Ditch 8 and Ditch 9 are comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.

It should be noted that sediment control measures were put in place for projects in the WMA in 2021, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria do not include all parameters listed in CNL's non radiological guideline limit values; however, the post-discharge analysis includes all these parameters. CNL staff have

determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the earlier system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging requires a day or less to complete, and can be more gradual if needed.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to measure pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the Research and Development (R&D) Complex in Building 300 and Building 100 should still be similar enough that a comparison is worthwhile.

In 2021, 0.09 ML was discharged from the LLLWTS.

The weighted averages of the joint releases from the LLLWTS are presented in Table 34 and monthly plots for the parameters that exceed the monthly guidelines are in Figure 6, Figure 7, Figure 8, and Figure 9.

The following are notable results for 2021:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being observed at the Outfall monitoring location downstream in the process.
- There were increases (> 10%) in the annual average concentrations of Phosphorus, Chromium, Lead, Nickel, and Oil and Grease, compared to the previous five-year average results.
- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines eight times (January, February, March, April, June, July, August, and November). The overall Iron concentration seen for the year is lower than the previous 5-years. The introduction of the environmental laboratories in Building 300 at the end of 2019 increased the amount of Iron being introduced into the system (through the lab processing soil samples), as a number of the drain lines in the environmental laboratories are being directed to the LLLWTS in the facility. The majority of the effluent being generated by the environmental laboratories does not require the treatment

operations offered by this system, but it is possible it is affecting the effluent stream non-radiological characteristics.

- Early in 2021 (January-March), it was identified that the environmental laboratories and sample management office practises were having a negative impact on the effluent, as acid wash water and the clean out of expired acid-preserved sampling bottles was not properly being neutralized prior to disposal down the drainage system. In Figure 6, the drop in iron concentrations in the LLLWTS effluent can be observed when cleaning practises were improved. The improper disposal of the acidified wash water is being identified as the major cause of the increased metal concentrations being observed in the first four months of the calendar year.
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines two times in 2021 (February and March). Frequent exceedances are being seen in relation to the new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon as the new tanks were commissioned and used, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration seen at the Outfall is still well below the monthly guideline limits.
- The Zinc concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in February.
- The phosphorus concentration in the Building 300 effluent has effectively doubled, and exceeded the CNL monthly guideline limit four times throughout the calendar year (March, August, September, and November). As this trend did not exceed a monthly administrative level it was not identified until all the data was compiled for the year, and the cause of this increase is currently unknown. The plot of the monthly concentrations for phosphorous appears to be correlated with the increased cleaning frequency (due to muddy work boots) that would be associated with the spring and the fall periods. CNL will begin with reviewing the current selection of cleaning products being utilized in Building 300.

9.5.1.5 Loading Calculations

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 36 shows the results from the calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- The Lagoon did not contribute to the observed loads in 2021 as it was not discharged.
- TSS, Nickel and Zinc are the parameters that had a load increase greater than 10% when compared to the five-year average.
- Unlike 2020, this increase in overall load for TSS is not tied to a similar increase being observed at the intake and is directly tied to demolition work occurring on site for 2021.
- The increase in the Nickel load is related to the increase in Nickel concentrations being observed in the Intake water being utilized by the site.
- The increase in Zinc is being attributed to the results at the Outfall over the years being detected very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase.
- Phosphorus, Chromium, Mercury, Lead, and Oil and Grease had a significant decrease of 10% or more in their loads when compared to the 5-year average.

Table 36: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	0	132	216	0	0	69.6	0	0	0
		Site Total	**0**	**132**	**216**	**0**	**0**	**69.6**	**0**	**0**	**0**
-	Un-ionized Ammonia	Lagoon	0.74	0.46	0.118	0.042	0.043	0.281	0	0	0
		Site Total	**0.74**	**0.46**	**0.118**	**0.042**	**0.043**	**0.281**	**0**	**0**	**0**
-	Total residual Chlorine	Lagoon	2.6	0.808	0.220	0.831	1.743	1.24	0	0	0
		Site Total	**2.6**	**0.808**	**0.220**	**0.831**	**1.743**	**1.24**	**0**	**0**	**0**
5b	Total Organic Carbon	Outfall	-	-	-	-	16814	16814	51	0	12230
		Site Total	-	-	-	-	**16814**	16814	**51**	**0**	**12230**
6	Phosphorus	Lagoon	6.2	3.29	1.59	1.90	2.30	3.06	0	0	0
		Outfall	55.4	38.0	42.6	27.7	25.2	37.8	52	1	25.9
		Site Total	**61.6**	**41.3**	**44.2**	**28.6**	**27.5**	**40.6**	**52**	**1**	**25.9**
8	TSS	Lagoon	143	227	46.4	44.7	120	116	0	0	0
		Outfall	3504	3142	2031	5764	6657	4220	52	3	6630
		Site Total	**3647**	**3369**	**2077**	**5809**	**6777**	**4336**	**52**	**3**	**6630**
9	Chromium	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.35	0	0.06	0.818	0.651	0.376	52	43	0.035
		Site Total	**0.35**	**0**	**0.06**	**0.818**	**0.651**	**0.376**	**52**	**43**	**0.035**
9	Copper	Lagoon	0.12	0.10	0.018	0.027	0	0.053	0	0	0
		Outfall	9.5	6.61	7.63	7.03	13.5	8.85	52	0	8.44
		Site Total	**9.6**	**6.71**	**7.65**	**7.06**	**13.5**	**8.90**	**52**	**0**	**8.44**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9a	Iron	Lagoon	18.3	13.34	4.52	4.56	3.57	8.86	0	0	0
		Outfall	417	291.1	258	296	381	329	52	0	322
		Site Total	**435**	**304**	**263**	**301**	**385**	**338**	**52**	**0**	**322**
9	Lead	Lagoon	0	0.003	0	0	0	0	0	0	0
		Outfall	0.55	0.312	0.23	0.220	0.481	0.359	52	17	0.303
		Site Total	**0.55**	**0.32**	**0.23**	**0.220**	**0.481**	**0.360**	**52**	**17**	**0.303**
9	Nickel	Lagoon	0.035	0.069	0.019	0.042	0	0.033	0	0	0
		Outfall	1.4	1.349	0.836	0.742	0.972	1.06	52	25	1.49
		Site Total	**1.4**	**1.42**	**0.855**	**0.784**	**0.972**	**1.09**	**52**	**25**	**1.49**
9	Potassium	Outfall	-	-	-	-	1348	1348	52	0	1302
		Site Total	-	-	-	-	**1348**	1348	**52**	**0**	**1302**
9	Sodium	Outfall	-	-	-	-	5223	5223	52	0	5086
		Site Total	-	-	-	-	**5223**	5223	**52**	**0**	**5086**
9	Strontium	Outfall	-	-	-	-	39.9	39.9	52	0	39.3
		Site Total	-	-	-	-	**39.9**	39.9	**52**	**0**	**39.3**
9a	Uranium	Outfall	-	-	-	-	0.485	0.485	52	0	0.461
		Site Total	-	-	-	-	**0.485**	0.485	**52**	**0**	**0.461**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0.024	0	0	0	0	0.005	0	0	0
		Outfall	6.3	1.167	1.77	6.13	0.306	3.13	52	15	7.88
		Site Total	**6.4**	**1.17**	**1.77**	**6.13**	**0.306**	**3.15**	**52**	**15**	**7.88**
12	Mercury	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.005	0	0.001	0.001	0.0003	0.0015	52	47	0.0003
		Site Total	**0.005**	**0**	**0.001**	**0.001**	**0.0003**	**0.0015**	**52**	**47**	**0.0003**
14	Phenolics	Lagoon	0.13	0.155	0	0	0	0.057	0	0	0
		Outfall	2.1	4.024	0.0001	0.0003	0	1.22	52	52	0
		Site Total	**2.2**	**4.18**	**0.0001**	**0.0003**	**0**	**1.28**	**52**	**52**	**0**
16	Bromodichloro methane	Outfall	-	-	-	-	0.547	0.547	52	52	0
		Site Total	-	-	-	-	**0.547**	0.547	**52**	**52**	**0**
16	Chloroform	Outfall	-	-	-	-	31.4	31.4	52	9	8.82
		Site Total	-	-	-	-	**31.4**	31.4	**52**	**9**	**8.82**
17	Toluene	Outfall	-	-	-	-	0	0	52	52	0
		Site Total	**-**	**-**	**-**	**-**	**0**	**0**	**52**	**52**	**0**
25	Oil & Grease	Lagoon	59	40.40	0	0	0	19.9	0	0	0
		Outfall	1147	163.5	124	19.1	0	291	52	50	188
		Site Total	**1206**	**204**	**124**	**19.1**	**0**	**311**	**52**	**50**	**188**

a Averages were calculated by setting to zero results reported as "< DL."
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

9.5.2 Airborne Effluent Monitoring

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen for cleaner burning propane used on site. Table 37 presents WL heating fuel consumption from 2016 to 2021. Fuel consumption continues to trend downward (see Section 9.7.2 and Figure 11).

Table 37: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2021
Parameter	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	361,110	287,982	209,158	243,268	190,372	258,378	160,159
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	9.815	7.827	5.685	6.612	5.1743	7.0227	4.3531
Total	**TJ**	**9.815**	7.827	**5.685**	**6.612**	**5.1743**	**7.0227**	**4.3531**
Heating Demand								
Heating Degree Days	HDD	5573	5403	5855	6079	5615	5705	5233

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.

b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

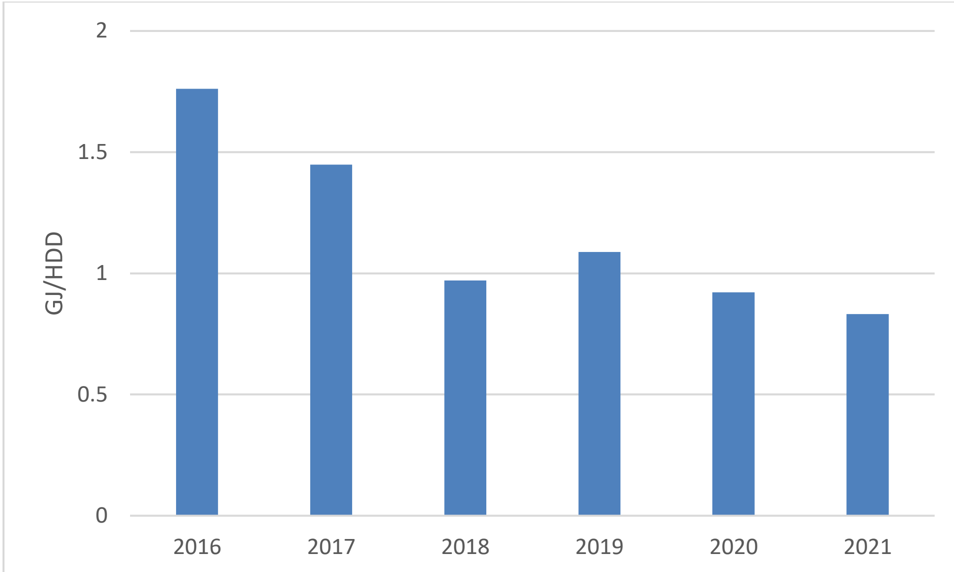

Figure 11: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [39]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2021 will be captured in the *2021 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories* [28].

Table 38 outlines the annual CACs generated from site activities, and shows a small decrease in emissions seen in 2021 compared to the 5-year average for the values for total particulate matter, PM_{10}, and $PM_{2.5}$. The PM_{10} value met the NPRI reporting threshold this year, and is reported to Environment and Climate Change Canada. Road dust emissions were the major contributor to meeting these reporting thresholds.

Table 38: Stationary Combustion Data and Emissions from WL

Parameter	Unit	Data for Previous Five Years						Data for 2021	NPRI Reporting Threshold
		2016	2017	2018	2019	2020	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	0.908	0.753	0.536	0.621	0.602	0.684	0.331	20
SO_2	Mg	0.023	0.020	0.014	0.016	0.017	0.018	0.005	20
CO	Mg	0.399	0.348	0.233	0.271	0.256	0.301	0.162	20
TPM	Mg	15.022	13.651	14.562	10.574	8.883	12.538	8.174	20
PM_{10}	Mg	3.853	3.499	3.726	2.712	2.281	3.214	2.091	0.5
$PM_{2.5}$	Mg	0.415	0.376	0.391	0.292	0.249	0.345	0.218	0.3
Volatile Organic Compounds	Mg	0.071	0.059	0.042	0.049	0.048	0.0538	0.026	10

9.5.2.3 Greenhouse Gas Emissions

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38] WL must calculate releases under the GHGs emissions notice [40] providing the facility emits over 10,000 tonnes of carbon dioxide equivalent or more within the calendar-year.

Greenhouse Gas emissions from WL include carbon dioxide, methane, and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill, and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

Table 39 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have decreased significantly from 2020. This decrease can be attributed to the decrease in propane needed to heat the site in 2021 as shown in Table 37. There was a decrease in the number of heating degree days (i.e., decreased demand for building heat based on temperature) in 2021, this combined with the fact Building 200 did not require any building heating during the calendar year, and Buildings 402 and 305 no longer had to be heated starting in the fall of 2021 due to demolition activities. Overall, greenhouse gases in 2021 are 29% less than the average for the last 5 years.

Table 39: Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2021 Releases
	2016	2017	2018	2019	2020	5-yr. Avg.	
GHG CO_2e tonnes	1883	1873	1678	1756	1692	1776	1177

Note: GHG CO2e tonnes - A unit of measure used to compare between gases that have different GWP. For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, following the Federal Halocarbon Regulations [41]. All releases greater than 10 kg are considered reportable.

As seen in Table 40, there were two reportable releases of halocarbons in 2021. Both releases were related to the Building 100 chiller system. The first release occurred in 2021 April. During maintenance activities it was discovered that 15.5 kgs of R-134a refrigerant escaped from the chiller system through a leak of one of the shut off values on the equipment. Upon replacement of the shut off valve it was observed that the threads of the valve were compromised. The second leak occurred in 2021 October. During maintenance activities to take the equipment offline for the season, it was discovered that 16.3 kgs of R-134a refrigerant escaped from the chiller system through a faulty solenoid valve.

Table 40: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2021	
Type	**Global Warming Potential[b]**	**Ozone Depleting Potential[c]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Number of Losses**	**Annual Loss (kg)**
Refrigerants[a]									
CFC (R-11)	4 600	1	0	0	0	0	0	0	0
CFC (R-12)	10 600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1 700	0	0	0	0	0	0	0	0
HFC (R-134a)	1 300	0	0	12.47	0	0	0	2	31.8
Fire Suppressants									
Halon (R-1301)	6 900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b GWP per unit mass, compared to CO2 = 1.00
c Ozone Depleting Potential per unit mass, compared to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [41]

9.5.3 Overall Performance

The non-radiological effluent monitoring program set up by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were no discharges from the Outfall and Lagoon which exceeded the current monthly guideline limits placed on CNL in 2021.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances or reportable events in 2021.

9.7 Discussion of Improvement Initiatives

The following sections describe some of the ongoing efforts the WL site is undertaking to enhance the effluent verification monitoring program.

9.7.1 Monitoring Site Intake Water and Outfall Effluent

In 2020, the WL site expanded the monitoring program to encompass additional parameters at the site's Intake and Outfall monitoring station. This expansion resulted from the enhanced monitoring that was performed on the Intake and the Outfall in 2019 to address the gaps in baseline data when assessed against the monitoring criteria in Table 19-1 of the *WL Effluent Verification Monitoring Plan* [25]. It was decided that when there was a 20% change in concentration when comparing the results for a given parameter at the Intake and Outfall, that these parameters would be incorporated in the effluent verification monitoring program.

Under this criteria, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene have been added to the list of parameters being measured at these stations. Currently, CNL can show that the source of the Potassium and Sodium being introduced to the Outfall is a result of the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products resulting from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL is planning to do temporary upstream process monitoring (monitoring at LLLWTS in Buildings 100 and 300) to try to be able to explain the operational source of the increase.

In order to be compliant with REGDOC-2.9.1 [42] it was determined that the effluent verification monitoring program needed to include acute lethality testing at the Outfall monitoring station.

Although the need to monitor for these parameters is currently captured in *WL Effluent Verification Monitoring Plan* [25], WL laboratories acknowledges that the plan needs to be updated to reflect that these parameters are actively being monitored, and plans to revise Reference [25] in 2022.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, to heat the site buildings. Starting in 2013, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 11 shows the annual fossil energy consumption since 2016, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 11, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply. Beginning in 2020 October, Building 200 no longer had to be heated as demolition activities on the building began at this time. In 2021 September, Buildings 305 and 402 no longer required to be heated as demolition activities began on these buildings.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28] (to be issued to the CNSC by 2022 June 30).

10 Emergency Management and Fire Protection

10.1 Emergency Preparedness Program

Whiteshell Laboratories adheres to the Corporate Emergency Preparedness Functional Support Area. See Section 10.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL program continues to adapt to the changes on site, including the demolition of buildings/assets, the construction of temporary structures, the number and composition of staffing levels, and the organisational structure. Vacated buildings are transitioned from building emergency procedures to construction/demolition oriented emergency placards.

Planning for and responding to COVID-19 continued as a primary focus for the Emergency Preparedness Functional Support Area at WL in 2021, providing procedures and guidance to enable work to continue safely in this dynamic situation. This was safely managed, without an outbreak at WL, despite the pandemic impact on Manitoba.

10.1.1 Drills and Exercises

The ongoing COVID-19 Pandemic continues to make running in-person emergency scenarios a challenge, especially with our external partners. For 2021, drill and exercise development focused on scenarios that allow for adequate physical spacing and still yield quality learning and evaluation potential.

In 2021, a total of 143 exercises and drills were delivered at WL. This is a significant step up from the 94 drills/exercises delivered in 2020. While not quite back to pre-pandemic levels, this increase signifies an adjustment in the program to the new normal of the current environment. Table 41 provides details on the number and type of the exercises and drills conducted in 2021.

Table 41: WL Emergency Preparedness Exercises – 2021

Type of Drill or Exercise	Number Completed in 2021
Fire Drills	2
Site-wide Specialty Drills	106
Table Top Exercises [a]	5
Targeted Communication Exercise	17
Site-wide Communication Exercise	12
Field Exercises (Functional)	1

a Table Tops include specific EOC Skill workshops as well. Each workshop focuses on a unique aspect of the EOC and includes a small practice scenario.

10.1.2 Training

There was no change to the Emergency Operations Centre (EOC) staff structure in 2021. Building emergency teams are being maintained for all occupied structures on site. Fewer occupied structures has resulted in a decrease in the number of team members required.

10.1.3 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains a physical EOC, and conducts monthly tests of the technical equipment stored for use in that location. Repairs, improvements and updates are requested as required and when identified. All checks were completed in 2021. A cache of emergency food rations is also maintained at WL, which have a five year shelf life. The rations were replaced in 2019. The cache is stored in a secure location and the condition of the cases is checked annually.

10.1.3.1 Emergency Operation Center

As part of WL's EOC framework, there are two teams of EOC staff, and an alternate person for each of the team positions that can be engaged to cover for members of either of the two teams. These two teams operate on a two week on-call rotation. One EOC member retired in 2021 and his trained alternate was able to step straight into this position.

There were no emergency events requiring activation of the EOC in 2021.

10.1.3.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories continues to maintain the Mobile Nuclear Laboratory (MNL) for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the MNL in 2021.

10.1.3.3 Equipment Checks

Respirators make up the majority of the equipment in the strategically placed emergency cabinets that remain on site. These cabinets are opened and inspected monthly by Radiation Protection staff. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2021.

There were no emergency events requiring the use of this equipment in 2021.

10.1.3.4 Public Address System

The Public Address (PA) system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2021.

10.1.3.5 Secondary Emergency Signals

The WL site still employs an exterior siren as a redundant form of emergency alerting. The system is no longer required and was replaced by the PA system as the primary alerting system. This system will continue to be used as a redundant alerting system until either the equipment fails completely (there have previously been some issues with the equipment) or the building it is mounted to is decommissioned and demolished.

10.1.3.6 EOC Notification System

WL continued to use the Everbridge Mass Notification system in 2021. The system continues to perform well, with a 100% response rate to all monthly communication tests (see Table 42) for the third year in a row.

Table 42: WL EOC Communication Tests: 2021

Y= Yes N= No	January	February	March	April	May	June	July	August	September	October	November	December
EOC Commander	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liaison Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Env. Protection Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safety Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Planning Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Logistics Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Operations Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nuclear Facilities Representative	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

In addition to these regularly scheduled monthly drills, a random quarterly drill is conducted. These drills are scheduled for random times and dates, including weekends, evenings and work hours. These random drills include the expanded EOC teams, including all alternates and non-routine staff. Table 43 identifies the response rates of the 2021 WL EOC Staff to the Quarterly Random EOC call out drills, with an average of 94% response. Only responses received within an hour of the notification being sent out are considered a positive response, the rest are considered ‘no response’.

Table 43: WL EOC Random Quarterly Communication Tests: 2021

	Q1	Q2	Q3	Q4
Response Percentage	96%	100%	88%	92%

10.1.4 External Collaborations

In 2021 contact was maintained with a variety of external emergency response/management organizations and interested public groups. Due to COVID-19 many of these were once again virtual meetings or connections. WL EmP:

- Engaged with the LGD of Pinawa Emergency Operations Centre staff for local response planning purposes.
- Participated in the Manitoba Provincial Flood and Forest Fire forecasting sessions.
- Continued to participate on the Manitoba Municipal Relations Governance COVID-19 teleconference meetings throughout 2021, though with decreasing frequency as the year progressed.
- Maintained working relationships with Manitoba Emergency Measures Organization staff through less formal interactions this year, including regional response officers and the Critical Infrastructure protection program staff.
- Attended the Provincial emergency management conference, which brought many Local, Provincial and Federal stakeholders together to share best practices and lessons learned on a variety of relevant topics.
- Maintained membership with the Prairie Region (Manitoba and Saskatchewan) of the Federal Coordination Working Group. The Federal Coordination Working Group helps WL maintain ties with representatives from multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police (RCMP), Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada, in order to support organizational planning and response.

10.1.5 Unplanned Emergency Events

There were no incidents requiring initiation of the WL Site Emergency Plan occurred during 2021.

10.2 Fire Protection Program

Whiteshell Laboratories adheres to the Corporate Fire Protection Functional Support Area. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

There were no reportable fire events at WL in 2021.

10.2.1 Fire Response Drills

In 2021, WL was unable to conduct all the fire drills that it identifies as an annual requirement in accordance with the National Fire Code of Canada [43] and CSA standard N393-13 Fire Protection for Facilities that Process Handle, or Store Nuclear Substances [44]. This deviation has been captured as part of an internal self-assessment and a corrective action plan is being developed to ensure these are adequately planned and executed.

10.2.2 External Collaborations

Whiteshell Laboratories and the Town of Pinawa signed a Fire Protection Service Agreement in 2019 to improve Mutual Aid support capabilities. The agreement is still in effect. Interdepartmental training has been interrupted by the COVID-19 pandemic, but will be resumed as soon as it is safe to do so.

10.2.3 Third Party Audits & Inspections

As per the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [44], a third party Fire Protection Audit was conducted in 2021. The findings are being collated and their resolution will be tracked through the corrective action program (see also Section 1.2.1.1).

10.2.4 Fire Hazard Analysis

All fire hazard analysis documentation for buildings requiring a fire hazard analysis have been reviewed and are being evaluated against the decommissioning schedule. A corrective action plan was developed and submitted to the CNSC outlining the timeline for Fire Hazard Analysis documentation review and revisions.

11 Waste Management

11.1 Waste Management Program

Whiteshell Laboratories adheres to the Corporate Waste Management Functional Support Area. See Section 11.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program include:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL Programs to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Closure Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for three of the waste receiving facilities on-site (including the Waste Handling Area and the WMA storage facilities) remained unchanged for 2021.

11.1.1 Waste Management Operations

Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for interim storage.

Demolition of Buildings 402 and 305 began in 2021 and is on target to be complete early 2022. A total of 2,246 m^3 clean waste was generated in 2021; 1,290 m^3 of concrete material was dispositioned to an off-site receiver for future re-use, 450 m^3 of metal was recycled, while 483 m^3 of asbestos-containing material and 17 m^3 of polychlorinated biphenyl (PCB) contaminated materials were dispositioned to appropriate off-site waste receivers.

Decommissioning on the south area of the WL main campus continued, which involved asbestos abatement and remediation of high temperature water lines, generating approximately 188 m^3 of clean concrete waste; 28.5 m^3 of this volume contained asbestos-containing materials which was sent to an approved off-site licensed facility.

Building 200 Active Liquid Waste Treatment Centre demolition was completed. A total of 1,077 m^3 of Low-Level Waste (LLW) and 77.5 m^3 of Intermediate - Level Waste[10] (ILW) waste

[10] In this context, ILW refers to any waste that does not meet the proposed Near Surface Disposal Facility (NSDF) Waste Acceptance Criteria (WAC) and requires storage in ILW facilities at CRL.

was generated; of this LLW total, 876 m³ has been safely dispositioned to CRL, with the remaining 201 m³ and 77.5 m³ of ILW waste safely stored in certified transportation packages awaiting shipment to CRL in 2022.

De-inventorying efforts of legacy waste stored in LLW Bunker 5 began. Wastes are undergoing additional qualification and inspection to ensure transportation and waste criteria compliance are met. This activity has generated 360 m³ of LLW to date, which are safely stored in certified transportation packages awaiting shipment to CRL in 2022.

Table 44 summarizes the quantities of radioactive waste generated in 2021 that was sent to each storage location. Table 45 summarizes the volumes of solid low-level radioactive waste originating from each facility in 2021. Table 46 summarizes the volumes of solid intermediate-level radioactive waste originating from facilities in 2021. Table 47 summarizes the volumes of solid low-level and intermediate-level radioactive waste transported to CRL for disposition.

Table 44: Radioactive Waste by Storage Location

Storage Facility	Volume (m³)	
	2020	2021
Low-Level Quonsets	32.3	0
Intermediate-Level Waste Bunkers	0	2.5
SMAGS[a]	4.1	0
Soil Storage Compound	0	0
Total	36.4	2.5

a Shield Modular Above Ground Storage (note: SMAGS is no longer used for waste storage)

Table 45: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2020		2021	
	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)
Building 100	0.8	9.2	1.5	0.0
Building 200	7.2	198.9	0.0	875.6
Building 300	0.3	0.0	0.0	0.0
Building 303	0.0	0.0	0.0	0.0
Building 304	0.0	0.0	0.0	0.0
Building 402	0.2	0.0	0.8	0.0
Building 421	0.0	0.0	0.0	0.0
Concrete Canister Storage Facility	0.0	0.0	0.0	0.0

Shielded Facilities (HCF & IFTF)	10.8	0.1	45.6	0.0
Waste Handling Area	0.0	0.0	0.0	0.0
Waste Management Area	2.5	0.0	14.2	0.0
LLW Bunker 6	0.8	0.0	0.0	9.0
LLW Bunker 5	0.0	0.0	0.0	360.0
Affected Lands	0.2	0.0	0.0	0.0
SSC	0.0	0.0	0.0	0.0
Total	**22.7 (5.0)[a]**	**208.2**	**62.1 (5.0)[b]**	**1244.6**
Total after Compaction	**213.2**		**1249.6**	

a This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

b This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

Table 46: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m^3)	
	2020	**2021**
Affected Lands	0.0	0.0
Building 200	5.8	77.5
Total	5.8	77.5

Table 47: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2020		2021	
	LLW Volume (m^3)	**ILW Volume (m^3)**	**LLW Volume (m^3)**	**ILW Volume (m^3)**
Building 402	0.0	0.0	0.0	0.2
WMA (Legacy Sources)	112.5	0.0	39.0	0.0
Soil Storage Compound	0.0	0.0	0.0	0.0
SMAGS[a]	14.0	7.7	0.0	0.0
LLW Bunker 6	182.0	0.0	6	3
LLW Bunker 5	0.0	0.0	0.0	0.0
Building 200	198.8	5.8	876	0
LLW Quonsets (B431, B432, B433)	20.4	12.8	0	0

Total	527.7	26.3	921	3.2

a Shielded Modular Above Ground Storage – legacy waste generated from various decommissioning projects.

Clearable waste from Controlled Areas was monitored in-situ. Clean bagged waste was monitored using the bag monitor located in Building 300 where WL's laundry facility is now stationed; all bagged waste met the screening criteria and was deemed to be suitable for unrestricted release in 2021.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable; this includes both recyclable materials sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

Table 48 summarizes the disposition pathway of non-active wastes, while Table 49 summarizes the amount, by material type, of recyclable waste shipped off-site.

Table 48: Non-Active Waste Disposition Pathways

Disposition Location	Volume (m^3)	
	2020	2021
WL Asbestos Disposal Site [a]	0	0
WL Burn Pit	247	189
WL Inactive Landfill	0	0
Recycling[b] **Sent Off-Site**	513	271
Off-Site Landfill [c]	1,256	1,352
Total	2,016	1,812

a The WL Asbestos Disposal Site stopped receiving waste in 2019 to support the environmental risk assessment. Non-active asbestos is directed to off-site licensed landfills.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted at municipal recycling facilities.

c WL Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

Table 49: Recycled Waste Shipped Off-Site

Material[a]	Weight (kg)	
	2020	2021
Aluminum	0	0
Batteries Shipped	0	0
Batteries Recycled	227	0
Cardboard[b]	0	0

Copper and Brass	0	0
E-Waste Shipped	347	3,464
E-Waste Sold	0	0
Ferrous Metals	108,457	26,231
Glass	0	0
Lumber	0	0
Plastic Shipped	0	0
Plastic Sold	0	0
Stainless Steel	0	0
Lead	0	7,450
Total	109,031	37,145

a This recycling waste pertains to material that is sold or charged to be taken to a material specific recycling facility.

b Cardboard is sent to a municipal recycling facility and inclusive in Table 48.

Improvements were made in preventing waste accumulation inside of buildings and transferring the waste to appropriate waste facilities immediately after generation. Improvements continue to be addressed in reference to the lack of processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes radioactive wastes generated from decommissioning activities. Mitigation measures put in place in 2021 included finalizing a Nuclear Safety Note for the interim storage of cargo containers containing radioactive wastes in the WMA. This area is referred to as the Recoverable Surface Storage and Staging Area (RSSSA), and consists of an outdoor, above ground storage pad to enable the storage and loading of solid low-level waste in sea land containers and storage of oversize LLW items which are awaiting further processing, characterization and/or packaging to be considered compliant for off-site disposition. Additionally, satellite transshipment areas were established north of the WMA and one by the B200 demolition to reduce additional handling and improve efficiencies with off-site disposition of waste.

11.1.1.1 Liquid Waste Generation

During 2021, 78.9 m^3 of low-level liquid was processed in the Building 300 LLLWTS and 9.9 m^3 in the Building 100 LLLWTS, for a total of 88.8 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Whiteshell Laboratories adheres to the Corporate Cleanup Functional Support Area. See Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

11.2.1 Program Overview, Achievements and Accomplishments

As per the Licence Conditions Handbook for WL [2], CNSC have been notified of revisions to the Detailed Decommissioning Plan (DDP) for WL [45].

11.2.2 Land Use Program

Table 50 provides a summary of the status of the WL Site's Overview DDP.

Table 50: Overview Decommissioning and Cleanup Plan Updates for WL in 2021

Document Reference	Key Activity Status in Year	Effective Date (if applicable)
WLDP-02000-DDP-001	Approved by Regulator	December, 2021

The Overview DDP was revised, submitted to the CNSC, and approved for use in 2021.

11.2.3 Decommissioning and Demolition Program

Table 51 lists the WL DDPs and their status as of 2021.

Table 51: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned.
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility has been decommissioned. End-state report in development.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach)	Facility has been shut down and currently under monitoring and surveillance. Complete Dismantlement and Removal approach has been

Facility	DDP Document Title	Document #	Status
		WLDP-26400-DDP-001, Revision 5, 2021 (In Situ Decommissioning Approach)	approved by the CNSC (Revision 3). EA process for ISD is in progress, Revision 4 to be revised with final EA submission (note: copy of Revision 5 submitted for review of comment disposition to CNSC prior to final EA submission). DDP Volume (Revision 3) is available for use.
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC and comments received (to be dispositioned).
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001	Facility is operational DDP under development.
	Volume 8 - WMA Part 2: Intermediate - Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 5, 2021	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
R&D Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use.
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001	Decommissioning activities ongoing. DDP Volume is available for use.
DP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.

Facility	DDP Document Title	Document #	Status
	Area Buildings and Facilities		
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

11.2.3.1 Detailed Decommissioning Planning and Execution

Table 52 provides a summary of WL facility DDPs that were revised in 2021.

Table 52: Summary of WL Detailed Decommissioning Plans in 2021

Facility	Document Status	Document Name and Reference	Effective Date	Document Highlights
WMA	Current Published	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 8 - WMA: Part 3 - Low Level Waste Liabilities, WLDP-24400-DDP-001, Revision 5	April, 2021	DDP was submitted to and accepted by CNSC staff.

Table 53 provides a summary of decommissioning and demolition statuses for WL in 2021.

Table 53: Summary of WL Decommissioning and Demolition Status by Facility in 2021

Facility	Decommissioning and Demolition Status
B402	Active Decommissioning
B200	Building Demolished
B413	Active Decommissioning
B420	Active Decommissioning
B426	Active Decommissioning
B429	Active Decommissioning
WMA	Active Decommissioning
Site Affected Lands and Contaminated Structures	Active Decommissioning

Several buildings and structures were decommissioned in 2021, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition where feasible.

Demolition of Buildings 402 and 305 began, and is expected to be completed early 2022. The demolition of the buildings included remediation and abatement of asbestos-containing materials, specifically the mastic tar adhered between the masonry and exterior wall, and PCB's found within window glazing and exterior caulking and general demolition of construction and demolition materials.

Remediation of the south-side of the main campus continued. Phase one field work was completed, which consisted of remediating the high temperature water lines. Phase two field work to excavate and remove underground electrical bus ducts, isolate fire water, domestic water, storm drains and sanitary drain systems will commence in 2022. The exterior of Buildings 413, 420, 426 and 429 were radiologically surveyed for clearance, with interior portions to be completed in 2022.

Building 200 was successfully demolished, which involved the above and below grade structure, while the building footprint was backfilled. Remediation of this footprint was strategically adjusted to align with future remediation of the surrounding lands known to be contaminated from historical spills associated with the building. This will ensure remediation of the known contamination is completed in one phase, avoiding the potential of creating additional volumes of waste that may be generated from migration of contaminants within the soil.

Legacy wastes stored in the LLW Quonsets (Building 431, 432 and 433) and LLW Bunker 5 began to be retrieved in 2021. Wastes are undergoing visual examination, destructive and non-destructive characterization, and packaging to ensure transportation and waste criteria compliance are met, before waste can be dispositioned to CRL. This work is scheduled to be complete in 2022.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

11.2.3.2 End State Reporting

Table 54 provides a summary of end-state reports completed for WL in 2021.

Table 54: Summary of WL Decommissioning and Demolition End-State Reports in 2021

Facility	Document Type	Document Status	Document Name and Reference	Submission Date (if applicable)
Building 514 (WMA)	End State Report	Submitted to CNSC	Decommissioning and Demolition of Organic Coolant Incinerator Complex (B514), WLDP-24400-ESDR-001, Revision 1	July, 2021

12 Security

12.1 Security Program

Whiteshell Laboratories adheres to the Corporate Security Functional Support Area. See Section 12 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Whiteshell Site Security Report [46] outlines the security arrangements that are in place at the WL site. The Security Functional Support Area consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Functional Support Area and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in REGDOC-2.2.4, *Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness* [47].

Hours of Work Exceedances

As per REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* [47] Sections 4.2 and 4.3, CNL has recorded all exceedances of hours of work for Security's safety-sensitive positions. See Table 55 below for a list of exceedances for 2021. NOTE: COVID pandemic had a direct contribution to Table 55 in order to ensure minimum shift complement.

Table 55: Hours of Work Exceedances for Nuclear Security Officers and Tiered Response Force Personnel at WL in 2021.

Limits:			2021			
			Q1	Q2	Q3	Q4
4.2	**1.**	**>16 hrs in a 24-hour period**	3	4	7	4
4.2	**2.**	**> 28 hrs in a 48-hour period**	15	21	28	11
4.2	**3.**	**> 120 hrs in a 14-day period**	6	4	1	1
4.3	**2. d.**	**Min recovery 48 hrs after 2 consecutive nights**	19	11	5	15
4.3	**2. d.**	**Min recovery 72 hrs after 3 consecutive nights**	2	5	3	2
		Total	45	45	44	33

A CNSC Type II Security Compliance Inspection was carried out - see Section 1.2.2. A corrective action plan was submitted to the CNSC to address findings.

CNL-WL received notification from the CNSC on the closure of one (1) enforcement item, Directive WL-SEC-19-T2-001-D01 – Training. The Directive closure was granted as CNL-WL completed all actions required to address the enforcement items listed in the Directive.

12.1.1 Security Events

In 2021, there were no security events that affected the Whiteshell Laboratories.

13 Safeguards and Non-Proliferation

13.1 Safeguards Program

Whiteshell Laboratories adheres to the Corporate Nuclear Materials and Safeguards Management (NM&SM) Functional Support Area. See Section 13 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

13.1.1 IAEA Activities

The IAEA conducted various types of activities as part of the safeguards approach for CNL, including, but not limited to, IAEA safeguards seals changes, human surveillance, implementation and/or maintenance of IAEA safeguards monitoring equipment, and technical visits. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2, Management System of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In 2021 May-June, 14 of 16 WL concrete canisters were re-welded, during which the IAEA provided oversight. The IAEA also verified and changed the IAEA seals attached to the canisters to maintain continuity of knowledge. Minor difficulty was encountered during resealing of one canister and the IAEA inspector decided to employ an alternate sealing arrangement. In 2021 September, the other two canisters were re-welded, during which IAEA provided oversight, including resealing the one canister into the original configuration as it was operationally preferable.

A Physical Inventory Verification (PIV) inspection was completed by an attending IAEA inspector on 2021 May 25. This inspection was a sampling of accessible items containing Special Fissionable Material.

The IAEA also completed a Design Information Verification (DIV) inspection on 2021 May 25 - 27. The activities associated with the DIV included:

- Verification of the Design Information Questionnaire:
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

14 Packaging and Transport

14.1 Packaging and Transport Program

Whiteshell Laboratories adheres to the Corporate Transportation of Dangerous Goods (TDG) Functional Support Area, which includes the requirements of the Packaging and Transport SCA. See Section 14 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances and radiation devices. The TDG Functional Support Area applies to any activities involving the transportation of dangerous goods to or from CNL sites. The TDG Functional Support Area provides an operational framework for the safe off-site transport of dangerous goods by conforming to all applicable laws and regulations, as well as company policies and procedures.

The Waste Certification & Transportation branch is a centralized organizational department responsible for planning, coordinating and executing radioactive waste shipments from the WL site to the off-site disposal or storage facilities in a safe and compliant manner, including having fully trained Radioactive Material Shippers as authorized under the CNL TDG Functional Support Area.

Significant activities in 2021 included:

- Transportation of 921 m^3 of low-level waste and 3.2 m^3 intermediate-level waste sent off-site and safely delivered to CRL;
- Throughout 2021, additional technical assessments and studies on the WL used fuel inventory were completed in support of the licensing application of the Used Fuel Transportation Package (UFTP). These assessments were focused on the WL mixed fuel types (i.e., enriched and experimental fuel types, including Uranium Carbide and Uranium Metal fuel types) and the physical operation of the UFTP. The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations starting in 2022 (due to the COVID-19 Pandemic, these transportation operations were delayed and subsequently pushed out from 2020). There is a two-step licensing strategy for the UFTP, with the first phase focusing on licensing the UFTP for non-enriched CANDU fuels and the second phase focusing on WL's inventory of mixed fuel types. The phase UFTP Safety Analysis Report (SAR) Addendum was submitted to the CNSC in 2019 May, with updates provided throughout 2020, and acceptance is anticipated in early 2022. The UFTP SAR for Mixed Fuel Types (representing phase two) will be submitted in 2022, following the CNSC's acceptance of the phase 1 SAR addendum. Additional accomplishments throughout 2021 include the revision and acceptance of the revised UFTP pre-shipment leak tests, the progression of detailed planning and operational readiness deliverables, and the completion of field trials with the UFTP, Shielded Interface Module (SIM) and Fuel Transfer Flask.

- Award of the subcontract to Nuclear Assurance Corporation (NAC) to design and fabricate Type B casks, cask handling equipment and on-site services needed to support ILW transport to CRL was completed. Two versions of the OPTImal Modular Universal Shipping (OPTIMUS) casks, the OPTIMUS-H and OPTIMUS-L were accepted for use after their licence review and received. Personnel from WL and CRL participated in a week long training session, qualifying them on the use, loading and transport of the casks.
- Extensive training was conducted to site personnel responsible for the handling and packaging of radioactive waste materials, which included Class 7 RAM Material – Handler Training, as well as Waste Management and Packaging Fundamental Training, which was developed to capture the requirements to compliantly process, load, and handle waste materials into certified transport packages, as well as the various waste receivers' waste acceptance criteria.

14.1.1 Shipments

At WL, 68 radioactive transport packages making up 53 loads were safely and successfully sent off-site in 2021. One reportable event occurred in 2021 (see ImpAct ERM-21-1036 in Table 5) where a consignment of waste material was misclassified in accordance with the Packaging and Transport of Nuclear Substances Regulations [48] and IAEA Safe Transport of Radioactive Material [49], due to an incomplete inventory of the package's contents. Several corrective and remedial actions were completed to address the event.

15 Other Matters of Regulatory Interest

15.1 Public Information and Disclosure Program

Whiteshell Laboratories adheres to the Corporate Public Information Program. See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Public Information Program document [50] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure* [51].

15.1.1 Outreach and Stakeholder Engagement

WL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events. As employees are CNL's greatest ambassadors, they are kept informed of developments so that they can also share information with their relatives, friends, and neighbours.

CNL engaged with the public on WL using a number of tactics. During the COVID-19 pandemic, engagement followed public health and corporate guidelines and was primarily virtual. Table 56 presents public engagements from 2021.

Table 56: Public Engagements for Whiteshell Laboratories

Date	Location	Activity
March 2, 2021	Pinawa, MB	Presentation and meeting with Local Government District of Pinawa Council and Mayor
April 20, 2021	Webinar	WL Closure Project: Environmental Protection
May 18, 2021	Webinar	WR-1 Reactor Decommissioning Fact or Fiction Webinar
September 21, 2021	Webinar	WL Closure Project: Project update
November 16, 2021	Webinar	WL Closure Project: Environmental Protection
November 24, 2021	Winnipeg, MB	Emerging issues conference 2021: The net-zero future investing in sustainability

15.1.2 Public Consultation

CNL actively works to engage local stakeholders on matters related to WL activities. In 2021, a number of methods were deployed to gain feedback from and create discussion with interested parties including: breakfast sessions, social media, and feedback forms available online and at external events, and responses provided to inquiries. CNL strives to create open and transparent communication with all identified stakeholders, and to address concerns and respond to all inquiries.

Throughout 2021, CNL received 21 community inquiries related to WL (Table 57), largely through the WR-1 Breakfast Session/Webinar series.

Table 57: Whiteshell Laboratories Closure Project Public Inquiries

Nature of Enquiry	Number
Transportation	3
Environmental protection	7
Whiteshell Laboratories Closure Project	11

15.1.3 Traditional and Online Communications

15.1.3.1 Website

CNL's Whiteshell Decommissioning web page had 1,667 page views in 2021.

To support the Whiteshell projects and site, CNL has used social media to promote events, share and receive information, and generally engage with the public. As Table 58, Table 59 and Table 60 show that social media has been an effective tool to reach and engage stakeholders. Table 61 shows that CNL also shared information through a community information bulletin.

Definitions:

Engagements - Measures how much and how often others interact with you and your content in social media.

Shares or retweets - Measures how often the message was shared or forwarded on the twitter website.

Table 58: Facebook Metrics for WL-related Posts*

Date of Post	Engagement	Shares
February 16, 2021	3	0
March 29, 2021	3	1
April 14, 2021	20	11
May 5, 2021	34	19
September 14, 2021	38	4

Table 59: Twitter Metrics for WL-related Posts*

Date of Post	Engagement	Retweets	Clicks
April 14, 2021	1	0	0

Table 60: YouTube Videos

Date of Post	Engagement	Views
April 21, 2021	Webinar: WL Closure Project (April 2021)	163
April 21,2021	Webinar: Déclassement des Laboratoires de Whiteshell (2021 avril)	12
May 20, 2021	Déclassement du réacteur WR-1 Webinaire "Mythe ou Réalité" – 2021 mai	27
May 20, 2021	WR-1 Reactor Decommissioning Fact or Fiction Webinar – 2021 May	42
July 12, 2021	CNL Live Event: CNL's major projects and opportunities for supply chain engagement	224
October 1, 2021	Whiteshell Closure Project Webinar – 2021 September	56
October 1, 2021	Déclassement des Laboratoires de Whiteshell Webinaire - 2021 septembre	12
November 22, 2021	Overview of Environmental Protection at Whiteshell Laboratories	34
November 22, 2021	Un aperçu de la protection de l'environnement à les Laboratoires de Whiteshell	25

Table 61: Community Information Bulletins

Date	Bulletin
January 28, 2021	Whiteshell Monitoring

15.1.3.2 Newsletters

CONTACT is CNL's external, bilingual newsletter. It is distributed to community stakeholders, businesses and approximately 8,000 homes in the region surrounding WL, and is available on www.cnl.ca. This publication informs the reader on activities undertaken at CNL's Whiteshell Laboratories and profiles CNL's community activities. Two issues of *CONTACT* were distributed in 2021 and included the following topics:

- WL Closure Project and WR-1 updates
- Highlights of public and Indigenous engagement activities
- CNL initiatives in the community, demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- CNL's COVID-19 response
- Employee transition
- Environmental stewardship, including steps CNL has taken to reduce greenhouse gas emissions, protect wildlife and minimize waste.

15.1.3.3 Media Releases

During 2021, there were seven articles written by media on the Whiteshell Closure Project (see Table 62).

Table 62: Media Coverage for 2021

Date	Article	Title of Publication
January 2021	Canada's Radioactive Waste Policy Review	LGD of Pinawa Municipal Quarterly Newsletter
January 20, 2021	O'Regan All In On Unnatural Resources	Winnipeg Free Press
March 18, 2021	CNL contributes to Pinawa daycare upgrades	The Clipper
March 24, 2021	Who decides where nuclear waste goes	Winnipeg Free Press
March 26, 2021	Nuclear waste solution	Winnipeg Free Press
July 15, 2021	Pinawa erosion responsibility in question	The Clipper
September 2, 2021	CNEA continues funding North Forge East with three-year deal	The Clipper

15.1.4 Ongoing Projects

15.1.4.1 WR-1 In-Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning project (also referred to as in situ disposal) is a key part of CNL's overall integrated approach to safely manage and reduce Canada's legacy liabilities. The Environmental Assessment (EA) process for the project includes a requirement that WR-1 project information be made available to neighbouring communities, Indigenous communities and organizations, and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Engagement activities conducted in support of this requirement included social media and website content, presentations, meetings, site tours and fulfilling stakeholder requests for information.

Project-specific webpages and content were produced for the WR-1 Project and included: fact sheets, info-graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages at www.cnl.ca/wr-1.

15.2 Indigenous Engagement

CNL follows CNSC REGDOC-3.2.2 *Indigenous Engagement* [52] which sets out requirements and guidance for licensees on Indigenous engagement. CNL recognizes and values ongoing engagement with Indigenous communities and organizations in the spirit of truth and reconciliation.

15.2.1 Engagement Objectives

As part of its corporate, environmental, and social responsibility, CNL recognizes and encourages the ongoing engagement of the First Nations and the Red River Métis (represented by the Manitoba Métis Federation) through the course of the environmental assessment process for the WR-1 Project and engagement on the overall site closure project. Through information-sharing and engagement activities, CNL seeks to build awareness and learn about interests and concerns in an effort to strengthen mutual understanding and pursue

opportunities for collaboration and long-term relationships. CNL engages with First Nations and Red River Métis leadership, representatives and members on the potential effects of the WR-1 Project and the Whiteshell Laboratories Closure Project (WLCP) on the environment and on Indigenous and/or treaty rights including rights to trap, hunt, fish, gather and conduct cultural ceremonies.

CNL has five overarching Indigenous engagement goals:

- **Build awareness and mutual understanding** by supporting and facilitating opportunities for mutual learning on topics including current and traditional use, values and perspectives on nuclear decommissioning, environmental remediation and radioactive waste management, in order to demonstrate CNL's long-term commitment and approach to safe and responsible management of radioactive waste and decommissioning liabilities (e.g., through site monitoring activities).
- **Share information on the project**, including the potential effects on the environment. This includes developing meaningful, user-friendly information and communication products for the First Nations and the Red River Métis, and providing accessible and current information on project activities.
- **Seek input and feedback from the First Nations and the Red River Métis** on project-related activities, and traditional and current uses of the land surrounding the WR-1 project site. Initiate early and meaningful two-way communication between CNL and the First Nations and the Red River Métis to determine the best methods for sharing information and to provide opportunities for Indigenous Peoples to give input on project considerations including design, the EA process, and assessment of impacts.
- **Develop long-lasting relationships with the First Nations and the Red River Métis** to support their continued involvement in the project, community healing and reconciliation. This will extend beyond the scope of the EA process for WR-1.
- **Meet or where possible exceed all regulatory-based communication and engagement requirements** and facilitate engagement that reflects current memorandums of understanding and contribution agreements, and that takes into account the interests, needs and schedule of each Indigenous Nation.

15.2.2 Identified Indigenous Communities

CNL developed a list of the First Nations and the Red River Métis with a potential interest in the WR-1 Project and the WLCP. The identification of the First Nations and the Red River Métis was based on consultation with the CNSC, through CNL's previous Indigenous engagements, and through the use of publicly available sources of information including:

- First Nation and the Red River Métis and organization websites;
- The Aboriginal and Treaty Rights Information System (ATRIS; Government of Canada and INAC 2016); and
- Crown-Indigenous Relations and Northern Affairs Canada First Nation community profiles.

The list was based on the identified potential or established Indigenous or treaty rights of the First Nations and the Red River Métis and is provided in Table 63 with a brief rationale for inclusion. The inclusion of specific Nations considers the nature of the established and/or claimed rights and potential effects on those rights caused by the proposed project, based on a preliminary assessment of existing and available information. As such, the working list is subject to change based on information and dialogue with the identified First Nations, the Red River Métis, and Indigenous organizations.

Table 63: Identified Indigenous Communities

First Nations, the Red River Métis or Organizations	Identification Rationale
Sagkeeng First Nation (Treaty No. 1 and 3)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve located 52 kilometres (km) north of the WL site, and downstream along the Winnipeg River. Existing relationship and interest in the Whiteshell Laboratories site.
Brokenhead Ojibway Nation (Treaty No. 1)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy three reserves: 44 km northwest, 55 km northwest and 73 km southwest of the Whiteshell Laboratories site respectively. Interest expressed comments on Project Description.
Manitoba Métis Federation (MMF)	The MMF is the official democratic and self-governing political representative for the Métis Nation's Manitoba Métis Community. The MMF is considered the government of the Red River Métis. Potential asserted and/or established Métis harvesting rights in the vicinity of the Project. Interest expressed comments on Project Description.
Black River First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve 75 km north of the Whiteshell Laboratories site.
Hollow Water First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Occupy one reserve, 113 km north of the Whiteshell Laboratories site.
Shoal Lake No. 40 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 94 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Iskatewizaagegan No. 39 Independent First Nation (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.

First Nations, the Red River Métis or Organizations	Identification Rationale
	Occupy four reserves: 93 km southeast, 102 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Northwest Angle No. 33 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 111 km southeast, 140 km southeast and 176 km southeast of the Whiteshell Laboratories site, respectively.
Wabaseemoong Independent Nations (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy four reserves: 80 km east, 85 km east, 95 km east and 140 km southeast of the Whiteshell Laboratories site, respectively.
Grand Council of Treaty 3	Umbrella treaty organization which represents 28 First Nations and 5 with potential interest in the Project. Treaty 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.
Chiefs of Ontario	First Nations umbrella organization that represents 133 First Nations and 4 with potential interest in the Project

15.2.3 Summary of Engagement

Table 64 lists CNL's Indigenous engagement activities related to the WLCP from 2021. Further details on Indigenous engagements are available in the Indigenous Engagement Report [53].

Table 64: CNL Indigenous Engagement Activities for 2021

Date	Event	Location
Sagkeeng First Nation (SFN)		
January 5	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 18	Discussion on the application of Free Prior and Informed Consent on the WR-1 Project	Teleconference
March 9	Discussion with Chief and Council on engagement with Sagkeeng's members	Teleconference
April 6	Leadership discussion on Sagkeeng's Psychosocial Impact Assessment Report	Teleconference
April 15	Site Tour with Sagkeeng's Liaison Officer	On-Site Visit
June 16	CNL, AECL, and Sagkeeng participated in first Technical Working Group meeting	Teleconference
June 17	Sagkeeng's Liaison Officer visits the site to record video for National Indigenous Peoples Day	On-Site Visit
July 14	Sagkeeng's Liaison Officer participated in a bat survey on site	On-Site Visit
July 19	CNL, AECL, and Sagkeeng participated in second Technical Working Group meeting	Teleconference
August 11	Sagkeeng's Liaison Officer participated in a site tour	On-Site Visit
August 12	Sagkeeng's participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 17	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
August 24	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 7	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 14	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
September 22	Sagkeeng's Liaison Officer participated in Trauma-informed Engagement Training with CNL, AECL, and the CNSC	In-person, Winnipeg
September 28	Sagkeeng's participated in the second preliminary discussion of the Indigenous Advisory Committee	In-person, Winnipeg
November 10	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
November 15	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
December 15	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
Manitoba Metis Federation		
January 6	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 8	Technical Workshop on WR-1 Groundwater Monitoring	Teleconference
February 18	Environmental Monitoring and MMF Green Initiatives Discussion	Teleconference

Date	Event	Location
March 2	Technical Workshop on Alternative Means Assessment and VC Components	Teleconference
March 9	Discussion on developing a relationship agreement	Teleconference
March 17	Overview presentation on the site's Environmental Protection Program	Teleconference
May 11	Wrap-up Meeting for Technical Workshops	Teleconference
May 25	Discussion on participation in site field monitoring	Teleconference
June 2	Discussion on WR-1 draft commitments and relationship agreement	Teleconference
June 3	Update on Whiteshell Laboratories Closure Project	Teleconference
June 14	MMF participated in groundwater monitoring, a songbird survey, and a turtle search at the site	On-Site Visit
June 18	Discussion on developing a relationship agreement	Teleconference
June 22	MMF participated in a bat survey on site	On-Site Visit
June 23	MMF participated in the a second bat survey on site	On-Site Visit
July 14	MMF participated in the a third bat survey on site	On-Site Visit
August 12	MMF participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 13	MMF hosted a leadership discussion with CNL's President and AECL's	In-person, Winnipeg
August 16	MMF observed river sediment, soil, and vegetation sampling	On-site Visit
August 19	MMF, CNL, and the CNSC participated in a trilateral meeting	Teleconference
August 19	Discussion on collaborating on a green initiative	Teleconference
September 8	MMF participated in Mushroom collection at site	On-Site Visit
September 21	Discussion on developing a relationship agreement	Teleconference
September 28	MMF participated in a second preliminary discussion on developing the Indigenous Advisory Committee	In-person, Winnipeg
October 20	Alpha Targeted Therapy Discussion	Teleconference

Date	Event	Location
November 17	Alpha Targeted Therapy Discussion	Teleconference
November 22	Discussion on developing a relationship agreement	Teleconference
December 2	Discussion on developing a relationship agreement	Teleconference
Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation		
February 1	Discussion on developing a relationship agreement	Teleconference
April 1	CNL, Black River First Nation, and Hollow Water First Nation sign a relationship agreement	E-mail
May 18	Discussion on onboarding the newly appointed liaison officer	Teleconference
May 25	Liaison officer participated in a site tour	On-Site Visit
June 1	Liaison officer onboarding discussion	Teleconference
June 23	Participating in site monitoring discussion	Teleconference
July 6	Participating in site monitoring discussion	Teleconference
July 14	Liaison officer participates in bat survey	On-Site Visit
August 12	Communities participate in preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 16	Liaison officer participates in observation of river sediment, soil, and vegetation sampling	On-Site Visit
August 19	WR-1 Environmental Impact Statement Document review discussion	Teleconference
September 20	Update on Site Decommissioning Activities	Teleconference
September 28	Communities participate in second preliminary discussion of the Indigenous Advisory Committee	Teleconference
November 10	Six-month Relationship Agreement Discussion	Teleconference
December 13	Update meeting of community liaison committee development	Teleconference

15.2.4 CNL's Long-Term Relationship with Indigenous Peoples

CNL recognizes First Nations and the Red River Métis as stewards of the land and is working towards developing meaningful long-term relationships with each Nation that occupies and has traditional territories and/or modern-day interests near its site operations. CNL recognizes each Nation has its own unique set of interests and concerns associated with both the WR-1 decommissioning project and the WLCP is committed to taking a distinctions based approach to engagement to ensure each Nation's interests and concerns are addressed. CNL also takes a

holistic, relationship-based approach to engagement with each Nation, working closely with AECL, to help address interests and concerns regarding all aspects of the WLCP.

This shift in CNL's Indigenous engagement approach from project based engagement to a holistic, relationship and distinction-based approach will support meaningful actions to build foundations for trust, understanding, and mutually beneficial relationships, including addressing broader issues and concerns such as the historical siting of the Whiteshell Laboratories site.

CNL is currently working with each Nation to formalize these relationships through relationship-building and corresponding agreements. These agreements are intended to help enable greater integration of Traditional Knowledge, ceremony, and cultural and stewardship practices in the decommissioning, monitoring, and closure of the project. These agreements will also enable dialogue and participation through the development of monitoring programs, culturally appropriate communications, and trauma-informed engagement. In addition, the agreements help to enhance community engagement, build trust and strengthen relationship-building, and provide mechanisms that facilitate Indigenous participation and input into CNL's environmental monitoring program, economic development and procurement opportunities, future land use, and other areas of collaboration.

CNL has signed a relationship agreement with Black River First Nation and Hollow Water First Nation. Relationship agreements with Sagkeeng First Nation and the Red River Métis are contemplated, and steps are being taken to negotiate such agreements. CNL is committed to ongoing engagement and finalizing these agreements.

CNL continues to build relationships with local First Nations and the Red River Métis to support overall decommissioning of the Whiteshell Laboratories site, including the WR-1 Project. CNL is committed to learning about Indigenous values through ceremony and ongoing dialogue, and discussing, incorporating, and addressing concerns to the extent possible.

16 Acronyms

α	Alpha
ACMR	Annual Compliance Monitoring Report (formerly Annual Safety Review (ASR) or Annual Compliance Report (ACR))
AECL	Atomic Energy of Canada Limited
ALWTC	Active Liquid Waste Treatment Center
β/γ	Beta-Gamma
CCSF	Concrete Canister Storage Facility
CNEA	Canadian National Energy Alliance Limited
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COVID-19	Novel Coronavirus Disease 2019
CRL	Chalk River Laboratories
DRL	Derived Release Limits
EM	Environmental Monitoring
EmP	Emergency Preparedness
EnvP	Environmental Protection
GHG	Green House Gases
HCF	Hot Cells Facility
ImpAct	Improvement Action
LCH	Licence Conditions Handbook
LLD	Lower Limit of Detection
LLW	Low-Level Waste
LLLW	Low-Level Liquid Waste
LLLWTS	Low-Level Liquid Waste Treatment System
LMDL	Laboratory Method Detection Limit
NEW	Nuclear Energy Worker
OPEX	Operating Experience
OSH	Occupational Safety & Health
REGDOC	Regulatory Document

R&D	Research & Development
RP	Radiation Protection
SAR	Safety Analysis/ Assessment Report
SCA	Safety and Control Area
SF	Shielded Facilities
TLD	Thermoluminescent Dosimeters
WL	Whiteshell Laboratories
WLCP	Whiteshell Closure Project
WMA	Waste Management Area

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Appendix A Concrete Canister Storage Facility

A.1 Operations

The Concrete Canister Storage Facility (CCSF) is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [54]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2021, staff of the Site and Nuclear Operations Branch monitored the operation of the CCSF.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2021.

Routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

With the recognition of increased work in the CSSF and WMA, three operator trainees were hired, with two of the trainees starting in late 2021. A senior operator was appointed as Facility Supervisor.

In 2021, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [54]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the CCSF in 2021. Procedures for the Facility began their updates as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

A.2 Compliance Monitoring

A.2.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in October. Despite multiple attempts flow could not be established in the Canister 8 air lines, these air lines have had issues in previous years obtaining flow. The normal approach to establishing air flow through lines was unsuccessful. Attempts will be made in 2022 to clear the line again.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters that were measured.

There was no visible moisture detected from the internal canister space during 2021 monitoring, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.2.2 Monitoring of Ground and Surface Water

Figure 12 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, and compliance results for the CCSF are described below.

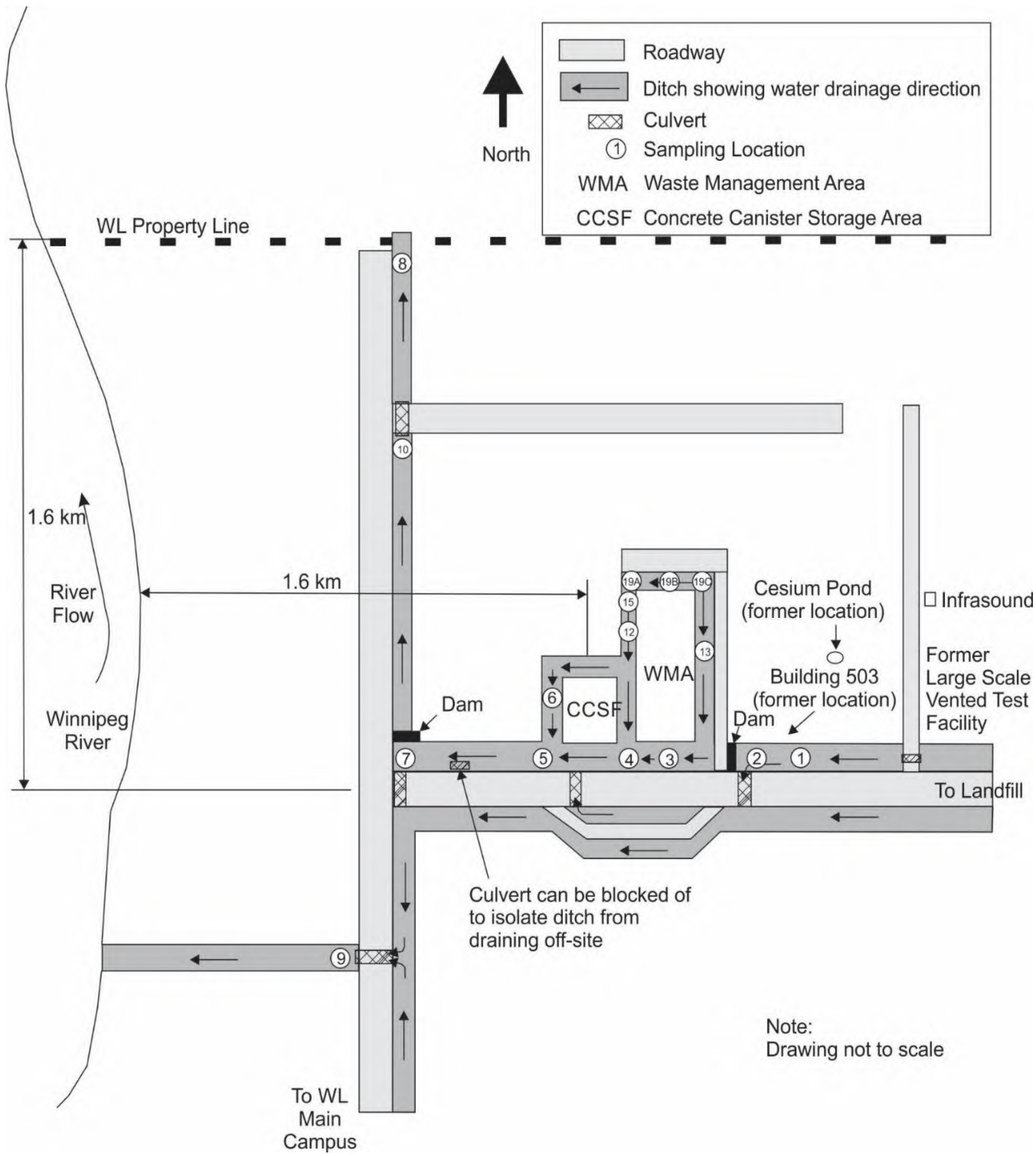

Figure 12: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Appendix D of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Strontium (Sr)-90. Gamma spectrometry analysis provides individual results for Cobalt (Co)-60, Niobium (Nb)-94, Antimony (Sb)-125, Cesium (Cs)-134, Cs-137 (Barium (Ba)-137m), Promethium (Pm)-147 and Americium (Am)-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [34]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Ditch Location 5 and Ditch Location 6 samples (see Figure 12 for sampling locations) could contain surface drainage from the CCSF, however, due to drought conditions and limited snow fall over the 2020/2021 winter, there was only one day with sufficient ditch water movement. This did not include Locations 5 and 6.

The alpha activities were below the trigger level of 0.5 Bq/L.

Table 65, Table 66, Table 67 and Table 68 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2021. Operational control-monitoring data from previous years has been included for completeness.

The ditch sample collected immediately downstream from the WMA (Location 7) contained elevated levels of tritium[11] (see Table 67), which did not exceed the associated Maximum Acceptable Drinking Water concentration of 7,000 Bq/L [34]. The activity seen is from the WMA as discussed in Appendix D.

[11] Tritium analysis of samples from Ditch Locations 5 and 6 was previously discontinued due to the higher levels of tritium (~4000 Bq/L) noted at upstream locations associated with the WMA.

Table 65: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.56	1.02	2.37	0.69	0.61	IF

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 66: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.25	0.24	0.29	0.27	0.36	IF

a The reference nuclide for total alpha is total Uranium.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry
ND Sample not available for analysis

Table 67: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2021
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	706	699	111	117	67	IF

a Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 68: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data[a] (Uranium ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	NR	NR	24.70[b]	13.8	11.3	IF

a Arithmetic average of samples collected.
b Single Value
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

A.3 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13]. There were no major facility changes made in 2021.

A.4 Equipment Performance, Planned Maintenance Testing and Inspections

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2021. None of the canisters had a deviation greater than 1°. In 2021, Canister C5 had a deviation of 0.8° to the east. This deviation and those observed on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2021.

As required by Section 8 of the Facility Authorization [54], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2021. The general appearance and fencing were found to be satisfactory on each inspection. Minor infilling was done along the base of the fence to meet security requirements.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes and it has been noted that edges of many pour pockets are more brittle as was noted in 2020. Selective patching is done of these pour pockets, only minor patching was conducted in 2021. No increased radiation field was noted from the canisters.

A.4.1 Canister Site Monitoring and Surveillance

GAMMA FIELD SURVEYS

Gamma exposure rates from the canisters were measured quarterly in 2021. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No gamma field anomalies were found during 2021.

Table 69 shows the averaged gamma near contact exposure rates measured during 2021, and for the previous four years.

Table 69: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.08	0.08	0.07	0.08	2021	C13	0.16	0.18	0.12	0.14	2021
	0.07	0.08	0.06	0.09	2020		0.16	0.25	0.15	0.14	2020
	0.11	0.08	0.10	0.12	2019		0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
	0.08	0.08	0.09	0.08	2017		0.18	0.25	0.15	0.18	2017
C6	0.08	0.08	0.08	0.08	2021	C14	0.11	0.09	0.09	0.07	2021
	0.08	0.09	0.07	0.09	2020		0.11	0.17	0.15	0.13	2020
	0.09	0.11	0.10	0.08	2019		0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
	0.08	0.10	0.08	0.06	2017		0.11	0.18	0.17	0.13	2017
C7	0.11	0.14	0.09	0.14	2021	C15	0.20	0.32	0.23	0.21	2021
	0.15	0.12	0.13	0.14	2020		0.29	0.37	0.27	0.29	2020
	0.18	0.16	0.14	0.16	2019		0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
	0.20	0.16	0.14	0.14	2017		0.33	0.39	0.31	0.30	2017
C8	0.11	0.12	0.10	0.10	2021	C16	0.17	0.21	0.15	0.15	2021
	0.11	0.12	0.10	0.09	2020		0.16	0.21	0.15	0.17	2020
	0.11	0.13	0.11	0.11	2019		0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
	0.10	0.10	0.10	0.09	2017		0.18	0.29	0.13	0.17	2017
C9	0.23	0.18	0.16	0.18	2021	C17	0.12	0.12	0.20	0.20	2021
	0.23	0.21	0.14	0.22	2020		0.15	0.13	0.23	0.22	2020
	0.26	0.23	0.17	0.21	2019		0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
	0.25	0.19	0.20	0.22	2017		0.20	0.15	0.23	0.24	2017
C10	0.16	0.20	0.17	0.13	2021	C18	0.52	0.70	0.94	0.55	2021
	0.23	0.20	0.19	0.42	2020		0.67	0.49	1.05	0.55	2020
	0.24	0.28	0.22	0.21	2019		0.69	0.76	1.25	0.62	2019
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
	0.24	0.30	0.21	0.22	2017		0.70	0.70	1.22	0.70	2017
C11	0.25	0.17	0.21	0.27	2021	C19	0.16	0.18	0.16	0.17	2021
	0.19	0.21	0.23	0.28	2020		0.16	0.17	0.20	0.17	2020
	0.25	0.24	0.29	0.29	2019		0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
	0.26	0.26	0.30	0.30	2017		0.18	0.18	0.25	0.22	2017
C12	0.16	0.15	0.12	0.08	2021	C20	0.11	0.09	0.13	0.13	2021
	0.16	0.19	0.10	0.13	2020		0.14	0.12	0.14	0.16	2020
	0.19	0.21	0.13	0.13	2019		0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018
	0.22	0.25	0.15	0.13	2017		0.16	0.11	0.18	0.18	2017

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h =1 mrem/h

AIR MONITORING

Air monitoring was conducted on each of the canisters in the CCSF in 2021. This involved an air pump that circulates air from an outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero. As 2021 was a drier, warmer year, 7 months of sampling were done. As discussed above in Section A.2.1, flow could not be established in the Canister 8 air lines.

One anomalous but still low reading was found in Canister 20 leading to an average of 1.8 Bq/filter for the year. As the other readings were zero, this reading was retained but it is not indicative of a trend. Canister 13 and 16 had single readings slightly greater at 1 Bq/filter. The values may also relate to some disturbances of contamination on the baskets by the previous year's visual observations and the air flow from sampling.

Table 70 shows the averaged beta readings on each filter measured during 2021, and for the previous four years.

Table 70: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	7	<0.02	2021	C13	7	0.25	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	0.02	2017
C6	7	0.02	2021	C14	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	<0.02	2017
C7	7	<0.02	2021	C15	7	0.12	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C8	7	No Flow	2021	C16	7	0.16	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C9	7	0.02	2021	C17	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C10	7	<0.02	2021	C18	7	0.03	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
	6	<0.02	2017		6	<0.02	2017
C11	7	0.03	2021	C19	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
	6	<0.02	2017		6	0.03	2017
C12	7	<0.02	2021	C20	7	1.81	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.03	2017

A.5 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

See Section 11.1 Waste Management Program for summaries of any volume of radioactive solid and/or liquid waste generated in the CCSF in 2021.

A.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the CCSF as part of routine operations.

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix B Active Liquid Waste Treatment Center

B.1 Operations

The Active Liquid Waste Treatment Center (ALWTC) in Building 200 did not operate in 2021.

Previously, in 2020 October, CNL notified the CNSC that the ALWTC, Building 200 was being demolished and had requested that the Facility Authorization [55] and the Safety Analysis Report [56] associated with the ALWTC be removed from the Whiteshell Laboratories LCH [14]. CNSC granted this request in 2020 December [57].

In 2017, new LLLWTS began operation in Buildings 100 and 300. All of the Building 100 low level liquid waste is now being tested, treated and controlled release to the river in the Building 100 LLLWTS and likewise in Building 300.

In 2020 October, the last of the operating systems in Building 200 were shut down and isolated (ventilation and compressed air systems). The building was rendered cold and dark and demolition of the building started later in 2020 October. Demolition of Building 200 above grade and 1.5m below grade were completed in 2021 October. The demolition footprint is still fenced and protected. The fence will remain until the potentially contaminated ground can be remediated.

B.2 Facility Changes

The demolition of the building was completed in 2021 October.

B.3 Wastes Generated

No solid radioactive or hazardous waste was generated in the ALWTC as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the ALWTC during demolition activities in 2021.

B.4 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the ALWTC as part of routine operations.

Appendix C Shielded Facilities

C.1 Operations

The WL Shielded Facilities (SF) operates under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [58]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shut down and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of HEPA filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

There were no organizational changes in 2021. Although there was a reduction in the staffing for the operating staff responsible for the SF in 2021, the minimum staffing requirements outlined in the SF Facility Authorization [58] was maintained at levels to provide the needed operational and safety support.

No program changes were made for the SF in 2021. Procedures are being updated as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

C.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

C.3 Equipment Performance, Planned Maintenance Testing and Inspections

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Equipment tests and inspections were completed with the exception of a secondary Intermediate-Level Liquid Waste containment tank leak detector due to a defective probe. Compensatory measures were put in place until the detector was repaired. Monthly housekeeping and fire prevention inspections were completed.

VENTILATION SYSTEM

Maintenance activities requiring part of the ventilation system to be taken down occurred without incident.

The annual routine Poly-Alpha-Olefin testing of the HCF HEPA filters were successfully conducted.

C.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of the volume of radioactive solid and liquid wastes generated in the SF in 2021.

LOW-LEVEL SOLID WASTE

In 2021, the SF generated 45.6 m^3 of compactable low-level radioactive solid waste and no non-compactable waste.

The Waste Handling Area processed 62.1 m^3 of low-level radioactive solid waste which was reduced to 5 m^3. A portion of this waste was generated in the SF, and the remainder came from all of the nuclear facilities and decommissioning projects at WL where waste is being generated.

Table 71 lists the annual low-level solid waste generated in the SF for 2021 and the previous four years.

Table 71: Solid Wastes Generated

Total Volume	2017	2018	2019	2020	2021
Low-Level Solid Waste (m^3)	0.4	73.3	64.3	10.9	45.6
Medium-Level Solid Waste (m^3)	0	0	0	0	0

MEDIUM-LEVEL SOLID WASTE

In 2021 the SF generated no medium-level (intermediate-level) radioactive solid waste. Table 71 lists the annual medium-level solid waste generated for 2021 and the previous four years.

LOW-LEVEL LIQUID WASTE SYSTEM

In 2021, 99 m^3 of low-level liquid waste was processed through the Building 300 low-level liquid waste system (see Appendix E).

MEDIUM-LEVEL LIQUID WASTE SYSTEM

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2021, there was one transfer of 0.1 m^3 medium-level liquid waste to transportable totes that is being stored for future disposition.

Table 88 lists the annual aqueous waste generated for 2021 and for the previous four years.

C.5 Effluents Released

Liquid radioactive and hazardous effluents were discharged from the SF as part of routine operations are provided and discussed in Section 9, Environmental Protection.

Appendix D Waste Management Area

D.1 Operations

The Waste Management Area (WMA) operated under the WL Site Licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [59]. During 2021, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2021, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, Facility Supervisor, WMA Operators and two WMA based utility workers, with support from other Site and Nuclear Operations personnel and Environmental Monitoring personnel as required.

In 2021, the staffing of the WMA was increased. A Facility Supervisor (Senior Operations Technician) was appointed and three additional Operations Technologist trainees were hired.

In 2021, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the WMA in 2021. Procedures are being updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

D.1.1 Inventory Additions And Deletions

Changes in inventory are reported in Table 72 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.2 Low-Level Solid Waste

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. Some of the inventory of stored waste in WMA was sent to CRL for storage pending future disposal. The stored volume of waste is listed in Table 72.

D.1.3 Industrial Waste

There were no additions of industrial chemical waste during 2021.

Table 72: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2020 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433.	18,798.84	1,967.38	330.58
Additions for 2021	Building 431 to 433	0	0	0
Removals for 2021	LLW Bunker 6 Buildings 431 to 433	9 0	13 0	0 0
Total Accumulation as of 2021 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433	18,789.84	1,954.38	330.58

D.2 Compliance Monitoring

D.2.1 Monitoring And Surface Water

SURFACE WATER

Figure 12 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period. In 2021, there was only one day where the ditch flow met the required flow conditions in some sample locations due to the light snow pack leading to limited snow melt, limited rainfall and dry soil conditions.

A recorded amount of precipitation of 395 mm occurred in 2021, which was less than the 441 mm recorded in 2020, and is a ten year low for recorded precipitation. The low precipitation is reflective of an ongoing drought in the area.

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

- If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.

- If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, as was the case last year, all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration (MAC) established by Health Canada [34]. If uranium is detected, the result is evaluated against the MAC for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity at ditch sample Locations 1 to 7 (Table 73) all remained well below 10 Bq/L. Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. Most beta activity levels in the ditch water remained below the drinking water screening level of 1 Bq/L, and below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137 [60]. Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. There were no exceedances of the Canadian Drinking Water [34] standard of 1.0 Bq/L (Table 73) in 2021.

The alpha activity levels in the surface water are presented in Table 74, and were below the trigger level of 0.5 Bq/L. Uranium results are presented in Table 75.

There was no flow at Locations 19 A, B and C in 2021. In past years, the uranium values recorded at these locations are believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation. This rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018. The Lac du Bonnet Batholith granite is noted to have naturally occurring uranium.

As shown in Table 76, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [34] at all locations with only one result above near-detection limits of 124 Bq/L at Location 7 in 2021. Other locations had no flow or near non-detection of tritium. Locations 19 A, B and C were originally chosen for sampling for the potential migration of cesium-137 due to the presence of the Cesium Pond soil pile. Although the Cesium Pond soil has been removed, CNL will continue to monitor locations 19 A, B and C due to the elevated levels of tritium.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [61], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is slightly elevated immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 4.7 Bq/L in 2021). With the low flow volumes, tritium was only detected in one location. Although the amount measured in Locations 1 to 7 are above that noted at the Control location, the levels are much lower than the Maximum Acceptable Concentration in drinking water for tritium (7000 Bq/L).

Table 73, Table 74, and Table 75 present the WMA surface-water sampling data. The data represents continuing documentation of a spill incident that occurred in 1979 near ILW Bunker 3, from the reference sample point (Location 3) in the southeast section of the WMA, as shown

in Figure 12 and Figure 13. In 2017, sampling Location 3 was reconfigured to allow preparations for future bunker and standpipe remediation, but the location was dry this year due to the dry summer. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater are below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of 1.27×10^7 Bq/L [62]. These tables, and Table 76, have been expanded to include the historical monitoring at Ditch Locations 19 A, B and C, water flow permitting.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. There was no flow recorded in the north WMA ditch in 2021 (Locations 19 A, B and C) (Figure 13). Table 77 reflects this circumstance and shows that previous years indicated no migration of Cs-137 to these ditches.

As Trench 16 has a known quantity of Technetium-99 (Tc-99), Tc-99 measurements were performed as part of ditch water monitoring in 2021. Only one value near the limit of detection was measured (Table 78) The Tc-99 limit for drinking water is 200 Bq/L [60] and the measurement is well below this level.

Table 73: Gross Beta Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	1.23	1.62	1.24	IF	1.96	IF
19 A	0.40	0.69	0.36	0.44[c]	IF	IF
19 B	0.52	0.72	0.24	0.43[c]	IF	IF
19 C	0.39	0.58	0.38	IF	IF	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 74: Gross Alpha Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	0.64	0.28	0.31	IF	0.06	IF
19 A	0.34	0.53	0.92	0.26[c]	IF	IF
19 B	0.36	0.74	0.24	0.51[c]	IF	IF
19 C	0.40	1.05	0.39	IF	IF	IF

a The reference nuclide for total alpha is total Uranium
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 75: Uranium of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data (Average[a] ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	ND	NR	21	IF	10.06	IF
19 A	NR	24	52[a]	13[b]	IF	IF
19 B	NR	39	NR	16[b]	IF	IF
19 C	NR	67	47[a]	IF	IF	IF

a Arithmetic average of samples collected
b Based on single sample analyses
ND- Not Detected/Below Detection Limit
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
NR Analysis not required

Table 76: Tritium Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	**Sampling Data (Total Tritium Bq/L) in 2021**
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	228	1335[b]	178	IF	348	IF
19 A	2324	5535	459	543[b]	IF	IF
19 B	4001	8123	325[b]	777[b]	IF	IF
19 C	4203	9610	405	IF	IF	IF

a Arithmetic average of samples collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 77: Cesium-137 Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample	Sampling Data (Total Cesium-137 Bq/L) in 2021
Locations	**25 May**
19 A	IF
19 B	IF
19 C	IF
Background	<1

Historical Cs-137 Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
19 A	ND	ND	ND	<1[b]	IF	IF
19 B	ND	ND	ND	<1[b]	IF	IF
19 C	ND	ND	ND	IF	IF	IF

a Arithmetic average of sample collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 78: Technetium-99 Results from Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Technetium-99 Bq/L) in 2021
Locations	**25 May**
1	1.17
2	ND
3	IF
4	IF
5	IF
6	IF
7	ND
10	ND
13	IF

IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

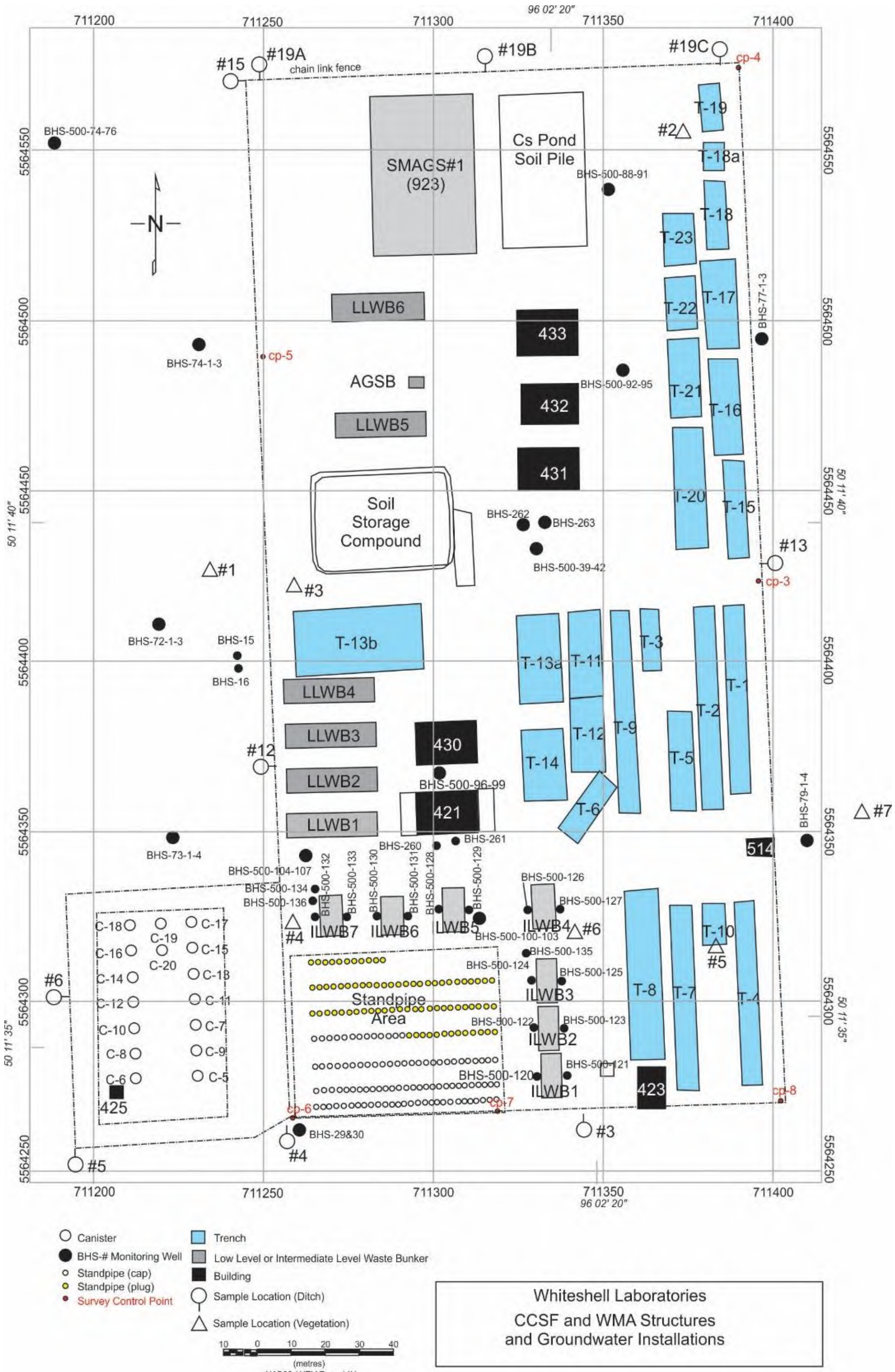

Figure 13: Ground Water Sample Points

INTERMEDIATE - LEVEL WASTE BUNKERS NEAR FIELD WELLS

A series of shallow near field wells were installed adjacent to the ILW bunkers in the WMA in 2015 (Figure 12). Groundwater samples were taken from the wells and from water in the ILW Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile but will bond with sand, and tritium is the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2021, Sr-90 was noted to be a maximum of 34 Bq/L adjacent to ILW Bunker 1, and 20 Bq/L adjacent to ILW Bunker 3. For all other locations, the Sr-90 and Cs-137 levels were minor or negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 79) from the ILW Bunkers, and Sr-90 (Table 80) and tritium levels (Table 81) that are orders of magnitude below the levels observed in the water in the adjacent ILW Bunkers. At ILW Bunker 3, the tritium results remain high (126,326 Bq/L) and moderately high at ILW Bunker 5 (11,051 Bq/L).

A series of water measurements were made as a confirmatory check in 2020 for the presence of base neutral chemicals (e.g., benzenes, ethylenes) and PCBs. These measurements indicated these chemicals were not present in the water around the bunkers. The measurement was not repeated in 2021.

Table 79: Cesium 137 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	31762					
BHS 500-120	-	<1	<1	<1	<1	<1
BHS 500-121	-	<1	<1	<1	<1	<1
ILW Bunker 2	1170					
BHS 500-122	-	<1	<1	<1	<1	<1
BHS 500-123	-	<1	<1	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	<1	<1	<1	<1	<1
BHS 500-125	-	<1	<1	<1	<1	<1
BHS 500-135	-	<1	<1	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	<1	<1	<1	<1	<1
BHS 500-127	-	<1	<1	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	<1	<1	<1	<1	<1
BHS 500-129	-	<1	<1	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	<1	<1	<1	<1	<1
BHS 500-131	-	<1	<1	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	<1	<1	<1	<1	<1
BHS 500-133	-	<1	<1	<1	<1	<1
BHS 500-136	-	<1	<1	<1	<1	<1

a Bunker values from 2015 samples
ND Not detected

Table 80: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate - level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	98300					
BHS 500-120	-	32	15.30	22.10	24.9	33.9
BHS 500-121	-	1.31	4.44	2.92	5.19	4.15
ILW Bunker 2	865					
BHS 500-122	-	0.25	0.21	0.14	0.5	0.68
BHS 500-123	-	1.27	2.55	1.59	1.84	1.08
ILW Bunker 3	26950					
BHS 500-124	-	5.70	11.3	6.58	12.6	19.8
BHS 500-125	-	<0.20	<0.10	<0.10	<0.10	0.69
BHS 500-135	-	0.72	0.74	1.32	0.84	0.75
ILW Bunker 4	2485					
BHS 500-126	-	0.33	0.24	0.30	0.21	0.7
BHS 500-127	-	<0.20	0.28	0.35	0.24	0.56
ILW Bunker 5	3850					
BHS 500-128	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-129	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 6	157500					
BHS 500-130	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-131	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 7	3335					
BHS 500-132	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-133	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-136	-	<0.20	<0.10	<0.10	<0.10	<0.10

a Bunker values from 2015 samples
ND Not detected

Table 81: Tritium Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	42000					
BHS 500-120	-	70	279	258	410	700
BHS 500-121	-	765	2788	2355	1509	1230
ILW Bunker 2	6100					
BHS 500-122	-	1877	475	4274	3587	966
BHS 500-123	-	1876	2554	2834	1640	2942
ILW Bunker 3	4600000					
BHS 500-124	-	158564	83604	128534	179094	126326
BHS 500-125	-	2956	2512	39	2484	2349
BHS 500-135	-	2404	3536	47	2737	3372
ILW Bunker 4	41000					
BHS 500-126	-	69	24	39	225	20
BHS 500-127	-	76	< 4	47	37	45
ILW Bunker 5	5500000					
BHS 500-128	-	2981	2674	2655	2793	2748
BHS 500-129	-	10700	9100	9633	9601	11051
ILW Bunker 6	210000					
BHS 500-130	-	310	29	5	37	50
BHS 500-131	-	22	19	5	38	4
ILW Bunker 7	970000					
BHS 500-132	-	49	131	100	NR	94
BHS 500-133	-	16	<4	6	158	20
BHS 500-136	-	36	78	72	58	97

a Bunker values from 2015 samples
ND Not detected

WATER TABLE WELLS AND DEEP WELLS

Water samples were collected from wells in and around the WMA (Figure 13) in the spring and fall of 2021. The gross alpha and gross beta results are summarized in Table 82. The beta activity levels in the clay, clay till and basal zone wells remained below the drinking water screening level of 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs-137

(10 Bq/L) [34]. The average alpha activity in the samples collected from the Basal zone wells was below the screening level.

Uranium concentrations in the basal zone wells ranged from 0 to 0.59 Bq/L. The concentrations in the Clay zone wells ranged from 0.19 to 3.60 Bq/L, and in the clay till from 0 to 1.61 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [63], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (23.29 Bq/L) and clay-till (11.33 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA.

Table 82: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2017 Avg. (Bq/L)	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2020 Avg. (Bq/L)	2021 Avg (Bq/L)	2021 Avg. Range (Bq/L)
Total Beta [a]						
Clay	0.35	0.29	0.42	0.26	0.43	0.19 to 1.39
Clay Till	0.36	0.25	0.26	0.30	0.45	0.09 to 1.06
Basal	0.16	0.13	0.34	0.11	0.25	0.11 to 0.91
Total Alpha [b]						
Clay	1.01	1.03	0.87	0.52	0.67	0.27 to 2.81
Clay Till	0.77	0.72	0.75	0.80	0.58	0.07 to 1.21
Basal	0.10	0.12	0.22	0.14	0.19	0.03 to 0.48
Total Uranium [c]						
Clay	0.90	0.88	0.86	0.70	0.82	0.19 to 3.60
Clay Till	0.52	0.62	0.60	0.71	0.55	0.003 to 1.61
Basal	0.01	0.04	0.01	0.06	0.03	0.003 to 0.59
Total Tritium						
Clay	11.60	11.36	8.07	7.56	10.37	3.11 to 55
Clay Till	13.36	13.51	14.07	21.31	11.33	3.32 to 65.21
Basal	4.08	4.63	5.66	3.48	3.59	3.16 to 4.62

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value calculated from the concentration of uranium in the water sample

HIGH-LEVEL LIQUID WASTE TRAY WATER

Monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. This is sampled in the summer months. The sample results indicated no leakage has occurred from the tanks. The data are

summarized in Table 83. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 83: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2017 Avg (Bq/L)	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2020 Avg (Bq/L)	2021 Avg (Bq/L)	2021 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	13.8	13.8	12.1	11.2	17.7	13.6 to 25.3
Total Alpha [b]						
Tank Tray Water	0.65	0.69	1.5	0.95	0.2	0.1 to 0.4

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13Bq/L of the gross beta activity is due to K-40.

b The reference nuclide for total alpha is Pu-239

D.2.1.1 RADIATION FIELD MEASUREMENTS

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2021 radiation field measurements were similar to those in 2020. The data is summarized in Table 84.

Table 84: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021 Avg	2021 Range
Spring Survey						
South Fence	0.2	0.2	0.2	0.3	0.2	0.1 – 0.3
West Fence	0.4	0.4	0.4	0.3	0.3	0.1 – 0.6
North Fence	0.2	0.2	0.2	0.4	0.2	0.1 – 0.3
East Fence	0.3	0.3	0.3	0.2	0.4	0.1 – 0.5
Fall Survey						
South Fence	0.2	0.2	0.2	0.4	0.3	0.2 – 0.3
West Fence	0.4	0.4	0.5	0.3	0.4	0.2 – 0.6
North Fence	0.2	0.2	0.2	0.3	0.3	0.2 – 0.4
East Fence	0.3	0.3	0.4	0.3	0.2	0.1 – 0.5

D.2.1.2 VEGETATION

In 2021, vegetation samples were collected at monitoring locations within the WMA (Figure 13), and at a control location unaffected by WL operations. The gross beta results are

summarized in Table 85. Potassium (K)-40 represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. The average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90). Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 85: Waste Management Area Vegetation Monitoring Data

WMA Sample Locations	Average Gross Beta[a] (Bq/kg)				
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021Avg
North-East Area[d]	NA	672	450	196	207
Mid-West Area	1619	411	155	173	190
South-West Area	275	414	NA	296	243
South-East Area	460	409	441	230	246
Control Sample[b]	379	187	210	162	171
Background Sample[c]	419	324	317	203	157
East of ILW Bunkers 3 and 4	NA	672	450	NA	218

a The reference nuclide for beta is Sr-90
b Adjacent to the WMA outside of the fence boundary
c Ambient Radiation monitor Stations Background Samples
d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area. Only a single set of vegetation samples was taken as of 2017 as uptake occurs over the summer. Range is no longer included because of this change.

In 2021, the Facility continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Three trainee operators were hired in 2021 to begin increasing staffing to meet with planned decommissioning activities. Staffing was maintained at levels to provide the needed operational and safety support.

D.3 Facility Changes

All facility changes are performed as per the approved Engineering Change Control procedure [13].

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2021 with most of the physical preparatory work done with continued fabrication of extraction equipment off site.

The pad to the east of the north access road had the requisite safety analysis and procedural documents prepared. The pad is now designated as the Recoverable Surface Staging and Storage Area and will be placed into service in 2022 to store Seacan containers containing

waste and oversized items. The Seacan containers or items will be awaiting processing, characterization and packaging for off-site shipment. This was required to allow Building 923 (SMAGS) to be converted to a Cask Loading Facility (CLF).

Building 923 is in the process of being converted to the CLF. In 2021 this included installation of a 15 ton overhead crane, additional lighting and ventilation ducting and an air handling unit. Interior shielding walls were also erected. The current interior equipment is awaiting commissioning and connection of additional power. Further installation work will be done in 2022.

The WR-1 Phase 1 decommissioning waste material was stored in Buildings 432 and 433 in the WMA. Approximately 96% of the WR-1 Phase 1 decommissioning waste stored in Buildings 432 and 433 had been processed by the end of 2016. One oversized crate along with five asbestos crates remain in Building 433 at the end of 2021. Through 2021, work to characterize the contents of B431, B432 and B433 occurred. This effort will continue in 2022 with off site shipping planned.

The marine container used for storing sealed sources that was transferred from Building 430 in the WMA to the Standpipes Protected Area to meet revised security regulations from the CNSC in 2015, remained in place through 2021. Sources are still held pending future dispositioning.

The process to convert Low Level Waste Bunker #6 to the Intermediate-Level Liquid Waste Treatment Centre, Building 202, began in 2021. Work consisted of removal of waste that had been temporarily returned to the bunker due to restrictions in work crews and shipments related to the COVID-19 Pandemic. Once the waste was removed, interior surveys were conducted in preparation for the next phases of work in 2022.

Removal of waste from Low Level Waste Bunker #5 began in 2021. The waste removal is a component of the decommissioning effort for the WMA, and will extend into 2022.

The Waste Transshipment Area outside the northern perimeter of the WMA had its footprint extended and pad upgraded to improve areas of formerly soft ground. The Waste Transshipment Area allows for holding shipments of waste that are ready to be shipped. The larger area will support the planned pace of waste extraction from the WMA.

In 2021, the Waste Transshipment Area also provided access through a west gate in that area to allow for construction of a road along the west side of the WMA. Pads off the west side of that road will host transformers and generators to provide Class IV and Class III power to waste extraction and processing equipment to be installed in the WMA. A non-active organic material laydown area was established on the north end stub of the west road to allow for an area for organic material from the development of the Waste Transshipment Area pad improvement and west road to be retained.

A replacement section of the north fence running from the west side of Building 923 to the east edge of the Recoverable Surface Staging and Storage Area was installed. This fence included an expanded width north gate to allow shipping containers to be transported without having to

raise them above the fence. The fence replacement was done to correct fence sections that were leaning outwards.

On the south side of the WMA, a new well nest was installed to the south of the south road. This well nest was installed to provide groundwater measurements outside of the zone of influence of the work conducted at the WMA. The previous wells fulfilling this role are now too close to the Protected Area expansion to be considered outside the zone of influence and will be used as part of the monitoring network for that area.

A bedrock well was installed to the west of the WMA-CCSF. This provided improved coverage at depth to monitor for potential contaminant migration.

D.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the bunkers and other structures in the WMA remained fit for service. Building 923 and Low Level Waste Bunker #6 were removed from operations pending their conversion to the Cask Loading Facility and Intermediate Level Liquid Waste Treatment Centre respectively. Building 421 continued to operate as a waste examination and re-packaging area, making use of the Temporary Ventilated Enclosure.

Medium-Level Waste Bunker 4 did not have new waste placed in 2021 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues. Medium-Level Waste Bunker 7 is ~86% full with one placement occurring. The percentage full values are estimates only. Road transportable totes of liquid waste remain in the heated Building 430 pending future processing. Building 431 contains historic waste which is in the process of being characterized and packaged. Building 432 and Building 433 also contain various historic wastes and wastes held in various stages of characterization and repacking operations.

A small seepage of an oily substance first noted in 2020 was again noted at the central gasket, near the south wall base of LLW Bunker 1. The substance was sampled in 2020 and found to contain oil and likely degraded liquid organic. The volume was small in 2020 and remained so in 2021. Seepage again only occurred during hot weather, and as weather cooled the seepage stopped. The area will continue to be monitored. The bunker is slated for remediation of its waste in the next few years.

The Soil Storage Compound remained empty of stored waste soil bags. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018 and 2021.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.2.1 under "Intermediate - Level Waste Bunkers Near Field Wells", and indicates limited migration of tritium beside the ILW bunkers, in particular ILW Bunker 3. There is no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have only found limited levels of contaminants, below drinking water guidelines, suggesting the waste storage structures and natural barriers of low permeability clay soil and upwards groundwater flow are performing as expected. In 2021, the weather was extremely dry and spring melt similarly limited to surface water in ditches was limited to a single set of measurements on one date in May.

As required by Section 8 of the Facility Authorization [59], most routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, however, two tests, both on transformers were not completed in 2021. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [16], and is further discussed in Section 6.

D.5 Wastes Generated

Solid radioactive waste was generated in the WMA as part of routine operations. This was mostly bagged waste generated from routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of radioactive solid waste generated in the Waste Management Area in 2021.

Liquid radioactive waste was generated in the WMA as part of routine operations.

In 2021, approximately 564 L of water was removed from ILW Bunker 4, 863 L of water was removed from ILW Bunker 6 and approximately 114 L of water was removed from ILW Bunker 7. Low Level Waste Bunker 1 had 8 L from the west sump and 227 L from the east sump removed, and Low Level Waste Bunker 2 had 84 L from the west sump and 202 L from the removed from the east sump. The sumps are pumped out by Site and Nuclear Operations personnel using a WMA tanker with pump rig. The water collected in the tanker is later transferred to double walled totes. There totes are retained pending future processing.

The Building 923 sump tank and the Soil Storage Compound were both sampled as required and their water found not to be active in all cases. Water was directed to the WMA ditches. No other storage facilities and collection sumps at the WMA required pumping.

D.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the WMA as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection. There are no liquid effluents generated from this facility.

Appendix E Auxiliary Operation Facilities

E.1 Operations

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2021. There were no organizational changes.

No program changes were made for the auxiliary facilities in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contained experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops were located in the South High Bay.

The research program in the Stage 6 (RD-14M) area was completed in 2018, and operational shutdown was started. The operational shutdown, decontamination, and decommissioning of the remainder of the building was completed in 2015. The demolition of Stages 4 and 7 was completed in 2016. The demolition of Stage 6 was completed in 2019.

During 2021, WL Site and Nuclear Operation's staff and user groups in Building 300 carried out routine operations which included:

- Non-radiological laundry activities.
- Respirator fit test / maintenance activities.
- Ongoing CNL Nuclear Engineering & Systems Analysis R&D activities.
- Cleanup activities associated with decommissioning.
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

Health and Safety Facilities (Buildings 402 and 305)

Building 402 has three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

Environmental and Dosimetry services continued to operate in Building 402 until 2021 May.

In 2021, routine operations were carried out and supervised by Site and Nuclear Operations personnel. Operational cleanout of Buildings 402 and 305 continued and demolition of Building 402 started in 2021 November. Demolition of the building worked around the Whole Body Counter which was scheduled to move in early 2022.

E.2 Facility Changes

All facility changes were performed using the Engineering Change Control procedure [13]. The environmental and Dosimetry services were moved to Building 300. Building 402 was completely isolated and rendered cold and dark in 2021 July.

E.3 Equipment Performance, Planned Maintenance Testing and Inspections

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed up until Building 402 went cold and dark.

E.4 Wastes Generated

There were minimal amounts of radioactive and/or hazardous wastes generated in the facilities as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the facilities in 2021.

Building 300 generated 0.0 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

Building 402 generated 0.8 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

After processing at the Waste Handling Area, all waste was shipped to the WMA for storage.

See Table 86 for a summary of solid wastes for the last five years.

Table 86: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2017	2018	2019	2020	2021
Building 300 (m^3)	14.7	4.5	0.4	0.3	0.0
Building 402 (m^3)	2.8	1	0.7	0.2	0.8
Building 411 (m^3)	355.1	7.6**	0.2**	0.0	0.0

* Volume prior to compaction, all compactable waste is consolidated at the Waste Handling Area.

** Legacy waste processed in 2018 for Building 411 that was decommissioned in 2017.

There was no liquid radioactive and/or hazardous waste generated in 2021 in this facility.

RESEARCH AND DEVELOPMENT (BUILDING 300) LOW-LEVEL LIQUID WASTE SYSTEM

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in Building 300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The

sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2021, 78.3 m^3 of low-level liquid was processed through the Building 300 LLLWTS. Table 87 shows the historical volumes of LLLW processed through the Building 300 LLLWTS and also the total volume of Building 300 and Building 100 LLLW processed.

Table 87 - Historical Records of Low-Level Liquid Waste Processed

	2017	2018	2019	2020	2021
Total Combined Low-Level Waste Liquid Processed (m^3)[a]	172.3[b]	131.5[c]	189.3[c]	107	88.2
Low-Level Waste Liquid Processed in Building 300 (m^3)[d]	46	123	186.5	99	78.3

a All low-level liquid waste processed in Active Liquid Waste Treatment Centre for 2014-2016. This total includes laundry and decontamination and ALWTC facilities for 2014 and 2015. For 2016 the total is Building 100 and Building 300 and ALWTC. After 2017 all low-level liquid waste is processed in Building 100 and Building 300.

b This includes 126 m^3 of low-level liquid waste that was processed through the Active Liquid Waste Treatment Centre in Building 200.

c All Low-Level Liquid Waste processed through the low-level liquid waste treatment systems in Building 100 and Building 300.

d Building 300 LLLWTS came online in 2017 July.

The total activities given below are the combination of the Shielded Facilities, Building 300, and Building 100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the Building 300 and Building 100 LLLWTS during 2021 was 0.01 GBq, compared with 0.01 GBq released during 2020. The maximum release in a month during the year was 0.001 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.001 GBq for 2021 compared with 0.001 GBq released during 2020. The maximum release in a month during the year was 1.4E-04 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Am-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 88 provides a summary of the total activity released for both the Building 100 and Building 300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [30]. These values were revised in 2016. An error was discovered in Table 88, note “d” in previous years’ reports. The alpha DRL was listed as 1.11×10^1 GBq/month, and should have read 1.11 GBq/month. The annual release limits for alpha were calculated using the correct value for DRL. The % of monthly DRL for alpha was calculated using the wrong DRL value. This made the % of monthly DRL for alpha a factor of 10 lower than the true value.

Observed levels of alpha in WL's LLLW active releases are sufficiently low that even with this correction, levels are well below the DRL. This correction was made for the 2021 values.

Table 88 – Building 100 and Building 300 LLLWTS Radioactive Releases

Radionuclide	Total 2021 Effluent (GBq)	Annual Release Limit[a] (GBq/a)	Total 2021 Effluent as a % of Annual Release Limit	Peak Release	
				Max. Monthly Release (GBq)	% of[b] Monthly DRL
Total (Total-Beta Analysis) [c]	0.01	–	–	0.001	–
Sr-90	1.02×10^{-3}	1.56×10^{2}	0.76×10^{-3}	2.18×10^{-4}	1.87×10^{-3}
Cs-137	3.74×10^{-3}	1.39×10^{2}	2.69×10^{-3}	5.95×10^{-4}	5.12×10^{-3}
Total Alpha (As Pu-239 Equivalent) [d]	0.86×10^{-3}	1.33×10^{1}	6.46×10^{-3}	1.35 x 10-4	1.22×10^{-2}
Historical Data Total Effluent (GBq)					
	2017[e]	2018[e]	2019[e]	2020[e]	2021
Total (Total-Beta Analysis) [c]	0.04	0.02	0.01	0.01	0.01

a The annual release limit is calculated by multiplying the DRL by 12.

b DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [30].

c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.

d DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11 GBq/month [30].

e Year's 2014 to 2016 effluent was all processed in ALWTC. 2017 effluent was processed in ALWTC and Building 300 LLWTS. From 2018 on, all effluent was processed in Buildings 300 and 100 LLWTS.

E.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in Building 300 Room B-33.

Any liquid and/or gaseous releases from the facilities are provided and discussed in Section 9, Environmental Protection.

Appendix F WR-1 Facility

F.1 Operations

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [65]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64].

Routine operations in the WR-1 facility, as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64], were carried out by the five (four and one trainee) Site and Nuclear Operations Technologists assigned to Building 100. Throughout the course of 2021, the number of Building 100 staff dropped to three (two and one trainee) with plans to hire additional staff. Building 100 continued to maintain the minimum staffing requirements outlined in the Facility Authorization [64]. Staffing was maintained at levels to provide the needed operational and safety support.

In 2018, approximately 20 m^3 of low concentration (3.4 E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained. Investigation is also ongoing to determine what the impact would be if this water is left in situ as part of the proposed in situ disposal of WR-1.

No program changes were made for WR-1 in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

F.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

F.3 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the operations status of WR-1 remained unchanged. There were no changes to the reactor's equipment.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence. All Monthly housekeeping and fire prevention inspections were completed.

F.4 Wastes Generated

Solid Radioactive and/or Hazardous Wastes

See Section 11.1 Waste Management Program for summaries of the volume of any volume of radioactive solid and/or liquid waste generated in WR-1 in 2021.

Solid radioactive waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

During 2021, 1.5 m^3 of low-level radioactive compactable waste and no non-compactible waste were generated from Building 100/WR-1 operations and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

Liquid Radioactive and/or Hazardous Wastes

Liquid radioactive and no hazardous waste was generated in the facility as part of routine operations.

During 2021, 9.9 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the facility as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix G Non-Nuclear Facilities

G.1 Operations

The WL non-nuclear facilities status and changes for 2021 are as noted in Table 89.

Table 89: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
304	Waste Clearance Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
306	Waste Clearance Facility	Removed in 2016	None	None	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Operational	None	None	All Site/Visitors	No change
408	Stores	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Shut down	None	None	Security and Common Services	Preparing for demolition

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
415	Warm Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Shut down	None	None	Transportation, Security and Stores	Preparing for demolition
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Removed in 2020 l	None	None	Facilities	Building removed,, End-State Report to be completed
426	Quonset: Cold Storage	Shut down	None	None	Utility	Preparing for demolition
427	Cold Mechanical Storage	Removed in 2016	None	None	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Shut down	None	None	Maintenance	Preparing for demolition
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
540	Modular Office Complex	Operational	None	New	Facilities	Modular Trailer office complex installed in parking lot
543	Dosimetry Building	Under Construction	None	New	Facilities	Start of construction 2021 To be completed 2022

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	Relocated from Building 402 to near Building 300 Shielded Facilities. Placed back in Operation.
597	Portable Boiler Building 1	Out of Operation	None	None	Powerhouse Operators and Maintenance	Taken out of Service due to shutdown of Building 200
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hy dro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

[a] Security personnel perform regular patrols of all site buildings

There were no policy, program or procedural changes for the non-nuclear facilities in 2021. There were no changes in organization in 2021.

In 2021, the Facility continued to maintain the minimum staffing requirements to provide the needed operational and safety support.

G.2 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13].

G.3 Equipment Performance, Planned Maintenance Testing and Inspections

Systems and equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2021 with the exception of Compressed Air Systems where one of the three compressors was not operational (awaiting parts). In addition, issues with some gas detection systems were part of the missed preventive maintenance activities that was reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Routine maintenance was carried out, and equipment tests and inspection were completed in 2021 with no significant results.

G.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the non-nuclear facilities as part of routine operations.

G.5 Effluents Released

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the facilities as part of routine operations.

There was 1.15E+09 L of effluent released from buildings Building 422 (Outfall Monitoring Station) and 0 L of effluent released from Building 907 (Sewage Lift Station and Lagoons) as there was no lagoon release in 2021.

Landfill Dugout Water Monitoring

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2021, the precipitation was low over the year (395 mm) and the dugouts had low water levels during the summer sampling period. The location of the dugouts are shown in Figure 14. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

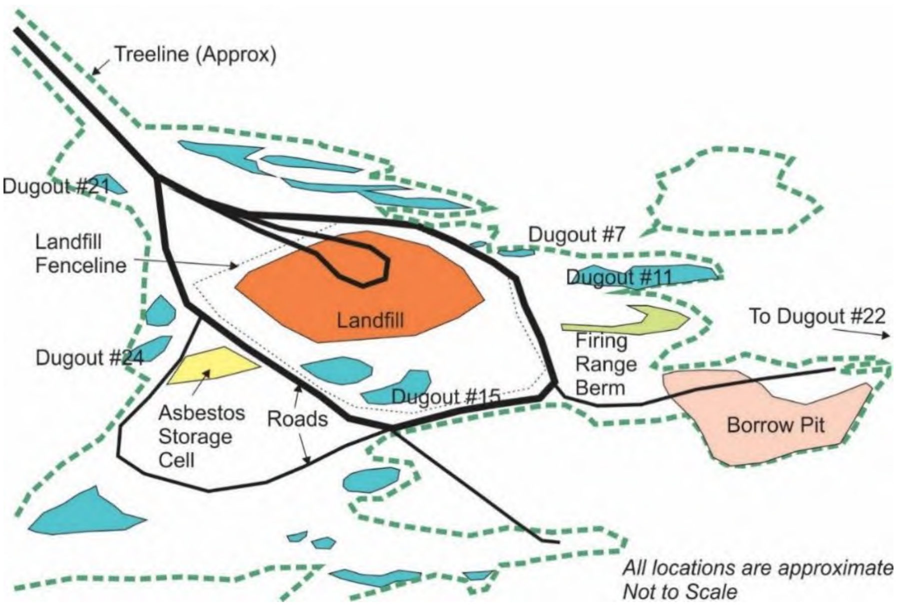

Figure 14: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Table 90 and Table 91 respectively. All alpha results for 2021 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. All beta results for 2021 were near the detection limits, and are below the drinking water screening level of 1.0 Bq/L. Both alpha and beta results for 2021 are consistent with previous results obtained from 2016 to 2020.

Table 90: Gross Alpha Results from the Landfill Dugouts

Sample	Gross Alpha (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	< 0.14	< 0.17	< 0.17	0.07	<0.05	<0.05
Dugout #11	< 0.10	< 0.14	< 0.14	< 0.05	<0.05	0.05
Dugout #15	0.16	0.10	0.10	0.28	<0.05	0.05
Dugout #21	0.16	0.07	0.07	Dry	<0.05	<0.05
Dugout #22	< 0.11	< 0.14	< 0.14	0.11	<0.05	<0.05
Dugout #24	< 0.18	< 0.19	< 0.19	0.29	<0.05	<0.05

Table 91: Gross Beta Results from the Landfill Dugouts

Sample	Gross Beta (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	0.19	0.17	0.17	0.11	0.07	0.08
Dugout #11	0.07	0.02	< 0.10	< 0.05	< 0.05	0.01
Dugout #15	0.35	< 0.07	< 0.07	0.12	0.16	0.30
Dugout #21	0.12	< 0.05	< 0.05	Dry	< 0.05	0.13
Dugout #22	< 0.06	< 0.13	0.13	< 0.05	0.05	0.05
Dugout #24	0.26	0.08	< 0.08	0.25	0.06	0.10

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a low value was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there through 2021. The higher tritium level in Dugout 15 was 93 Bq/L, approximately one-half of that measured in 2019 (212 Bq/L). All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2021 that contain < 5 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 92.

Table 92: Results from the Landfill Dugouts

Sample	Tritium (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	< 4	< 4	< 4	< 3	< 4	< 5
Dugout #11	< 4	< 4	< 4	< 4	18	< 5
Dugout #15	98	82	105	212	54	93
Dugout #21	< 4	NA	< 4	Dry	< 3	< 5
Dugout #22	< 4	< 4	< 4	< 4	< 3	< 5
Dugout #24	5.5	< 4	76	< 4	< 4	< 5

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has

a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill had been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing conducted in 2018 included Sr-90 and Tc-99, two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. In 2019, only Sr-90 was tested, and was found to be at the detection limit. In 2020, both Sr-90 and Tc-99 were again measured. Sr-90 was at the detection limit and Tc-99 was not detected. In 2021 (Table 93), no Sr-90 analysis was conducted as per the instructions provided to lab to only analyze if gross Beta exceeded 5 Bq/L. Tc-99 was again below the detection limit. The water from these dugouts and wells is not used for human consumption. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99.

Table 93: Sr-90 and Tc-99 Results from the landfill Dugouts in 2021

Sample Location	(Bq/L)	
	Sr-90	Tc-99
Dugout #7	NA	ND
Dugout #11	NA	ND
Dugout #15	NA	ND
Dugout #21	NA	ND
Dugout #22	NA	ND
Dugout #24	NA	ND

NA – No Analysis Gross Beta below analysis trigger limit.

ND – Non Detect

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia (N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron were detected in Dugout #15, a continuation of results from 2017 onwards (Table 94). The value in 2021 remained under the Drinking Water Guideline for Boron (5,000 µg/L). Dugout #24 showed 431 µg/L in 2021, all other dugouts showed values below detection limits.

Table 94: Boron Results from the Landfill Dugout #15

Sample Location	(µg/L)				
	2017	2018	2019	2020	2021
Dugout #15	1630	5460	8460	2040	3760

Molybdenum remained at detection limits from 2020 through 2021. In 2021, Manganese remained higher than drinking water guidelines of 50 µg/L in Dugout #15 (509 µg/L). No other parameters were detected at concentrations of concern.

Groundwater results will be discussed in the annual Environmental Monitoring report [29]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [28].

Landfill Dugout Sediment Monitoring

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, as such no sediment sampling was conducted in 2021.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program [28].

Landfill Radiological Monitoring

Annual radiological monitoring of the landfill surface is performed as a confirmatory measure. The results show readings consistent with background levels at the landfill fence line. Table 95 provides a five year listing of survey results at the top of the landfill. For some years monitoring was performed at the base of the pile, and more recently monitoring was performed around the perimeter of the fenced area of the landfill.

Table 95: Landfill Radiological Monitoring

Sample Location	(µR/h)				
	2017	2018	2019	2020	2021
Landfill Top Surface	10-16	8 - 10	6 -12	6 - 12[2]	10
Landfill Base	< 20	NR	5 - 8[1]	5 - 8[1]	10

NR – Not recorded

[1] Taken at the fence line instead of base of landfill

[2] Metal waste collection bins sited at top of landfill

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Annual Compliance Monitoring Report

Whiteshell Laboratories Annual Compliance Monitoring Report for 2021

WL-514300-ACMR-2021

Revision 0

Prepared by:	R. Swartz Manager, Licensing & Quality Management	2022/04/28 Date
Reviewed by:	S. Cotnam Senior Director, Compliance – Chief Regulatory Officer	2022/04/28 Date
Approved by:	J. Gilbert Head, WL Closure Project	2022/04/28 Date

UNRESTRICTED

This page is for Content Controls that apply to this document. If no Content Controls apply, none will be listed.

Revision History

Rev. No.	Date	Details of Rev.	Prepared By	Reviewed By	Approved By
0	2022/04/28	Issued as "Approved for Use".	R. Swartz	S. Cotnam	J. Gilbert
D2	2022/04/04	Issued for "Review and Comment".	R. Swartz	S. Cotnam J. Gilbert S. Brewer C. Gallagher	
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EXECUTIVE SUMMARY

This annual compliance monitoring report for the 2021 calendar year has been prepared as per licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 and CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Facilities and Uranium Mines and Mills* as a summary report of annual compliance monitoring and operational performance.

Canadian Nuclear Laboratories (CNL) would like to acknowledge Canada's Indigenous Peoples and their traditional territories upon which CNL carries out its work. CNL also wishes to confirm its commitment to being an active participant in Canada's journey towards healing and reconciliation.

This annual compliance report provides CNL 2021 performance data for WL and is organized by 14 Safety and Control Areas (SCAs)[1], as well as a report on each of the WL nuclear and non-nuclear facilities.

The following provides overall performance highlights for 2021 activities:

- All licensed activities continued to be carried out safely and securely.
- No member of the public received a radiation dose that exceeded any regulatory limit.
- No worker at WL received a dose in excess of any of the respective radiation dose limits for radiation workers, as defined in the Radiation Protection Regulations.
- All releases of radioactive material in WL effluents during 2021 were below their respective Derived Release Limits (DRL).
- Demolition of Building 200, the former Active Liquid Waste Treatment Centre (ALWTC), is complete, and Building 402/305, the former Health and Safety Facilities, is partly demolished.
- The WL site maintained safe and compliant performance under COVID-19 Pandemic conditions and protocols.

Below is a summary of the annual compliance report for calendar year 2021.

- **SCA - Management System**: WL has continued its focus on implementation of the corporate management system, as well as the WL Quality Assurance program for decommissioning. After having no Canadian Nuclear Safety Commission (CNSC) inspections in 2020, four inspections were carried out in 2021.
- **SCA - Human Performance Management**: A significant effort towards training individuals in human performance related areas continued as a result of the fieldwork pause in 2020 November. Another outcome of the fieldwork pause was the development and delivery of the initial Annual General Employee Training which goes

[1] The CNSC evaluates how well licensees meet regulatory requirements and CNSC expectations for the performance of programs in 14 safety and control areas.

over site and project updates, as well as review of policies and procedures. This will be updated and delivered annually to all employees.

- **SCA - Operating Performance**: WL decommissions and operates its facilities according to prescribed programs and procedures, and monitors safety performance in the operational area through the concept of "events". The total number of internal event reports raised continues to show a strong reporting culture. There were six CNSC reportable events in 2021.
- **SCA - Safety Analysis**: Effective Safety Analysis Reports and Facility Authorizations continue to be in place for WL's nuclear facilities, helping meet health, safety, security, environmental and regulatory requirements. Safety analyses continue to be developed for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and Cask Loading facilities being constructed in the Waste Management Area.
- **SCA - Physical Design**: The Certificate of Authorization was renewed with Engineers Geoscientists Manitoba, authorizing CNL to engage in the practice of professional engineering in Manitoba. The new revised WL Pressure Boundary Quality Assurance Plan was accepted by Inspection and Technical Services Manitoba and a new Certificate of Authorization was issued.
- **SCA - Fitness for Service**: The Periodic Inspection Plan (PIP), previously developed to confirm the ongoing fitness-for-service of the concrete storage facilities at the Waste Management Area (WMA), continued implementation with no significant issues identified. Regular preventative or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Missed maintenance of safety-related systems was reported to CNSC, and a corrective action plan was developed that will fix the issues and prevent recurrence.
- **SCA - Radiation Protection**: No worker received a whole-body dose (including committed) in excess of any of the respective dose limits for radiation workers as defined in the Radiation Protection Regulations, and average individual doses remain a small fraction of these limits. Maximum dose to a person working at WL was 0.6 mSv and collective doses remained below 50 person-mSv (19.0 person-mSv) for 2021. Members of the public received no measureable radiation doses.
- **SCA - Conventional Health and Safety**: Implementation of CNL's Occupational Safety and Health program at WL continues to drive improvements in safety and safety culture. Safety advisories are regularly issued to staff about imminent issues that could impact their safety. There were no lost-time injuries at WL in 2021.
- **SCA - Environmental Protection**: The results of the radiological and non-radiological effluent monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment. Radiological emissions were 0.00019% of the Derived Release Limit (DRL) for air emissions and 0.47% of the DRL for liquids. The monitoring program confirms that the WL site is operating in a manner that protects workers, the

public, and the environment. WL maintained their ISO-14001 registration, and are compliant to a number of CSA environmental standards.

- **SCA - Emergency Management and Fire Protection**: The Emergency Management program at WL continued to be focussed on supporting COVID-19 planning and coordination efforts, providing procedures and guidance to enable work to continue safely in this dynamic situation. A third party Fire Protection Audit was conducted, and resolution to findings will be tracked through the corrective action program.
- **SCA - Waste Management**: WL continued to reuse or recycle as much material as was practicable. Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects, including disposition of 924 m^3 of radioactive waste to Chalk River Laboratories (CRL), and 271 m^3 (37,145 kg) of recycled waste shipped off-site. The WL Site Overview Detailed Decommissioning Plan was revised and accepted by CNSC.
- **SCA – Security**: The Security Program at WL supports the CNL Corporate Security mandate and addresses the regulatory requirements for high-security sites. Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers as required by the CNSC.
- **SCA - Safeguards**: There were no issues identified with International Atomic Energy Agency (IAEA) Safeguards inspections conducted at WL. The IAEA also provided human surveillance and IAEA seal verification, removal and reapplication during canister inspection activities.
- **SCA - Packaging and Transport**: There were 68 radioactive transport packages making up 53 loads that were safely and successfully sent off-site, including approximately 921 m^3 of low-level waste and 3 m^3 of intermediate-level waste shipped to CRL.
- **Other matters of regulatory interest**: Two virtual meetings of the WL Public Liaison Committee took place. Numerous public information sessions and Indigenous engagements (mainly virtual) were held on the Whiteshell Reactor 1 (WR-1) in-situ decommissioning and overall activities of the WL Closure Project, including four Webinars.
- **Facilities** (operating nuclear facilities, permanently shut down facilities, facilities being decommissioned and the non-nuclear facilities): All the licensed activities in these facilities continue to be carried out safely and securely with acceptable radiation doses to personnel and releases to the environment. The following notable facility-specific activities took place: the Active Liquid Waste Treatment Centre, Building 200, completed demolition, and significant progress was made in demolition of the Health and Safety Facilities, Building 402/305.

CNL is committed to achieve high standards of operational safety and security. The information and data presented in this report support the conclusion that safe and secure performance was achieved at the Whiteshell Laboratories site, while enhancements were implemented to further improve results.

ACKNOWLEDGEMENT

The “Author” of this document would like to thank the many Whiteshell Laboratories authors and reviewers from the various Functional Support Areas and Facilities for their production of the individual sections of the report.

CNL’s Continued COVID Pandemic Response

For a detailed description of CNL’s robust mitigation initiatives and controls to protect its employees, contractors, visitors and Site operations from the COVID pandemic, see the Executive Summary in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories*.

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TABLES

INTRODUCTION

Whiteshell Laboratories (WL) was established by Atomic Energy of Canada Limited (AECL) in the early 1960s to carry out nuclear research and development activities. The site is a Class 1B nuclear facility which encompasses an area of 4,375 hectares. The WL site is located near Pinawa, Manitoba; approximately 100 kilometres northeast of Winnipeg, on the eastern bank of the Winnipeg River. AECL made a business decision in 1997 to discontinue most of the research programs and operations at WL. Subsequently, AECL received government concurrence in 1998 to proceed with actions to achieve closure of WL. This work transitioned to Canadian Nuclear Laboratories (CNL) who are carrying out the work to achieve site closure on behalf of the site owner, AECL.

Activities are now underway to complete the orderly decommissioning of the WL site, following the general plan laid out in the Comprehensive Study Report supporting the approval of the Environmental Assessment of the WL Decommissioning Project. The exception to this is the change in strategy for Whiteshell Reactor (WR) -1 (see the Decommissioning Strategies Section below).

Name:	Whiteshell Laboratories
Location:	*1 Ara Mooradian Way* *Pinawa, Manitoba* *R0E 1L0*

Licence Information and Reporting Period

This annual compliance monitoring report is produced to comply with licence condition 3.2 of the Whiteshell Laboratories Licence NRTEDL-W5-8.00/2024 [1], in accordance with the compliance verification criteria Compliance Monitoring: Annual Report of the *Licence Conditions Handbook (LCH) for Whiteshell Laboratories,* herein referred to as “Licence Conditions Handbook” [2], and section 3 Annual Compliance Monitoring Report of CNSC REGDOC-3.1.2, *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* [3]. Information included in this report is for the period of 2021 January 01 to December 31.

This report provides site-specific information to supplement information in the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4], which provides corporate updates to 14 Safety and Control Areas as they are applied across all of CNL.

The intent of this report is to provide sufficient detail to demonstrate how Whiteshell Laboratories programs are meeting the regulatory requirements as specified in the licence [1] and the LCH for Whiteshell Laboratories [2].

Facilities Included in this Report

Appendices Appendix A through G of the report provide information that is pertinent to the Nuclear and Non-Nuclear Facilities (including operating and permanently shut down facilities, and facilities being decommissioned).

The Nuclear Facilities included in this report are: Concrete Canister Storage Facility, Active Liquid Waste Treatment Center, Shielded Facilities, Waste Management Area, Research and Development Facilities Complex (Building 300), Health and Safety Facilities (Building 402 and Building 305), and WR-1 Reactor.

Summary of Licensed Activities

There are no new licenced activities.

Decommissioning Strategies

As discussed since 2015, work is underway to complete decommissioning of the entire WL site (current schedule is to be complete in 2027). This includes leaving in-situ the selected WMA trenches as per the Comprehensive Study Report under institutional control, and transporting active waste off-site for disposal or storage. A significant departure from the end-states defined in the Comprehensive Study Report is in situ decommissioning (also referred to as in situ disposal) of the WR-1 reactor. Work continues for an environmental assessment and regulatory approvals required for this proposed change. The Environmental Impact Statement supporting this is in progress.

Financial Guarantees

CNSC was previously sent a letter from the Honorable G. Rickford [5], advising that as an agent of Her Majesty in Right of Canada, AECL’s liabilities associated with the decommissioning of WL are ultimately liabilities of Her Majesty in Right of Canada (note: AECL retains ownership of the lands, assets and liabilities associated with CNL's licences). This financial guarantee remains valid and in effect, as per the communication issued on 2020 August 25 [6].

1 Management System

1.1 Management System Program

Whiteshell Laboratories adheres to the Corporate Management System. See Section 1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL Quality Assurance Plan [7] supports the CNL Management System Manual [8] and summarizes the processes and practices applicable to WL licensed activities, while still retaining compliance to CSA N286-12 [9] and N286.6-98 [10].

1.2 Audits, Inspections and Self-Assessments

As per the requirements of the Management System [8], both Safety Control Areas and Facilities conduct various audits, inspections, and self-assessments to ensure that the management system is functioning according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate actions taken to resolve them.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Corrective Action Program.

1.2.1 Audits

See Section 1.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* [4] for a list of all CNL-wide Audits for the reporting year 2021.

1.2.1.1 External Audits

The external audits conducted at Whiteshell Laboratories are summarized in the table below.

Table 1: External Audits

Title	Type of Audit	No. of Non-Compliances Raised	No. of Non-Compliances Completed
SAI Global Recertification Audit of the WL Environmental Management System	14000:2015	0	Not applicable
PLC Fire Safety Solutions Audit of the Fire Protection Program	CSA N393	31	0

For the Fire Protection Program audit, the non-compliances related mostly to missing documentation for inspection, testing and maintenance activities. The audit report was received late in 2021, and a corrective action plan is to be submitted to CNSC staff in early 2022.

1.2.1.2 Internal Quality Audits

There were no internal audits completed by the Quality Audits and Processes branch specific to Whiteshell Laboratories in 2021.

1.2.2 Inspections

CNSC Inspections

The following CNSC Inspections were conducted at Whiteshell Laboratories.

Table 2: CNSC Inspections for 2021

Inspection No.	Area Inspected	No. of NNC[a]s	No. of NNC[a]s Completed
CNL-WL-2021-01	Human Performance Management	2	2
CNL-WL-2021-02	Management System	6	6
CNL-WL-2021-03	General	3	0
CNL-WL-NSD-T2-2021-001	Security	7	0

a NNC – Notice of Non-Compliance

Inspections by Other Regulatory Bodies

A Physical Inventory Verification (PIV) inspection was carried out by the IAEA on 2021 May 26. This inspection was a sampling of accessible items containing Special Fissionable Material. A Design Information Verification inspection was carried out by the IAEA on 2021 May 25-27. This inspection verified the information provided in the Design Information Questionnaire.

Transport Canada conducted a virtual Transport of Dangerous Goods (TDG) inspection at WL in 2021 and did not find any non-conformances.

1.2.3 Self-Assessments

In 2021, there were 18 self-assessments conducted at Whiteshell Laboratories covering various aspects of the management system, including both safety and control areas, and various facilities.

Table 3: List of Self-Assessment Conducted at Whiteshell Laboratories in 2021

Title	Facility/Department
Effectiveness of Industrial Hygiene Instrumentation	WL Occupational Safety and Health (OSH)
Workload on the SMO	WL Environmental Management (EM)
WL Integrated Work Control	WL Site and Nuclear Operations
TDG Requirements	WL Waste Management

Movement of Radioactive and Non-Radioactive Materials	WL Waste Management
Registration and control of radiation sources	WL Radiation Protection (RP)
WL RP Program Compliance Review	WL RP
WL-510400-OI-366-01 - WL Lock Out Tag Out (LOTO)	WL Site and Nuclear Operations
900-510400-MCP-032 - Work Permit	WL Site and Nuclear Operations
WL EM QA Plan WL-514200-QAP-001 to 17025, Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Document Control	WL EM
Compliance to ISO/IEC 17025:2017 Risk Assessment Process	WL EM
Compliance to ISO/IEC 17025:2017 Improvement	WL EM
WL Radiation Dose Reporting to NEW Workers for 2020 Doses	WL RP
Manager Dose Control Points and RP Training Designation Annual Reviews for 2021	WL RP
REGDOC 2.12.1, High Security Sites: Nuclear Response Force Section 7	WL Emergency Services
REGDOC 2.10.1 Section 2.2.1, Emergency Response Organization and Staffing	WL ES
Impairment Notification and Compensatory Measures	WL ES

1.3 Management Reviews

The Quality Assurance Program/Management System Review for 2018/19 and 2019/20 was completed. The review identified 6 actions, all of which are completed.

2 Human Performance Management

2.1 Human Performance Program

Whiteshell Laboratories adheres to the Corporate Human Performance (HU) Program. See Section 2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.1.1 Program Improvements and Accomplishments

The effectiveness of the HU program at WL has been enhanced through the following improvements:

- Following the 10 week fieldwork pause in 2020 November to address an adverse trend in human performance, WL gradually increased fieldwork throughout 2021 February. WL executed an extensive Corrective Action Plan, which included comprehensive reviews and updates to procedures and a significant investment in employee training. Improvements implemented included increased supervisor presence in the field, in depth review of proper use of tools and equipment, procedure awareness and compliance, sharing of lessons learned, and better pre- and post-job briefs. WL also performed several self-assessments through the integrated assessment plan and implemented new work control metrics.
- In 2021 May, Performance Assurance reintroduced the two-level rigorous review of ImpAct records by re-instating the Management Screening Team (MST) weekly meeting. MST's mandate is to provide management level review and oversight of the ImpAct record and ensure it has sufficient and accurate information to let the Management Review Meeting (MRM) team conduct their review. The MST assesses and recommends the significance level, cause determination effort, cause statement and the Responsible Manager. MRM provides Director level (and above) oversight for the ImpAct Corrective Action Program. The MRM team confirms, or modifies as appropriate, decisions made by the MST.
- In 2021 August, a three day TapRooT® Essentials Course was delivered to nine (9) WL Employees. The virtual sessions were taught by an external root cause analysis and investigation expert who guided immersive learning activities using interactive presentation technology, group exercises, and two-way interaction. TapRooT® is a powerful tool in conducting investigations and has already been used to augment CNL's current cause analysis techniques.
- WL enlisted the support of the recently formed CNL Strike Team, comprised of experts from across CNL, to conduct a causal analysis for a discovered adverse condition regarding the WL Preventative Maintenance program (see ERM-21-3009 in Table 5). Unlike the usual Apparent Cause Analysis or Root Cause Analysis processes, the Strike Team's causal analysis used a Facts Issues Causes Actions table. Doing the investigation in this manner allowed the team to develop the causal analysis and corrective actions in

a concise and timely manner. This tool will be beneficial for future investigations that may need to be conducted.

2.2 Training programs

Whiteshell Laboratories adheres to the Corporate Training and Development Functional Support Area. See Section 2 of the Annual Compliance *Monitoring Report for Canadian Nuclear Laboratories* for details [4].

2.2.1 Program Improvements and Accomplishments

The effectiveness of WL Training Program has been enhanced through the following improvements:

- Revisions to the content for the New Employee/Contractor Orientation to reflect current policies and procedures for working on site.
- WL introduced the Integrated Work Control Core 5 Elements course, which provides contractors with training that combines the 5 core courses delivered during the safety stand down: Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls.
- Development of the initial Annual General Employee Training to review site and project updates, as well as policies and procedures. This will be updated and delivered annually to all employees.
- Updates and improvements to the content and media for the Radiation Group 4 Training delivered to all employees and contractors coming to site.
- Major revisions to the Delivering Practical Training course. Content now includes adult learning and learning principles content. This course is required for any employee who conducts on-the-job training and functional checkouts for skills assessments.
- Redevelopment of the Waste Management & Fundamentals courses to include updates to policies and procedures in our Waste Management Program.
- Revisions to the content and materials for Vehicle Spotter Training. Delivery to all staff who are required to have spotter training.
- Development of the ‘Training Matrix tool’ which allows managers and supervisors to quickly look up the training status of their teams.

2.2.2 Systematic Approach to Training

CNL maintains a list of positions and roles requiring Systematic Approach to Training (SAT) training programs in compliance with REGDOC-2.2.2, Personnel Training [11].

Training and Development evaluated the training programs for listed positions and roles at WL against the main elements of SAT. The results led to initial individual action plans which are being managed and further evaluated by the Curriculum Review Committees. Additional corrective actions and program improvements will be identified and managed by the

Curriculum Review Committees going forward. Since the initial analysis of the listed positions, dedicated Training and Development personnel have been hired and assigned to support WL in the completion of the action items identified. Curriculum Review Committees for the WL WMA and Shielded Facilities have been established and progress on the actions is underway.

2.2.3 Required Training

Some WL listed positions and roles require additional training documentation development to achieve full SAT-compliance. Current workers are qualified based on existing training programs combined with their years of experience in the role. Existing training programs include classroom training, practical training, computer-based training, and mentor style training. These experienced workers will assist as Subject Matter Experts (SMEs), in the development of training documentation that is required to achieve full SAT-compliance.

All Whiteshell Laboratories personnel, both employees and contractors, are adequately trained (and refreshed) to ensure safe operation of their facilities and to conduct work under the licence [1]. Section 2 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories [4] provides the 2021 CNL Employee and Manager/Supervisor required training. Table 4 provides a list of federally/provincially legislated training courses that appear in position-specific training plans at Whiteshell Laboratories.

Table 4: Whiteshell Laboratories Operating Staff Training in 2021

Course Code	Course Title	No. of Attendees
OSH-1001-Online	Crane (Safe Indoor Hoist) – Theory	44
OSH-1002-Online	Lift Truck Operation – Theory	40
OSH-1003-Online	Aerial Work Platform – Theory	59
OSH-1004-Online	Lock Out / Tag Out Exam	28
OSH-1004-Virtual	Lock Out / Tag Out (Virtual)	28
OSH-1005-Online	Working at Heights – Theory	84
OSH-1006	Confined Space Entry	14
OSH-1006-Online	Confined Space Exam	15
OSH-1006-Virtual	Confined Space Entry (Virtual)	25
OSH-1007	Asbestos Module 6E	51
OSH-1033-Online	Ladder Safety	27
OSH-1034-Online	Hazard Prevention Program	31
OSH-1042-Online	WHMIS – 2015	40
OSH-1046-Online	Heat Stress	7
OSH-3001-E	Crane – Safe Indoor Hoist – Practical – Jib Crane	3
OSH-3001-F	Crane – Safe Indoor Hoist – Practical – Bridge Crane	3

OSH-3001-J	Crane – Safe Indoor Hoist – Practical Gantry Crane	2
OSH-3001-K	Crane – Safe Indoor Hoist – Practical	1
OSH-3001-L	Crane – Safe Indoor Hoist Only	13
OSH-3001-MULTI	Crane – Safe Indoor Hoist – Practical – All Equipment Codes	8
OSH-3002-C	Lift Truck Practical – Counter Balance	18
OSH-3002-MULTI	Lift Truck Operation – Practical/All Equipment Codes	4
OSH-3003-B	Aerial Work Platform Practical – Articulating Boom 60 ft (or less)	21
OSH-3003-C	Aerial Work Platform Practical – Rough Terrain Scissor Lift	27
OSH-3003-D	Aerial Work Platform Practical – Scissor Lift	25
OSH-3003-E	Aerial Work Platform Practical – Single Person Up-Up	1
OSH-3003-Multi	Aerial Platform – Practical (All Equipment Codes)	34
OSH-3005	Working at Heights – Practical	88
HU-1036-Online	Pre job Brief	12

2.2.4 Contractor Training

Before accessing the Whiteshell Laboratories, contractors are required to complete the following training:

- Contractor Safety Orientation
- Radiation Protection Group 4
- Integrated Work Control Core 5 Elements (Work Permit Authorization, Job Safety Analysis, Pre-job Brief, Stop/Pause Work and Integrated Work Controls)
- CNL COVID Awareness

WL utilizes the contract terms and conditions, in addition verifying and approving the contractor company’s safety programs and training records, to ensure contractors are qualified to work at WL.

WL oversees contractors’ work in the field and all WL work control protocols apply.

2.2.5 Training Evaluations Summary

In 2021 WL continued to utilize trainee feedback forms to capture learner input as part of training program improvement and maintenance activities. Also, there were 16 documented Observation and Coaching sessions related to training events. These evaluations are reviewed weekly by Training and Development staff and training program improvements are managed through applicable training change processes.

3 Operating Performance

3.1 Operating Program

Whiteshell Laboratories adheres to the Operating and Decommissioning Functional Support Areas. See Section 3.1 and Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories decommissions and operates its facilities according to prescribed programs and procedures. Operating performance is monitored through the nuclear performance assurance review board and other internal assessment activities such as self-assessments and audits (see Section 1.2).

3.1.1 Operations / Decommissioning Operations

Operational details on facilities identified in the *Site Licences, Certificates, Permits, Building/Facility Contacts, and Licence Representatives* [12] for Whiteshell Laboratories are given in Appendix A through F.

3.1.1.1 Conduct of Operations

Conduct of operations documents ensure appropriate integration and adequate reflection of safe operation practices to meet the business requirements.

3.1.1.2 Modification to Facilities and Processes

All temporary and permanent modifications to facilities at WL are made following defined Engineering Change Control [13] processes.

Relevant modifications to WL facilities are given in Appendix A through G.

3.2 Reporting Requirements

3.2.1 Reportable Events to CNSC

In 2021, there were 6 events that occurred at Whiteshell Laboratories that were deemed reportable to the CNSC. They are listed in Table 5.

Table 5: Reportable Events to the CNSC at Whiteshell Laboratories in 2021

Event No.	Title	SCA	Facility (if applicable)
ERM-21-3585	WL Injury - Medical Aid - Slip, Trip, Fall (Leg Injury)	Operating Performance	WL Building 300 (Research and Development)
ERM-21-3009	WL Reportable Event – Missed maintenance of safety related systems as per the Shielded Facilities Facility Authorization	Operating Performance	WL Shielded Facilities

HSSE-21-1772	WL - Radiation Source Found in Area Radiation Monitor Removed from B305 Electron Accelerator	Radiation Protection	WL Building 402 (Health and Safety)
ERM-21-1732	WL Environmental Protection: Hydraulic Leak at the Building 200 Demolition site involving a contractor's Hyster 550 Fork Lift (Rental Unit)	Environmental Protection	WL Building 200 (Active Liquid Waste Treatment Centre)
ERM-21-1651	WL Reportable Event - Building 402 Fire Protection System Impairment	Fire Protection	WL Building 402 (Health and Safety)
ERM-21-1036	WL - Incomplete Inventory Results in Misclassification of Shipment	Packaging and Transport	

3.2.2 Reportable Events to Other Regulators

Reports to other regulatory agencies consisted of:

- 1 Hazardous Occurrence Investigation Reports (HOIR) was made to Employment and Social Development Canada (see Section 8.1.3 for further details)
- 2 reports made to Environment and Climate Change Canada (see Section 9.5.2.4 for further details).

3.2.3 Trending of Events Related to Operational Activities

As events at Whiteshell Laboratories occur, they are recorded in the Improvement Action (ImpAct[2]) system. This information is regularly reviewed and analyzed to identify any trends. To identify trends Event Code based trend reports are also prepared to analyse ImpAct data on monthly bases. Monthly site wide and WL specific trend reports are prepared by CRL Performance Assurance and shared with WL. WL specific trends are also specified in the monthly Contractor Assurance System scorecard.

The following trends were identified and raised as ImpActs:

- ERM-21-1299, WL TREND – No Purchase Order in Place Prior to Commitments of Contract Service Providers Coming to Site
- ERM-21-3088, WL TREND - Misuse of WHMIS (Workplace Hazardous Materials Information System) when labelling or storing hazardous waste.
- ERM-21-3132, WL TREND – Increased Vehicle Accident Incident Reports (VAIR), Equipment and/or Passenger Vehicles on site and in main parking lot at WL.
- HSSE-21-3283, WL TREND – Barrier Crossings.

[2] ImpAct – Abbreviation for Improvement and Action. It is an internal process used to identify events, problems, non-conformities, opportunities for improvements, and personnel injuries. The process also identifies and tracks actions to correct or remediate problems.

The use of the ImpAct process continues to foster the internal reporting of lower significance level events (Level 4 and some Level 3), affording the opportunity to implement continuous improvement initiatives through a robust Corrective Action Program.

In 2021, a total of 424 ImpActs were raised by CNL employees at WL.

The reporting of lower significance level events continues to be encouraged (e.g., Near Miss Reporting – see Section 8, which is an industry best practice), and efforts to improve safety culture (Event Free Tools use, Event Free Day Reset, Observation and Coaching, etc.) have been adopted by both management and staff.

The following table summarizes ImpActs raised over the past 5 years by Significance Level[3].

Table 6: Number of ImpActs raised at Whiteshell Laboratories

Year	Level 0[a]	Level 1	Level 2	Level 3	Level 4	Total
2017	5	0	0	42	448	496
2018	10	0	0	39	532	581
2019	8	0	0	54	547	609
2020	13	0	3	58	276	350
2021	5	0	2	81	336	424

a Level 0 will be assigned if the ImpAct is deemed to be a “non- problem” and a recommendation to close the Impact will be given.

3.2.4 Notification of Conflicts or Inconsistencies

In 2021, there were no conflicts or inconsistencies identified between licence conditions, codes or standards, operations, programs, methods, or regulatory documents referenced in the Whiteshell Laboratories Licence [1] or *Licence Conditions Handbook* [2].

3 Significance Level: Levels assigned to an event (SL1 being most significant, SL4 being least significant) based on the actual or potential result in safety, environmental, or business consequences.

4 Safety Analysis

4.1 Safety Analysis Program

Whiteshell Laboratories adheres to the Corporate Safety Analysis Functional Support Area. See Section 4.1 of the Annual Compliance Monitoring Report for Canadian Nuclear Laboratories for details [4].

4.1.1 Safety Analysis Reports

Safety Analysis Reports (SARs) are produced to demonstrate that the facilities are appropriately designed to meet health, safety, security, environmental and regulatory requirements, and operated safely. These SARs form part of the basis for a set of limiting conditions for safe operation that are documented within Facility Authorizations for each nuclear facility. At WL, three facilities have SARs and Facility Authorizations: Shielded Facilities (SF), WMA and Concrete Canister Storage Facility (CCSF). The ALWTC SAR and Facility Authorization documents were previously obsoleted in 2020 [14]. Assessments are in progress to determine if the SF and WMA SARs need to be revised. The CCSF SAR is being updated to address upcoming fuel retrieval activities.

A SAR is being prepared for the standpipe/bunker remediation, Intermediate-Level Liquid Waste Processing Centre and conversion of the SMAGS building to a Cask Loading Facility. This document will be an addendum to the existing WMA SAR and will be submitted to the CNSC before these facilities are operated.

4.2 Nuclear Criticality Safety Program

Whiteshell Laboratories adheres to the Corporate Nuclear Criticality Functional Support Area. See Section 4.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

As the Nuclear Criticality Safety Program is a companywide program, enhancements and improvements made were intended to target all sites including WL and are identified in [4].

4.2.1 Nuclear Criticality Safety Documents

The WL Criticality Safety Documents (CSDs) for the Waste Management Area (CSD-27), the Cask Loading Facility (formerly the Whiteshell Laboratories SMAGS Building B923) (CSD-73) were conditionally accepted and the Intermediate-Level Liquid Waste Processing Centre (CSD-74), Concrete Canister Storage Facility (CSD 11), and the Fuel Basket Transfer Flask (CSD-54) are in progress to allow retrieval of waste from the WMA and CCSF. The remaining WL CSDs have not been updated during this review period.

5 Physical Design

5.1 Design Program

Whiteshell Laboratories adheres to the Corporate Design Functional Support Area. See Section 5.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Design Authority and Design Engineering Functional Support Area maintains and controls the design basis for all design activities performed at WL.

In 2021 March, the Certificate of Authorization was renewed with Engineers Geoscientists Manitoba. This authorizes CNL to engage in the practice of professional engineering in the province of Manitoba in accordance with the provisions of The Engineering and Geoscientific Professions Act.

5.1.1 Safety Related Structures Systems and Components

In 2021, the Design Authority and Design Engineering Program ensured that any structures, systems and components important to safety met and maintained their design basis, and any changes made were controlled through the Engineering Change Control Process [13].

5.2 Pressure Boundary Program

Whiteshell Laboratories adheres to the Corporate Pressure Boundary Functional Support Area. See Section 5.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Pressure Boundary Functional Support Area applies to design, procurement, fabrication, installation, examination, testing, repair, modification, construction and maintenance of pressure retaining systems and components performed by CNL at WL.

The *WL Pressure Boundary (PB) Quality Assurance (QA) Plan* [15] details the specific scopes of pressure boundary work carried out at WL, as permitted by the Certificates of Authorization issued by Inspection and Technical Services (ITS) Manitoba, describes the controls, authorities, and responsibilities applicable at the WL site, and is consistent with CNL's PB Program requirements.

The revised *PB QA Plan* [15] was accepted by ITS and a new Certificate of Authorization was issued on 2021 August 10. The new certificate of Authorization permits CNL to perform Pressure Boundary work as described in the Quality Assurance Plan until expiry in 2024 August.

The CNSC has previously been notified of revisions to the *PB QA Plan* [15], as per the *Licence Conditions Handbook.*

6 Fitness for Service

6.1 Fitness for Service Program

Whiteshell Laboratories adheres to a Fitness for Service Program through its Maintenance Functional Support Area. See Section 6.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Site and Nuclear Operations Branch provides monitoring and operation of building's processes and support systems. Housekeeping inspections are performed monthly to provide a formal walkthrough of facilities to ensure compliance for specific areas relating to facility performance. Further inspections are conducted of waste storage structures by qualified personnel to maintain them in a fit for service state.

Operating procedure reviews are conducted on a five year cycle. Currently the Operating Procedures are under review; some of these procedures have reached the five-year timeline for review and those are being prioritized for review and updating. As facilities are decommissioned procedures related to those buildings or processes are obsoleted. Procedures to operate the facilities in order to enable decommissioning efforts are prepared as required.

Details on various inspection and maintenance activities are provided in the following sub sections.

6.1.1 Planned Maintenance, Testing & Inspections

As part of Fitness for Service, WL staff ensure that critical systems, structures and components related to the safe decommissioning of WL are understood and that activities are put in place to assure their safe continued operation as they age. An integrated set of programs and activities ensures that performance requirements for all critical systems, structures and components are met on an ongoing basis. These processes include:

- Maintenance, In-Service Inspection and Functional Testing, where preventive maintenance work done in the facilities is tracked to ensure it is completed.
- WL operational regulatory tasks are tracked on a weekly basis to ensure required compliance and facility checks are completed, this includes the tasks set out in the Facility Authorization documents.
- Inspections required to meet the conditions of WR-1 Monitoring and Surveillance Plan.
- Inspections of waste storage structures for fitness for service.

6.1.2 Equipment Fitness for Service/Equipment Performance

Preventive maintenance of safety-related systems in WL's nuclear facilities is carried out by qualified maintainers, in accordance with the facility's Facility Maintenance Plan, and approved maintenance procedures. Preventive Maintenance is defined as the pre-planned routine testing, calibration, inspection, service, and overhaul of safety-related systems, structures, and components. Preventive maintenance is performed to prevent failures from occurring and to

assure the continuing capability of the system, structure or component to perform its design function. The maintenance tasks and frequencies specified in the Facility Maintenance Plan are based on recommendations from qualified WL engineering and maintenance personnel, plus vendor's data where available. Situations where there is evidence of deteriorating conditions or suggestions of an increased probability of upcoming failure are addressed as they are identified. Regular preventive or corrective maintenance and testing of WL's safety-related systems were carried out to ensure the systems were fit-for-service. Maintenance scheduling is conducted with assistance of a Computerized Maintenance Management System which outputs preventive maintenance tasks for scheduling by maintenance and work planning staff.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed and is being implemented that will fix the issues and prevent recurrence. The effectiveness of the corrective action plan will be investigated upon completion of the actions.

6.1.3 Condition of Structures

Waste storage structures include the WMA bunkers and CCSF concrete canisters.

As a requirement of the Environmental Assessment Follow-up Program, a Periodic Inspection Plan (PIP) for WL Concrete Bunkers [16] was developed in 2007 and continues to be implemented to confirm the ongoing fitness-for-service of the concrete storage facilities (termed "bunkers") at the WMA. The PIP describes methods for conducting scheduled inspection surveys of these structures. The inspection is defined as examination, measurement and testing work done, to ensure the bunker systems are functioning as designed and the bunkers remain fit-for-service. The inspections are documented annually, with preventive maintenance and repairs occurring as needed. As the bunkers at the WMA are removed from service as part of the overall decommissioning of the WL site, they will be removed from the inspection process. The 2021 annual inspection of WL WMA concrete bunkers was conducted in accordance with the PIP [16].

Although the SMAGS building (Building 923) is not a bunker it has been included in the bunker inspection. Building 923 is being converted to the Cask Loading Facility, and during this conversion and subsequent re-commissioning for its new purpose, it will not store waste. A repair, conducted in 2016, to the north wall of Building 923 that extended into the core of the slab, remained stable through 2021 with no new crack expressions (the walls of Building 923 are pre-cast concrete slabs). All other repair items for the bunkers and Building 923 were minor in nature and were tracked through the WL work request system.

The concrete canisters are inspected quarterly for concrete spalls and any changes in the hairline cracks of the concrete. In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however existing cracks and pour pockets were regularly checked for changes. Requests for patching were placed in 2021, and several canisters will require more extensive patching of pour pockets that have gradually become more noticeable over time, however no increased radiation field was noted.

Environmental monitoring was conducted in the ditches at the perimeters of the WMA and the CCSF and show no evidence that any activity has been released from the bunkers, SMAGS or concrete canisters.

7 Radiation Protection

7.1 Radiation Protection Program

Whiteshell Laboratories adheres to the Corporate Radiation Protection Functional Support Area. See Section 7 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

Whiteshell Laboratories uses the Chalk River Laboratories (CRL) licensed Dosimetry Service Provider for external and internal dosimetry for site/facility staff and contractors.

Whiteshell Laboratories staff and contractors who work at the WL site are assigned Thermoluminescent Dosimeters (TLDs) to monitor for external radiation exposures.

7.1.1 ALARA Initiatives and Activities

As Low as Reasonably Achievable (ALARA) and Radiation Protection (RP) program improvement initiatives and activities performed at WL in 2021 included:

- Radiological hazard and precaution sheets were reviewed and updated as required to remove statements such as “at the Surveyor’s discretion” or “as directed by RP Surveyor”.
- Enhanced personal protective clothing and equipment requirements were implemented for work in Radiological Safety Zone 2 and 3 work areas.
- Guidelines were developed and implemented for field RP staff for consistent completion of radioactive material transit/storage tags.
- Radiological surveys completed in WL nuclear facilities to confirm absence or identify unknown and unmarked historical or legacy contaminated materials and areas.
- Facility review completed for the adequacy of radioactive material storage areas.
- Field compliance check list developed and implemented for use by field RP staff during facility housekeeping inspections.
- Guidelines provided for RP staff when knee pads or other additional measures are needed to prevent inadvertent knee contaminations when working in contaminated environments.
- New CNL RP program requirement for formal registration of long term radioactive material storage areas was implemented for any new storage areas, and work started on registration of pre-existing facility storage areas.
- WL site procedure developed for the dose monitoring program for WL workers, contractors and visitors.

WL RP performance metrics are measured and tracked weekly through WL Closure Project status reports and quarterly through the WL Nuclear Performance Assurance Review Board. These are designed to identify and address program and performance deficiencies and

opportunities for improvement, establish and effectively implement corrective and preventative action plans.

7.1.2 Dose Control

Regular radiation surveys are performed by RP staff to confirm: the radiological safety zones are correctly designated; areas with local elevated radiation doses rates are posted in accordance with the RP Regulations; and sufficient access control provisions are in place. In 2021, there were no occurrences of dose rates exceeding permissible levels for the designated radiological safety zones and there were no occurrences of work places with accessible dose rates exceeding 25 µSv/h not being posted or with inadequate access control.

Electronic Personal Alarming Dosimeters (PADs) are worn by workers in addition to TLD badges to track and control job specific daily and accumulated doses. The PADs have dose and dose rate alarms which are established by job specific radiological work assessments. The dose alarms are a back-out condition and the dose rate alarms are an alert condition. Table 7 summarizes maximum daily recorded doses and dose rates for PAD work in 2021 and the previous four years, and a summary of PAD alarms. In 2021, the maximum PAD recorded daily dose received by a worker was 0.22 mSv and the highest dose rate measured in the year was 3.1 mSv/h. These were associated with planned exposures associated with decommissioning activities in the Building 200 ALWTC, and removal and packaging hot cell roughing filters in the WL Shielded Facilities. There were no PAD dose alarms and 78 PAD dose rate alarms in 2021. The distribution of PAD dose rate alarms over the past 5 years is summarized in Table 8.

There was an increase in the number of low level dose rate alarms in 2021 due to increased decommissioning and operations activities in the WMA associated with the removal, characterization and packaging of low level radioactive waste from waste storage buildings. These low level dose rate alarms helped alert workers of dose rate areas they did not need to be working in, and thus helped to maintain low doses to workers.

Table 7: Personal Alarming Dosimeter Summary

	2017	2018	2019	2020	2021
PAD – Maximum Daily Dose (mSv)	0.17	0.24	0.42	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.10

Table 8: Distribution of Number of PAD Dose Rate Alarms 2017-2021

Year	Dose Rate Alarm Set Point (mSv/h)							
	≤0.10	>0.10 - <0.25	0.25 - < 0.50	0.50 - < 1.0	1.0 – < 2.5	2.5 - < 5.0	5.0 - < 10	≥ 10
2021	11	20	22	16	7	2	0	0
2020	10	2	1	5	9	1	1	0
2019	9	0	2	12	4	2	0	0
2018	22	0	13	5	31	3	0	0
2017	22	3	26	2	5	0	0	0

At the beginning of 2021, managers assigned and confirmed Dose Control Points (DCPs) for employees and contractors. DCPs are used by managers and supervisors to perform individual whole-body dose management for worker radiation dose for non-emergency work situations. DCPs of either 1 mSv or 2 mSv are assigned by WL managers and represent the worker's maximum allowable dose for the calendar year. The DCPs may be adjusted as necessary during the year upon approval of a Health Physicist after confirmation that additional dose is justified. At the end of 2021, there were no individuals with an assigned DCP higher than 2 mSv, 28 individuals with an assigned DCP of 2, and the remainder of workers with a DCP of 1 mSv. No worker dose exceeded their assigned DCP in 2021.

7.1.3 Contamination Control

Regular contamination surveys of workplaces, material transfers, and personnel exiting nuclear facilities and controlled areas, are used to confirm the absence of unknown contaminated material or the spread of contamination. Workplace air monitors are employed to confirm the adequacy of controls, and to warn of abnormal or unplanned airborne contamination conditions.

Table 9 shows the number of personnel, workplace and material contamination events identified in 2021 and over the past five years. None of the contamination events in 2021 resulted in a recordable whole-body, skin or internal dose.

Material contaminations increased from 1 in 2020 to 11 in 2021. This increase was due to historical surplus equipment being found with low level contamination during operational cleanup activities (8), building decommissioning waste disposition (1), and as a result of operational activities (2). There were no worker skin or clothing contaminations in 2021.

In 2021, there were no airborne contamination exposure events and no radioactive material spills.

The following table outlines contamination events that occurred at Whiteshell Laboratories in 2021:

Table 9: Contamination Events

	Skin and Clothing Contamination				Workplace Contamination	
	Skin[a]	Personal Clothing[a]	Radiological Work Clothing[b]	Total	Surface[c,d]	Vehicle / Materials [b, c]
2017/18 FY	0	0	1	1	3	
2018/19 FY	1	0	5	6	6	0
2019 CY	3	0	4	7	2	4
2020 CY	2	0	3	5	1	1
2021 CY	0	0	0	0	1	11

a Total surface contamination found is greater than 1 Bq/cm^2 beta-gamma or 0.2 Bq/cm^2 alpha over a 100 cm^2 averaging area.
b Total surface contamination found is greater than 4 Bq/cm^2 beta-gamma or 0.4 Bq/cm^2 alpha over a 100 cm^2 averaging area.
c Removable surface contamination found is greater than 0.2 Bq/cm^2 beta-gamma or 0.01 Bq/cm^2 alpha over a 300 cm^2 averaging area for Contamination Zone 1 areas
d Removable surface contamination found is greater than 10 times the maximum allowable levels for Contamination Zone 2 and higher designated areas.

7.1.4 Sealed Sources

Radiation sources are registered and tracked in accordance with CNL procedures.

In 2021, there were no lost or stolen radiation sources. Leak testing was completed as required with all sources passing their leak tests.

As of 2021 December 31, the total number of registered sealed or contained sources at WL, was 53. One Cesium (Cs)-137 source was added to the registry, and one mixed Cs-137 liquid standard and one Cs-137 gamma irradiator were removed from the registry. The liquid standard was evaporated and dispositioned as radioactive waste. The Cs-137 calibrator was transported back to the manufacturer.

7.2 Dosimetry

7.2.1 Interpretation of Reported Dose Quantities

WL uses the CRL licensed Dosimetry Service Provider for external and internal dosimetry for CNL staff, non-CNL employees and visitors. Compliance with the regulatory document REGDOC 2.7.2, *Dosimetry*, Volume II [17] requires external exposure measurements to meet performance criteria with respect to the measurement of personal dose equivalent, $H_p(d)$. This is the quantity currently measured using TLDs worn on the trunk of the body. External whole-body dose (photon) and external surface (photon plus beta) dose as reported herein can be interpreted as $H_p(10)$ (for photons) and $H_p(0.07)$ (for photons and betas), respectively. Effective

dose is the sum of the components external penetrating, neutron, tritium and non-tritium committed effective dose.

External radiation whole-body and skin doses are individually monitored using TLDs for persons entering or working in either radiological Controlled or Supervised Areas at WL[4].

Extremity dosimeters are worn for a defined job by a person who is likely to receive an extremity dose exceeding 1 mSv and significantly greater than a surface dose as monitored by their TLD, or if there is a reasonable probability that an extremity will be exposed to a beta and/or photon dose rate greater than 10 mSv/h.

Neutron dosimeters are issued to individuals who may be exposed to neutrons resulting in dose in excess of 1 mSv in a year or where accidental neutron exposures are possible.

WL staff participate in a routine bioassay program when there is a reasonable probability of receiving a committed effective dose from occupational intakes exceeding 1 mSv per year.

7.2.2 Radiation Doses to Personnel

Table 10 to Table 13 summarize the monitored radiation doses at the WL site for 2021. Doses are summarized for employees, contractors and visitors and are subdivided into Nuclear Energy Worker (NEW) and non-NEW status. Doses in the tables of this report do not include doses received by WL employees and contractors working at sites other than WL. Two visitors had NEW status that were associated with prior NEW requirements and visits within CNL as a whole, these two instances were CNSC and IAEA staff.

In 2021, there were no exceptions for individual monitoring of non-CNL employees and visitors at WL, other than drivers of delivery trucks and building demolition debris haulers in radiological Supervised Areas.

There were no operations of exposure devices in 2021 which required employees or contractors to be placed on a two-week dosimetry period, and there were no formal dose calculations required during 2021 for local area skin contamination.

No neutron dosimeters were assigned to employees during 2021.

In 2021, 180 individuals underwent internal bioassay, which involved urinalysis and/or whole-body counting. Eleven individuals underwent confirmatory and follow-up Pu-in-urine bioassay monitoring and there were no individuals requiring tritium-in-urine monitoring. No committed effective dose estimates were necessary as a result of any bioassay sampling in 2021.

In May of 2021 the building (B402) that housed the WL Whole Body Counter (WBC) began decommissioning and demolition and a new building (B543) is currently being commissioned to house the WBC. It is anticipated that the new facility will be ready for occupancy sometime in the spring of 2022. During this outage, workers who normally participate in annual or bi-annual WBCs were evaluated against the site’s current radiological activities to determine which

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[4] Exceptions are authorized on a case-by-case basis by the responsible RP Program Manager or RP Program Functional Support Manager (exceptions are noted in Section 7.2.2).

workers required alternative monitoring. Workers with reasonable potential for an intake which warranted alternate monitoring were placed on a gamma spectrometry in urine analysis (provided by CRL Dosimetry Services) which provides similar minimum detectable doses to the WBC analysis. Additional random (biased toward likelihood of an intake) urine bioassay monitoring of workers who did not meet the alternative monitoring criteria is being undertaken until the new facility is ready.

Table 10: Effective Dose for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	**Employee**	393	100	292	1	-	-	-	-	0.57	0.06	0.05	17.98
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	**Employee**	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
Totals		861	546	314	1	0	0	0	0				18.99

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 11: Distribution of Equivalent Dose to the Skin for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	393	99	287	7	-	-	-	-	0.94	0.08	0.06	22.46
	Contractor	77	59	18	-	-	-	-	-	0.19	0.04	0.01	0.74
	Visitor[c]	2	2	-	-	-	-	-	-	0.00	-	0.00	0.00
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	148	145	3	-	-	-	-	-	0.11	0.06	0.00	0.17
	Visitor	241	240	1	-	-	-	-	-	0.10	0.10	0.00	0.10
Totals		861	545	309	7	0	0	0	0				23.47

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 12: Distribution of Equivalent Dose to the Hands and Feet for Whiteshell Laboratories

Monitored Person Type		Total # of Persons	Dose Range (mSv)							Individual Dose (mSv)			Collective Dose (p·mSv)
			0	0.01-0.50	0.51-1.00	1.01-5.00	5.01-10.00	10.01-20.00	>20.00				
			Number of Persons							Max	Ø Avg[a]	Avg All[b]	
NEW	Employee	16	4	8	1	3	-	-	-	1.86	0.61	0.45	7.26
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor[c]	0	-	-	-	-	-	-	-	-	-	-	-
Non-NEW	Employee	0	-	-	-	-	-	-	-	-	-	-	-
	Contractor	0	-	-	-	-	-	-	-	-	-	-	-
	Visitor	0	-	-	-	-	-	-	-	-	-	-	-
Totals		16	4	8	1	3	0	0	0				7.26

a Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
b Average of all measured doses that include the zero dose value, rounded to two decimal places.
c Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

Table 13: Summary of Dose Components Received as a Result of Licensed Activities for 2021 [a]

Monitored Person Type		External Penetrating Dose					External Surface Dose					Extremity Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	393	17.98	0.57	0.06	0.05	393	22.46	0.94	0.08	0.06	16	7.26	1.86	0.61	0.45
	Contractor	77	0.74	0.19	0.04	0.01	77	0.74	0.19	0.04	0.01	0	-	-	-	-
	Visitor[c]	2	0.00	0.00	-	0.00	2	0.00	0.00	-	0.00	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	148	0.17	0.11	0.06	0.00	148	0.17	0.11	0.06	0.00	0	-	-	-	-
	Visitor	241	0.10	0.10	0.10	0.00	241	0.10	0.10	0.10	0.00	0	-	-	-	-
	Total	**861**	**18.99**				**861**	**23.47**				**16**	**7.26**			

Monitored Person Type		Tritium Committed Effective Dose					Non-Tritium Committed Effective Dose					Neutron Dose				
		Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]	Total # Persons	Collective (p·mSv)	Max	Ø Avg[b]	Avg All[c]
NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor[d]	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
Non-NEWs	Employee	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Contractor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Visitor	0	-	-	-	-	0	-	-	-	-	0	-	-	-	-
	Total	0	0.00				0.00					0	0.00			

a All quantities are measured in mSv unless otherwise noted.
b Average of all measured doses that exclude the zero dose value, rounded to two decimal places.
c Average of all measured doses that include the zero dose value, rounded to two decimal places.
d Visitor NEWs are persons who were former employee and/or contractor NEWs, but who have returned to the site as visitor while retaining their historical NEW status.

7.2.2.1 Discussion of Dose Data

The Regulatory effective dose limit for a NEW in a calendar year is 50 mSv. The maximum individual effective dose to a NEW at WL in 2021 was 0.57 mSv and the site collective dose was 18.99 p-mSv.

The Regulatory effective dose limit for a NEW in a five-year period is 100 mSv. The maximum individual effective dose to a NEW at WL for the current five-year dosimetry period from 2021 to 2025 at WL was 0.57 mSv.

The Regulatory skin dose limit for a NEW in a calendar is 500 mSv. The maximum individual skin dose to a NEW at WL in 2021 was 0.94 mSv and the site collective dose was 23.47 p-mSv.

The Regulatory hands and feet dose limit for a NEW in a calendar is 500 mSv. The maximum individual hands and feet dose to a NEW at WL in 2021 was 1.86 mSv and the site collective dose was 7.26 p-mSv.

The Regulatory effective dose limit for a pregnant NEW is 4 mSv for the remainder of their pregnancy. In 2021, the maximum individual effective dose from the time the pregnancy was declared to the end of the pregnancy term was 0.05 mSv.

The Regulatory effective dose limit for non-NEWs is 1 mSv in a calendar year. In 2021, the maximum individual effective dose to a non-NEW at WL was 0.11 mSv.

Table 14 provides a summary of radiation doses by worker group in 2021. The majority of radiation doses were received by RP, Nuclear Operations and Trades staff.

7.2.2.2 Radiation Dose Changes or Trends

Table 15 shows external whole body dose received from 2017 to 2021, and Figure 1 displays the maximum individual and collective dose from 2001-2021.

Worker doses decreased in 2021 with the completion of higher dose extensive decommissioning activities in Building 200 (ALWTC) in 2020. The site collective dose decreased from 33 p-mSv in 2020 to 19 p-mSv in 2021. The number of workers receiving occupational doses above 0.2 mSv in a calendar year decreased from 25 workers in 2020 to 11 workers 2021. This a significant decrease compared to a maximum number of 42 workers in 2017. There were no workers receiving an annual radiation dose above 1 mSv in 2021.

Main contribution to radiation dose in 2021 was radioactive tanks removal during B200 demolition activities, and operational replacement of hot cell roughing filters. There was increased waste handling in 2021 with the start of the removal, characterization and packaging of low level radioactive waste packages from storage facilities in the WMA. However, these activities had only a small contribution to site worker doses.

7.2.3 Program Exceedances

During 2021, radiation dose to all persons working at WL were below the WL dose Action Levels [2] and the respective CNSC regulatory limits [18]. In addition, there were no individual doses exceeding their respective DCP as a result of activities at WL.

Table 14: Summary of Worker Group Radiation Doses at WL for 2021

	Total Number of Persons	Individual Whole-Body Dose (Effective Dose[a])		Collective Whole-Body Dose (Effective Dose[a])	Collective Surface Dose (photon plus neutron plus beta)	Collective Extremity
		Average[b] (mSv)	Maximum (mSv)	p·mSv	p·mSv	p·mSv
Nuclear Facilities:						
SF Staff (HCF and IFTF)[c]	5	0.18	0.49	0.91	0.92	1.83
WR1 and ALWTC Staff	5	0.07	0.14	0.37	0.37	0
WMA and CCSF Staff[c]	6	0.07	0.21	0.39	0.39	0
Support Workgroups:						
Radiation Protection Staff [d]	41	0.11	0.43	4.43	6.02	1.06
Trades Staff [e]	48	0.09	0.57	4.31	6.35	4.37
All Remaining Staff:						
Other Staff [f]	513	0.02	0.19	8.48	9.32	0
WL Site[g]:	618	0.03	0.57	18.89	23.37	7.26

a Includes photon and neutron; there were no tritium committed effective doses for 2021.

b Average of all measured doses that includes the zero dose values, rounded to two decimal places. Includes employees and contractors.

c SF= Shielded Facilities; HCF = Hot Cell Facilities; IFTF = Immobilized Fuel Test Facility; ALWTC= Active Liquid Waste Treatment Center; WMA= Waste Management Area; CCSF= Concrete Canister Storage Facilities; WR1 = An experimental test reactor built at WL – WR-1 featured an organic liquid coolant.

d Radiation Protection staff include Radiation Surveyors, Radiation Protection Assistants, Contamination Monitors, and Decontamination Operators.

e Trades staff provide services for all listed facilities and decommissioning activities as well as the WL

site in general.

f Other staff is comprised of all remaining staff and includes decommissioning, administrative, management, engineering, quality assurance, researchers, contractors and tenants.

g WL Site includes 393 CNL staff (WL and staff visiting from other CNL sites) and 225 contractors working at the WL site during 2021. This tally does not include visitor doses.

Table 15: WL External Whole-Body Dose Performance 2017 to 2021

Performance Metric	2017	2018	2019	2020	2021
Site Collective Worker Dose (p-mSv)	19.9	40.2	49.6	33.4	18.9
Max Individual Worker Dose (mSv)	1.41	1.65	3.09	2.97	0.57
Number of Workers > 0.2 mSv in a year	42	39	38	25	11
Number of Workers > 1 mSv in a year	1	12	14	8	0
PAD[a] – Maximum Daily Dose (mSv)	0.17	0.24	0.40	0.28	0.22
PAD – Maximum Dose Rate (mSv/h)	1.99	4.95	5.82	5.56	3.1

a Personal Alarming dosimeter.

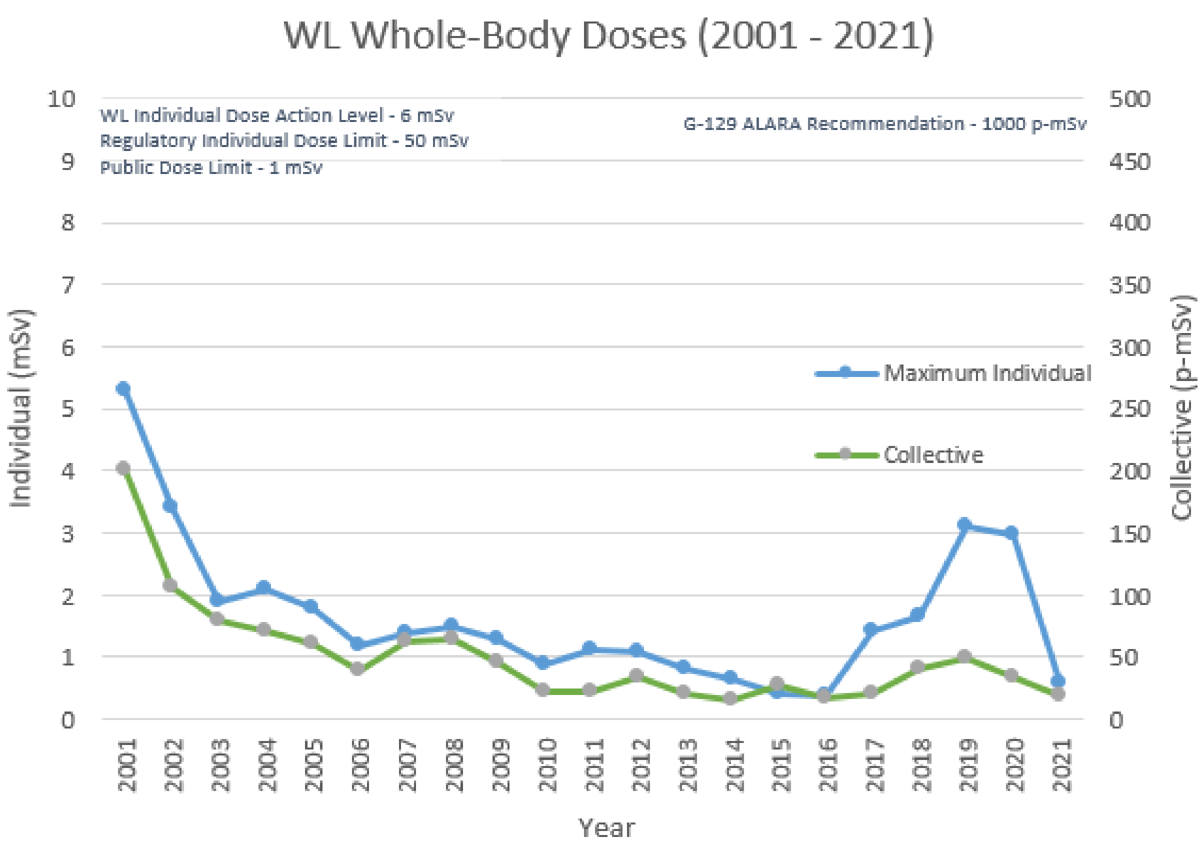


Figure 1: Whole-Body Effective Doses (2001 – 2021)

8 Conventional Health and Safety

8.1 Conventional Health and Safety Program

Whiteshell Laboratories adheres to the Corporate Conventional Health and Safety Functional Support Area. See Section 8 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In support of reducing the number and impact of incidents with the potential for injuries or incidents at WL, the following initiatives are continuing or began in 2021:

- To support project work, WL OSH purchased noise dosimeters, a sound calibrator, Jerome Mercury detector and Colorimetric Badges for chemical detection.
- OSH presence in the field continued at pre-job briefings, walk downs and daily work plan meetings together with early involvement in the planning process have contributed to WL's internal safety success.
- Contractors continued to be "pre-qualified" prior to bidding on WL contracts. The pre-qualification process involves reviewing safety statistics and the safety programs of the potential bidders.
- WL continued to participate in the Rapid Learning Morning Call to quickly share safety information with all CNL sites, as well as gather safety information relevant for the WL site.
- Increased contractor oversight continued by participating in activities such as site visits, pre-job briefs, pre-bid meetings and OSH orientation for contractors.
- There were 11 internal Safety Advisories and 2 Learning Advisories sent to WL site employees. The bulletins are intended to inform WL employees about imminent issues that could impact their safety. WL continued to be proactive in the approach to safety.
- Near Miss reporting (a known industry best practice) continued with a focus on early hazard recognition and strong situational awareness culture, supporting the minimization or elimination of hazards prior to resulting in injury (see Table 16).
- Near Miss reporting at WL always includes an investigation/fact finding session. The majority of Near Miss reports also generate an ImpAct. Whether an ImpAct is generated or not, the possibility of a human error trap being involved in the Near Miss incident is always considered, evaluated and followed up as appropriate.
- OSH Program weekly review of company injury/illness reports in support of recognizing trends and disseminating lessons learned.
- Focus on disability management / return to work in support of minimizing the impact to an injured employee and subsequent days lost.
- Promoted the Stop/Pause protocol.

Table 16: Summary of WL Near Miss Reporting

Year	2017	2018	2019	2020	2021
Near Miss Reported	60	53	46	10	26

8.1.1 Site Safety and Health Committee

The Site Safety and Health Committee is the principal forum at WL for joint employee/ management consultation and development of solutions to safety and health concerns at the WL site. The WL Site Safety and Health Committee meets on a monthly basis.

In 2021, the WL Site Safety and Health Committee received 93 inquiries out of which 6 remained open and in progress. There was one inquiry carried over from 2020. The Site Safety and Health Committee acts as an oversight body, therefore these actions are largely related to the Site Safety and Health Committee's need for more information that provides them with assurance of the effectiveness of the actions of the functional safety groups on site.

8.1.2 Inspections

There were 61 site health and safety inspections completed in 2021.

8.1.3 HOIRs and Lost-Time Injuries

There was one hazardous occurrences at Whiteshell Laboratories that was reported to Employment and Social Development Canada in 2021. CNSC staff received a copy of this notification, as per the requirements of the CNSC REGDOC-3.1.2 [3].

The following is a summary of injury rate data for the last 5 years.

Table 17: Summary of Whiteshell Laboratories Injury Rate Data

	2017	2018	2019	2020	2021
Whiteshell Laboratories					
Person Hours Worked	706,000	688,000	642,000	584,030	684000
Lost-Time Injuries	3	1	0	1	0
Working Days Lost	27	5	0	2	0
Frequency[a]	0.85	0.25	0	0.34	0
Severity[b]	7.76	1.45	0	0.68	0
Whiteshell Laboratories Contractors[c]					
Lost Time Injuries	1	0	0	0	0
Working Days Lost	0[d]	0	0	0	0

a Frequency rate equals # of Lost-Time Injuries x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

b Severity rate equals # of Working Days Lost x 200 000 hrs of exposure divided by person hours worked (based on 100 Full Time workers).

c The Number of Person Hours worked are not divulged by Contractors. As such, Frequency and Severity rates cannot be calculated.

d Number of days lost is unknown as the contractor terminated the employee.

The Recordable Lost Time Injury rate over the last five years at WL in Manitoba is significantly lower than local lost-time injury rates for construction (3.7) and manufacturing (2.4), as per the data from the Workers Compensation Board of Manitoba found in *The Manitoba Workplace Injury and Illness Statistics Report 2010-2019* (safemanitoba.com).

No Assurance of Voluntary Compliance or Directions were issued by Employment and Social Development Canada in 2021.

9 Environmental Protection

9.1 Environmental Protection Program

WL adheres to the Corporate Environmental Protection (EnvP) Functional Support Area. See Section 9 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

WL has an integrated Environmental Protection Program designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere, and consists of three distinct programs: the Effluent Verification Monitoring Program, the Environmental Monitoring Program, and the Groundwater Monitoring Program. The WL Environmental Protection Program is designed to implement the requirements of:

- CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [19],
- CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [20],
- CSA N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills* [21],
- CSA N288.7-15, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [22],
- CSA N288.8-17, *Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities* [23], and
- ISO 14001:2015, *Environmental Management Systems* [24].

The integrated Environmental Protection Program is dynamic in nature, meaning that it is continually evolving based on various sources of information received.

Program documentation is updated on an ongoing and/or required basis.

This report will focus and discuss the implementation of the WL Effluent Verification Monitoring Plan [25]. This plan defines the methodologies and protocols followed in performing the effluent verification monitoring required in CSA N288.5-11 [20].

The WL site has maintained its ISO 14001 [24] registration in 2021 with initial registration in 2010.

The CNSC has previously been notified of revisions to *Environmental Protection documents* [26], as per the *Licence Conditions Handbook.*

9.2 Quality Assurance

In order to ensure that the data collected through the program is valid, the laboratories performing monitoring for the program have strong Quality Assurance/ Quality Control programs as required by CSA N288.5 [20]. General quality assurance objectives for CNL's

Environmental Protection Program are set out in quality assurance plans. Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance plans. The plans include detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. The plans were written to align to ISO/IEC 17025 [27] for analytical laboratories.

Whiteshell Laboratories' Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are called Quality Verification Tests, and are grouped as follows according to purpose:

- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Environmental Management performed 3247 quality verification tests during 2021 on WL's radiochemical counting equipment. Of these tests, 99.6% fully complied with acceptance criteria. The results of these tests are shown Table 18.

Table 18: Whiteshell Laboratories' Summary of Quality Verification Test Performed

Method	No. of Tests	No. of Failures	% Pass
Total Alpha (Instrumentation)	1188	4	99.7
Total Beta (Instrumentation)	1188	5	99.6
Gamma (Instrumentation)	647	0	100.00
Tritium	224	4	98.2
2021 Total	**3247**	**13**	**99.6**

In 2021, the WL Effluent verification program continued performing regular field Quality Verification testing on the Outfall, Lagoon, and Ditch effluent sampling (Table 19). The program is using traveling blanks to determine and account for any possible introduction of contamination into the sample being analyzed by the sampling methodology being employed by the program, and the program is also collecting duplicate samples to demonstrate sampling reproducibility.

Table 19: Whiteshell Laboratories' Summary of Field Quality Verification Tests Performed

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Outfall				
Non-Radiological Parameters:				
pH	N/A	N/A	4	100%
Conductivity	4	<LDML	4	100%
Total Organic Carbon	4	< LMDL	4	100%
Phenols	4	< LMDL	4	100%
TSS	4	<LMDL	4	50%
Phosphorus	4	<LMDL	4	75%
Oil and Grease	4	< LMDL	4	100%
Mercury	4	<LDML	4	75%
Chromium	4	< LMDL	4	25%
Copper	4	0.222 mg/L	4	25%
Magnesium	4	< LMDL	4	100%
Iron	4	< LMDL	4	50%
Lead	4	0.0033 mg/L	4	25%
Nickel	4	< LMDL	4	50%
Potassium	4	< LMDL	4	75%
Sodium	4	< LMDL	4	100%
Strontium	4	< LMDL	4	100%
Uranium	4	< LMDL	4	75%
Zinc	4	0.010	4	50%
Bromodichloromethane	4	0.002 mg/L	4	100%
Chloroform	4	0.096 mg/L	4	100%
Toluene	4	0.044 mg/L	4	100%
Radiological Parameters:				
Gross Alpha	N/A	N/A	1*	100%*
Gross Beta	N/A	N/A	1*	0%*
Cesium-137	N/A	N/A	1*	100%*
Americium-241	N/A	N/A	1*	100%*

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Potassium-40	N/A	N/A	1*	100%*
Lead-214	N/A	N/A	1*	100%*
Beryllium-7	N/A	N/A	1*	100%*
Strontium-90	N/A	N/A	1*	100%*
Plutonium-238	N/A	N/A	1*	100%*
Plutonium-239/240	N/A	N/A	1*	100%*
Sewage Lagoon				
No Samples collected in 2021				
Ditches				
Non-Radiological Parameters:				
pH	N/A	N/A	2	100%
Conductivity	1	2.1 uS/cm	2	100%
Phenols	1	<LDML	2	100%
TSS	1	<LDML	2	50%
Phosphorus	1	< LMDL	2	100%
Oil and Grease	1	< LMDL	2	100%
Mercury	1	< LMDL	2	50%
Chromium	1	< LMDL	2	100%
Copper	1	0.434 mg/L	2	100%
Iron	1	< LMDL	2	100%
Lead	1	0.007 mg/L	2	100%
Nickel	1	0.0006 mg/L	2	100%
Zinc	1	0.043 mg/L	2	100%
Radiological Parameters:				
Gross Alpha	1	< LMDL	2	50%
Gross Beta	1	< LMDL	2	50%
Tritium	1	< LMDL	2	100%
Cesium-137	1	< LMDL	2	100%
Americium-241	1	< LMDL	2	100%
Cobalt-60	1	< LMDL	2	100%

Method	Traveling Blanks		Duplicates	
	No. of Travelling Blanks	Average Concentration of Blanks	No. of Duplicates	% Pass
Radium-228	1	< LMDL	2	100%
Europium-154	1	< LMDL	2	100%
Lead-210	1	< LMDL	2	100%
Thorium-228	1	< LMDL	2	100%
Thorium-230	1	< LMDL	2	100%
Thorium-234	1	< LMDL	2	100%
Uranium-235	1	< LMDL	2	100%
Radium-226	1	< LMDL	2	100%
Actinium-228	1	< LMDL	2	100%
Potassium -40	1	< LMDL	2	100%
2021 Total	**224**	**--**	**146***	**89%***

*: Not all 2021 data has been received from the contract laboratory.
LMDL = Laboratory Method Detection Limit

It is important to note that not all of the radiological results for 2021 have been received from the contract laboratories carrying out the analysis of samples (see also Section 9.4.1.3.2). At the time of writing this report, results received to date indicate that out of the 146 duplicate quality verification tests, 130 of these tests meet the acceptance criteria (+/- 20% of the actual result) of the program, to yield an 89% pass rate. A larger number of duplicates failed this year, with the majority of the failures being related to the metal concentrations being observed at the Outfall monitoring station. CNL is attributing this increase in failures to the fact that the metal concentrations being observed in the effluent are near the detection limit. This leads to results with low concentrations and high variability being produced, which will increase the likelihood of a failure in the duplicates being observed. This is supported by the large number of results classified as not being detected, and the low concentrations of metals being observed at the Outfall as seen in Table 32. No further action by CNL is needed to address the failures.

Reviewing the travelling blank data, and comparing it to the field results, the environmental program has concluded that the water source being used for the travel blank is slightly contaminated with Copper, Lead, Zinc, Chloroform, and Bromodichloromethane. The traveling blank results for these parameters are not reflective of contamination being picked up while sampling in regards to these parameters.

In 2021, the WL Environmental Management group took part in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses, were offered through the Canadian Association for Laboratory

Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in Table 20 and Table 21. There were four unacceptable test results out of thirty for the Environmental Research Associates inter-laboratory comparison studies, resulting in an 87% pass rate. The four unacceptable test results related to the gross alpha and gross beta analysis of water samples. The WL radiochemical counting laboratory is working on determining the cause of the problem, and until the cause has been identified, all quantitative analyses of this nature are being contracted out to a third party laboratory. The laboratory is in the process of ruling out possible factors. The areas the laboratory are currently reviewing includes the process for evaporation and ashing samples being utilized to prepare samples. The previously used method was required to change due to equipment limitations in the new environmental laboratories. The standard stock solutions that are used for the creation of the calibration curves used in this analysis may have also been compromised.

For the Proficiency Testing Canada inter-laboratory comparison studies, a 100% pass rate was achieved.

Table 20: Environmental Research Association Inter-Laboratory Comparison Program for CNL WL - 2021

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Air Filter Radionuclides	Americium-241	(pCi/Filter)	60.2	64.20	43.0 – 80.3	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	1030	898.76	668 - 1260	Acceptable
MRAD-34	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	163	173.30	134- 214	Acceptable
MRAD-34	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	1220	1310.15	1040- 1550	Acceptable
MRAD-34	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	771	926.67	632- 1180	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	96.1	105.09	50.2-158	Acceptable
MRAD-34	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	62.6	58.64	38.0-94.6	Acceptable
MRAD-34	Water Radionuclides	Americium-241	pCi/L	157	154.80	108-201	Acceptable
MRAD-34	Water Radionuclides	Cesium-134	pCi/L	1610	1369.04	1220-1770	Acceptable
MRAD-34	Water Radionuclides	Cesium-137	pCi/L	578	558.65	495-657	Acceptable
MRAD-34	Water Radionuclides	Cobalt-60	pCi/L	2180	2089.33	1880-2500	Acceptable
MRAD-34	Water Radionuclides	Zinc-65	pCi/L	1720	1765.19	1530 - 2170	Acceptable
MRAD-34	Water Gross Alpha/Beta	Gross Alpha	pCi/L	62.2	12.09	22.7 – 85.8	Not Acceptable

MRAD* Study	Matrix	Analyte	Units	MRAD Assigned Value	WL Reported Value	Acceptance Limits	Performance Evaluation
MRAD-34	Water Gross Alpha/Beta	Gross Beta	pCi/L	103	169.83	51.5 - 142	Not Acceptable
MRAD-34	Water Tritium	Tritium	pCi/L	22800	21216	17200-27800	Acceptable
MRAD-35	Air Filter Radionuclides	Americium-241	(pCi/Filter)	27.7	27.75	19.8-36.9	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-134	(pCi/Filter)	241	196.60	156-296	Acceptable
MRAD-35	Air Filter Radionuclides	Cesium-137	(pCi/Filter)	187	184.8	154-245	Acceptable
MRAD-35	Air Filter Radionuclides	Cobalt-60	(pCi/Filter)	310	310.75	264-394	Acceptable
MRAD-35	Air Filter Radionuclides	Zinc-65	(pCi/Filter)	366	401.32	559	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Alpha	(pCi/Filter)	77.6	91.00	40.5-128	Acceptable
MRAD-35	Air Filter Gross Alpha/Beta	Gross Beta	(pCi/Filter)	80.6	74.22	48.9-122	Acceptable
MRAD-35	Water Radionuclides	Americium-241	pCi/L	63.7	62.63	43.7-81.5	Acceptable
MRAD-35	Water Radionuclides	Cesium-134	pCi/L	649	558.51	490-714	Acceptable
MRAD-35	Water Radionuclides	Cesium-137	pCi/L	2170	2026.11	1860-2470	Acceptable
MRAD-35	Water Radionuclides	Cobalt-60	pCi/L	964	936.39	831-1110	Acceptable
MRAD-35	Water Radionuclides	Zinc-65	pCi/L	394	408.92	351-497	Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Alpha	pCi/L	93.9	27.66	34.3-129	Not Acceptable
MRAD-35	Water Gross Alpha/Beta	Gross Beta	pCi/L	97.0	142.66	48.5-133	Not Acceptable
MRAD-35	Water Tritium	Tritium	pCi/L	12800	12528.93	9650-15600	Acceptable

* MRAD: Multi-Media Radiochemistry

Table 21: Proficiency Testing Canada Accreditation Inter-Laboratory Comparison Program CNL WL - 2021

Proficiency Testing Canada	Sample Id	Analyte	Units	Proficiency Testing Canada Assigned Value	WL Reported Value	Score	Performance Evaluation
March -2021	CO1A-1	Conductivity	(µS/cm)	741	740	99	Acceptable
	CO1A-2	Conductivity	(µS/cm)	1160	1153		
	CO1A-3	Conductivity	(µS/cm)	374	376		
	CO1A-4	Conductivity	(µS/cm)	523	522		
March -2021	CO4A-1	TSS	(mg/L)	15	16	97	Acceptable
	CO4A-2	TSS	(mg/L)	64	66		
	CO4A-3	TSS	(mg/L)	128	130		
	CO4A-4	TSS	(mg/L)	203	203		
March -2021	C15-1	pH	(pH units)	4.89	4.87	95	Acceptable
	C15-2	pH	(pH units)	6.58	6.54		
	C15-3	pH	(pH units)	3.34	3.32		
	C15-4	pH	(pH units)	9	8.95		
October-2021	CO1A-1	Conductivity	(µS/cm)	676	695	91	Acceptable
	CO1A-2	Conductivity	(µS/cm)	454	469		
	CO1A-3	Conductivity	(µS/cm)	412	428		
	CO1A-4	Conductivity	(µS/cm)	707	719		
October-2021	CO4A-1	TSS	(mg/L)	22	16	86	Acceptable
	CO4A-2	TSS	(mg/L)	136	134		
	CO4A-3	TSS	(mg/L)	185	178		
	CO4A-4	TSS	(mg/L)	53	52		
October-2021	C15-1	pH	(pH units)	4.9	4.89	96	Acceptable
	C15-2	pH	(pH units)	7.72	7.77		
	C15-3	pH	(pH units)	2.82	2.80		
	C15-4	pH	(pH units)	8.52	8.55		

9.3 Supplementary Studies

In 2020, the WL site began to do temporary enhanced monitoring on the effluent verification ditches for the year. The enhanced monitoring is being done to confirm the absence of a number of radiological and non-radiological parameters. The enhanced monitoring involved doing an open scan for Volatile Organic Carbons, semi-volatile organic carbons, and an expansion of the metals and gamma isotopes list currently being used to monitor the ditches.

Whiteshell is reviewing the data, and is deciding whether there is a need to add any of these parameters to the effluent verification monitoring program going forward. This study was on going in 2021, and will be continued into 2022 due to the limited number of ditch sampling events that occurred in 2021.

9.4 Effluent Monitoring - Radiological

This section addresses the licence requirement regarding radiological monitoring of airborne and liquid effluents for the WL site, located on the Winnipeg River near Pinawa, Manitoba. It also addresses the effluent monitoring requirements listed under the Environmental Assessment Follow-Up Program [28] for WL.

Results of environmental monitoring and progress on the Environmental Assessment Follow-Up Program work packages will be provided in their respective annual reports, *Environmental Monitoring in 2021 at Whiteshell Laboratories* [29] and *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

9.4.1 Effluent Monitoring

9.4.1.1 Site Effluent Verification Monitoring System and Results Evaluation

Monitoring locations for airborne and liquid effluent streams are representative of the final discharge to the off-site environment, and may include the combined discharge from a number of facilities. Additional monitoring points are maintained at upstream locations as an aid in identifying the specific sources of emissions. Sampling system design ensures that samples are representative of the total content of the stream at each location.

Figure 2 includes a map of the effluent monitoring locations/effluent streams at WL.

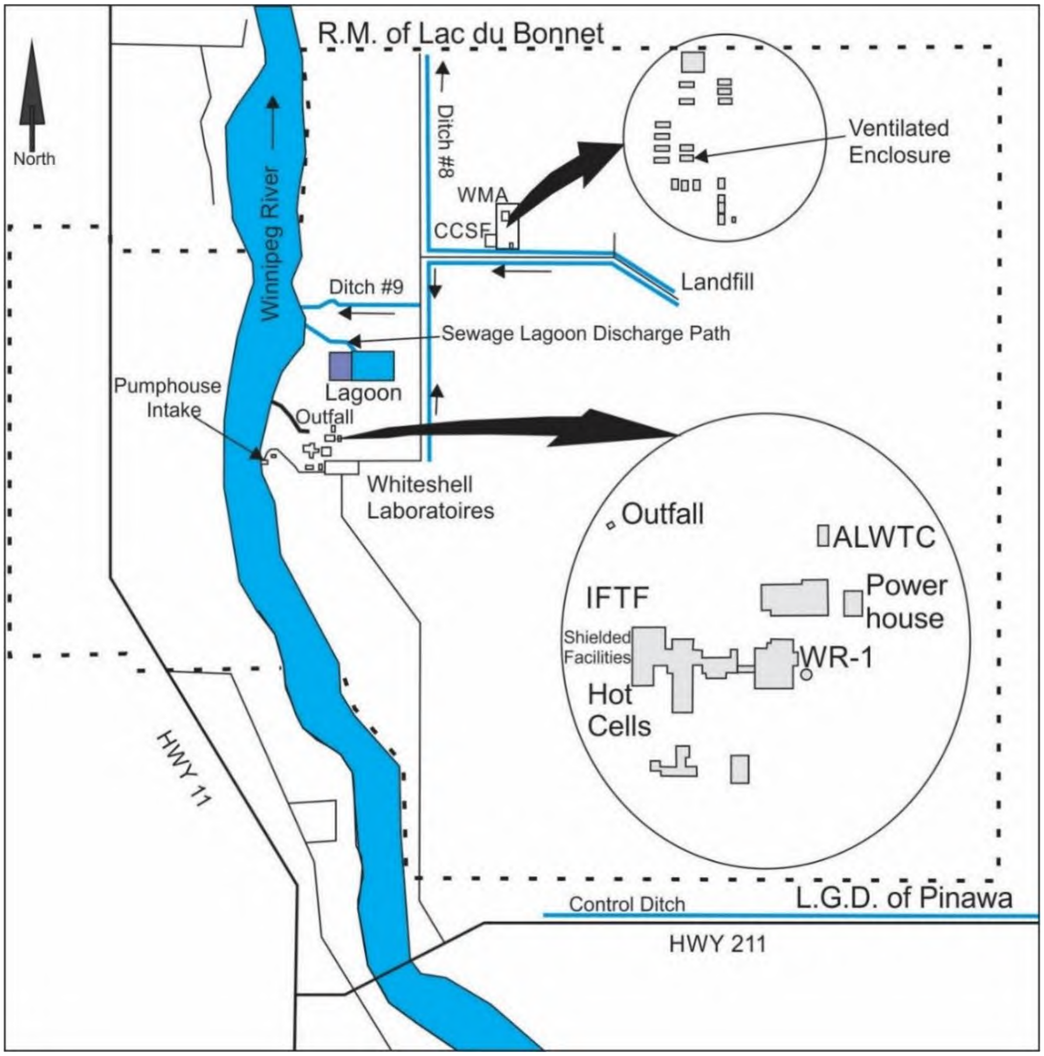


Figure 2: Effluent Monitoring Locations

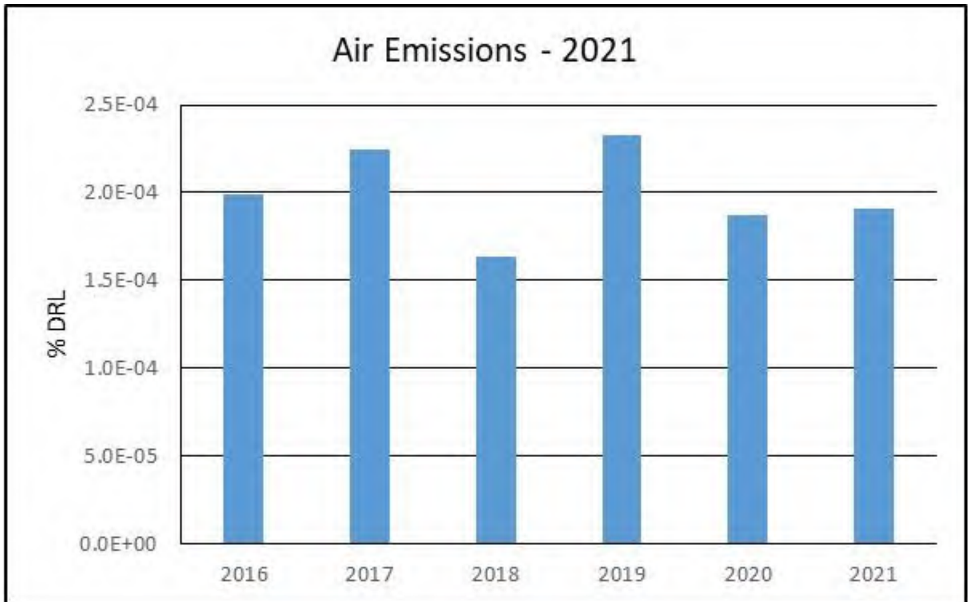
Effluent streams are monitored for all groups of radionuclides that are likely to be present and significant contributors to the total, expressed as a percentage of applicable DRLs [30]. The DRLs in use at WL came into effect on 2021 January 31. All current and historical data in this report has been compared against these DRLs. Monitoring is conducted either by direct measurement on location or by sampling and laboratory analysis. In many cases, gross-measurement parameters (e.g., gross beta) are monitored and reported rather than specific radionuclides. This is done provided that either the relative composition of radionuclides indicated by the gross parameter is not likely to vary significantly, or total emissions of the gross parameter are very small relative to the DRLs. For comparison with DRLs, the gross parameters are always evaluated conservatively. They are either assumed to consist solely of the most restrictive radionuclide, based on DRL value that is likely to be present in measurable quantities, or are assumed to be the radionuclide(s) known to be present in the effluent. To ensure proper selection of the DRL values, the effluents are periodically characterized using, for example, gamma spectrometry to identify individual gamma emitters, or chemical extraction

and analysis of individual beta emitting radionuclides, such as Strontium (Sr)-90, complemented by examination of historical data.

The significance of the measured radioactive materials in airborne and liquid effluents is assessed by comparison with DRLs that relate the releases to the potential radiation dose to the identified, most exposed groups (i.e., critical groups). DRLs are the upper limits for releases of radionuclides in airborne or liquid effluents from a facility or site. WL's DRLs were calculated in accordance with the principles and methodology in CSA N288.1-08 [31]. The DRL for a particular radionuclide is derived from the regulatory dose limit for members of the public, 1 mSv in a year, as specified in the Radiation Protection Regulations under the Nuclear Safety and Control Act [32]. The intention of the DRL is to establish a release limit such that compliance with it will give reasonable assurance that the annual regulatory dose limit for members of the public is not exceeded. Weekly DRLs are calculated and applied for airborne effluents, and monthly DRLs for liquid effluents.

For multiple effluents and radionuclides at a site, verifying that the sum of all releases as a percentage of the respective DRLs is less than 100% provides a reasonable assurance[5] that the annual dose limits have not been exceeded. This is a conservative approach since the critical group may differ for different release paths and radionuclides. The actual releases are a very small fraction of the DRL as discussed in the following sections and shown in Figure 3. As discussed in Section 9.4.1.3.2, the increase in 2019 to 2021 liquid effluents is due to an increase in detection limit values for Am-241 and Plutonium (Pu)-239/240. When the activities of radionuclide contaminants are not detected it is standard practice to report detection limit values as if they were observed concentrations. For example, Pu isotope activities were always detection level values and Am-241 and Cs-137 activities are very close to detection levels.

[5] The effluent DRL model and assumptions are further verified annually through results from the WL environmental monitoring program. The program assesses radiation doses to members of the public using direct measurements of radioactivity in the environment (e.g., in air, water, and food).



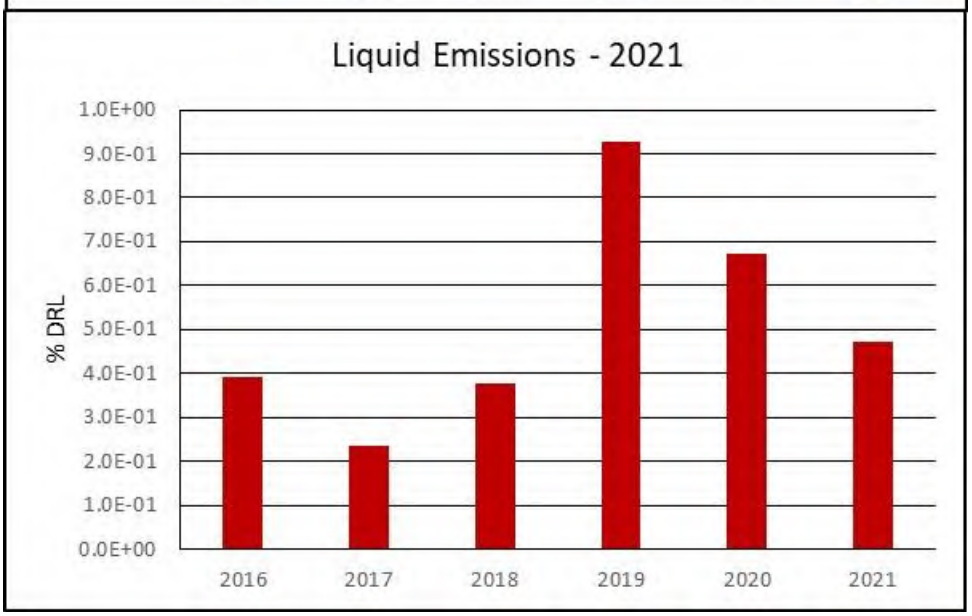


Figure 3: Trends for Airborne and Liquid Emissions form WL for 2016 to 2021

(Note: The Liquid Emissions for 2021 need to be corrected to include October to December data. This will be revised upon receipt of the data.)

Analytical models of all significant environmental pathways to an individual in the critical group are used in the DRL calculations. DRLs for WL have been calculated for a large number of radionuclides, many of which are currently not detected in site effluents. Derived Release Limit calculations (of a wide range of radionuclides) provide a means of determining which radionuclides may be significant dose contributors. Thus, they aid in determining which nuclides warrant inclusion in the monitoring program, and in interpreting monitoring results.

Performance is also measured against the regulatory Administrative and Action Levels[6] as specified in Reference [33]. The Action Levels were calculated based on current CNSC guidance to meet CSA N288.8 [23] and to better reflect current waste streams, and were released for use based on an implementation date of 2017 January 01.

9.4.1.2 Airborne Effluents Monitoring

9.4.1.2.1 Monitoring Points, Schedules and Parameters

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. These activities include waste compaction in the Waste Handling Area, located in the Immobilized Fuel Testing Facility (IFTF), and decommissioning activities in the ALWTC. The main sources of airborne radioactive effluents, as a result of this work and historical activities at WL, are the:

- Hot Cells Facility (Building 300)
- Immobilized Fuel Test Facility (Building 300)
- Reactor Building (Building 100)
- ALWTC (Building 200)

Air effluents from Buildings 100 and 300 were sampled continuously throughout the year. The frequency and type of monitoring will continue to be evaluated over time, and adjusted to reflect findings from the monitoring activities. The current monitoring schedule and locations are noted in Table 22. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. Any proposals on modifications to the monitoring program will be communicated to CNSC staff. In 2020, Building 200 (ALWTC) was prepared for demolition and the ventilation system was shut down in 2020 October. Monitoring of stack effluents for Building 200 ceased after 2020 October 13, and the building was demolished in 2021. Therefore the reported air emissions in 2021 do not include emissions from Building 200, which is no longer included in the monitoring schedule (Table 22).

6 Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to CNSC staff. Action Levels for WL radioactive effluents are lower than the DRLs.

Table 22: Radiological Air Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Method and/or Parameter			
	Frequency	Method	Gross Beta	Gross Alpha	Tritium	Gamma Spec
Building 100 Stack	Cont	GFA Filter	W	W	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Bubbler	N/A	N/A	W	N/A
Building 300 HCF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A
Building 300 IFTF	Cont	GFA Filter	W	N/A	N/A	W
	Cont	Charcoal Filter (Cartridge)	N/A	N/A	N/A	W
	Cont	Millipore Filter	N/A	W	N/A	N/A

Cont The air effluent is measured but passing a continuous sample of the exhaust through a filter. The GFA filter is normally used for beta-gamma, the Millipore normally for alpha, charcoal or silver zeolite for radioiodine, and a water Bubbler for tritium.

W Weekly

N/A Not Applicable

The air to be monitored from the buildings and facilities is drawn past sample probes located in the exhaust vents, pumped through filters and then returned to the exhausts. The WL maintenance planning team performs the measurements for the stack flows and the RP team measures the Sampler flow. The sampler flows at WL are checked during each sample collection period to ensure that they are within the established acceptance criteria, and are re-measured and verified on an annual basis. The release factors are calculated by the WL Environmental Management staff and verified independently on an annual basis. Activities measured in the laboratory are used in conjunction with sampler and exhaust stack flow rates to calculate the release in Becquerels (Bq). The Lower Limit of Detection (LLD) is the product of the release factor of the source and the laboratory Minimum Detectable Activity. For a given radionuclide, the Minimum Detectable Activity and LLD can vary, as they are calculated assuming a 30-minute count time and average detector efficiency, both of which can change.

Derived Release Limits have been calculated for 74 radionuclides for airborne effluents at WL [30]. Separate DRLs have been calculated for on-site workers and for members of the public at the site boundary. For gross alpha and gross beta activities, the DRL applied is the most restrictive from amongst those of the radionuclides that could be present (Sr-90 for gross beta and Pu-239 and Pu-240 for gross alpha).

Sampling procedures, field operating procedures, laboratory procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures are described in detail in the governing WL Environmental Management documentation.

9.4.1.2.2 Monitoring Results

The airborne emission results are summarized in Table 23 and Figure 3 for the years 2016 to 2021. Average weekly emissions, in Becquerels, are shown for gross alpha, and gross beta for facilities in Buildings 100, 200, and 300. Emissions from Building 100 also includes tritium. In addition, the current year releases, the average release for the past five years and the maximum weekly emissions as a percent of the DRL are given. Emissions from these identified release points are added for each year to provide an indicator of the performance of the site. The reader should be aware that the values for 2021 in Table 23 represent averages that include detection limit values where nothing has actually been detected. The releases from the Reactor Building include gross beta and tritium values that are always above detection, and gross alpha numbers that are often detection limits. The gross alpha releases from the HCF are normally detection levels and the gross beta are often, but not always detection levels. The gross alpha values from the IFTF are always detection limits and the gross beta are a mixture of detects and non-detects.

Airborne emissions remain a small fraction of the release limit. The result for 2021 (0.00019% of the DRL) is similar to 2020, and slightly lower than the average for the last five years. Total site gross alpha in 2021 is lower than in 2020 and the last five years average. It remains near detection limit values. The gross beta emissions are slightly more than in 2020 and similar to the last five-year average. In 2021, the air emissions from all facilities were below Administrative Levels and regulatory Action Levels. In 2021, Building 200 no longer contributed to air emissions. The average values of the previous five years shows that Building 200 had contributed 16 percent of the total alpha air emissions and 8 percent of the total beta air emissions.

Tritium emissions from the WR-1 stack were higher than in 2020 and slightly less than the five year average. During the Phase 1 Decommissioning of WR-1, all bulk heavy water was removed from WR-1, and an exhaustive process of eliminating heavy water and tritium from the reactor piping and tanks occurred. It was concluded that over the lifetime of WR-1, tritiated heavy water was adsorbed into the pipe and tank walls and probably also into concrete walls and floors. Therefore, the moderator system continues to be purged with air flow in order to remove additional tritium from the system and the tritium removal rates have been measured. The tritium emissions from the facility fluctuate with the humidity and temperature as the tritiated water is drawn out of the system. The maximum releases were all below the administrative level (1.52E+10 Bq/week) for the facility and well below the Action Level (7.62E+10 Bq/week) and DRL (1.65E+15 Bq/week). As many gross alpha and gross beta measurements are at or below the LLD, the yearly variations within these extremely small numbers are of very little consequence.

Localized operational workplace air monitoring is conducted as part of the Radiation Protection Program, and this was performed during operational shutdown and decontamination activities associated with Building 100, and work in the Shielded Facilities and Concrete Canister Storage Facility. Outdoor Workplace Air Sampler monitoring was performed for Building 200 demolition. Environmental airborne dust monitoring was performed close to the east, north,

west and south boundaries of the WL campus during building demolitions. The results of the 2021 dust monitoring are described in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28].

Table 23: Radionuclides in Air Effluents from WL Facilities – 2016 to 2021

Location/Parameter	DRL[a] (Bq/wk)	Action Level (Bq/wk)	2016 (Bq/wk)	2017 (Bq/wk)	2018 (Bq/wk)	2019 (Bq/wk)	2020 (Bq/wk)	Five-Year Average		2021		2021 Maximum	
								(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)	(Bq/wk)	(%DRL)
Reactor Building													
Gross Alpha[b]	1.73E+09	1.71E+04	4.16E+02	3.82E+02	2.65E+02	2.89E+02	3.07E+02	3.32E+02	1.92E-05	4.16E+02	2.40E-05	1.29E+03	7.45E-05
Gross Beta[b]	6.79E+09	1.68E+05	1.91E+03	1.83E+03	1.07E+03	1.95E+03	1.62E+03	1.67E+03	2.47E-05	2.34E+03	3.45E-05	7.36E+03	1.08E-04
Tritium	1.65E+15	7.62E+10	6.24E+08	9.68E+08	2.51E+08	6.43E+08	2.51E+08	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
ALWTC													
Gross Alpha	1.73E+09	1.00E+04	2.25E+02	2.37E+02	3.13E+02	3.12E+02	3.80E+02	2.93E+02	1.70E-05	N/A	N/A	N/A	N/A
Gross Beta	6.79E+09	2.02E+04	2.33E+02	2.92E+02	3.24E+02	4.54E+02	4.59E+02	3.52E+02	5.19E-06	N/A	N/A	N/A	N/A
HCF													
Gross Alpha	1.73E+09	1.58E+04	6.00E+02	6.00E+02	6.00E+02	6.10E+02	6.00E+02	6.02E+02	3.48E-05	6.19E+02	3.58E-05	1.59E+03	9.18E-05
Gross Beta	6.79E+09	6.82E+04	1.05E+03	1.15E+03	1.04E+03	2.05E+03	8.43E+02	1.23E+03	1.81E-05	1.07E+03	1.58E-05	1.29E+04	1.91E-04
IFTF													
Gross Alpha	1.73E+09	1.48E+04	5.78E+02	5.78E+02	5.78E+02	5.78E+02	6.37E+02	5.90E+02	3.41E-05	5.78E+02	3.34E-05	5.78E+02	3.34E-05
Gross Beta	6.79E+09	3.76E+05	8.92E+02	1.04E+03	8.41E+02	1.84E+03	1.18E+03	1.16E+03	1.70E-05	1.08E+03	1.58E-05	2.22E+03	3.26E-05
Total Tritium (as %DRL)			3.78E-05	5.87E-05	1.52E-05	3.90E-05	1.52E-05	5.47E+08	3.32E-05	5.30E+08	3.21E-05	1.11E+09	6.75E-05
Total Alpha (as %DRL)			1.05E-04	1.04E-04	1.02E-04	1.03E-04	1.11E-04	1.82E+03	1.05E-04	1.61E+03	9.32E-05	3.46E+03	2.00E-04
Total Beta (as %DRL)			5.90E-05	6.23E-05	4.73E-05	9.21E-05	6.04E-05	4.41E+03	6.50E-05	4.49E+03	6.61E-05	2.25E+04	3.32E-04
Total (%DRL)			**2.02E-04**	**2.25E-04**	**1.64E-04**	**2.33E-04**	**1.87E-04**	**2.03E-04**		**1.91E-04**		**5.99E-04**	

a The DRL's shown are for members of the public at the WL boundary as described in reference [30].

b Gross alpha releases are conservatively assumed to consist of Pu-239 and Pu-240, and Gross beta releases are assumed to be Sr-90, the radionuclides with the most restrictive DRLs and likely to be present in the effluent.

N/A – Not applicable

9.4.1.3 Liquid Effluent Monitoring

9.4.1.3.1 Monitoring Points, Schedules and Parameters

Figure 2 shows the locations of the sources of liquid effluents to the Winnipeg River, including the Outfall, the Lagoon and the numbered ditches.

The primary source of liquid radioactive effluents is the process water outflow (Outfall), which discharges continuously to the Winnipeg River. The discharge from the Outfall is composed of storm water runoff from paved roadways, around buildings through the weeping tile system, cooling water used in process and experimental facilities, and discharges from the Low Level Liquid Waste treatment systems tanks based in Building 100 and Building 300. The ALWTC was taken out of service in 2017 as part of preparations for the decommissioning of Building 200. Holding tanks collect water containing low levels of radioactivity, as a result of cleanup activities associated with operational and decommissioning work, as well as historical activities at WL. The current monitoring schedule and locations are listed in Table 24.

Table 24: Radiological Liquid Effluent Monitoring Schedule – 2021

Sample Location	Sample Collection		Analytical Methods and Parameters								
Location Name	Frequency	Method	Beta Screen	Gross Beta	Gross Alpha	Tritium	Gamma Spec (liquid)	Gamma Spec (ash)	Sr-90 (ash)	U-238 Pu-239/240 Pu-238	C-14
WL SITE											
Site Outfall	Continuous	Auto-Sampler	Wc	Mc	Mc	Mc	Wc	Mc	Mc	Qc	Mc
Lagoon	Continuous During Discharge	Auto-Sampler	N/A	Disch	Disch	N/A	N/A	Disch	Disch	Disch	N/A
Ditch N of WMA (8)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
Ditch W of WMA (9)	We	Grab	N/A	We	We	We	N/A	A/R	A/R	N/A	N/A
BUILDING 100 AND BUILDING 300											
B300 LAW-TK 1/2/3/4	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A
B100 LAW-TK 1/2	Discharge	Grab	N/A	Disch	Disch	N/A	Disch	N/A	Disch	N/A	N/A

Disch Per discharge, up to twice a year for the Lagoon.
Wc Weekly composite, composite of samples collected during the week.
Mc Monthly composite, composite of samples collected during the month.
We Weekly, when ditches have flowing water, usually after a rain or snow melt. Note that 2021 was a low precipitation year with very little running water.
Qc Quarterly composite, composite of samples collected during a 3 month period
A/R As Required.
N/A Not Applicable.

Cleanup and operational activities associated with decommissioning the site have been underway since 2003 January. Specific activities that may have influenced the 2021 liquid releases are similar to those for the past five years, and include cleaning of footwear and respirators. Radiation Protection introduced the use of disposable rubber shoe covers in 2018, which reduced the contribution from the washing of footwear. The water from these cleaning activities is combined with Building 300 sump water into the Building 300 receiver tanks. Sump water from Building 100 is now directed to the Building 100 receiver tanks. The liquids from these holding tanks are discharged to the Winnipeg River through the Outfall.

An automatic sampler continuously samples the outflow from the Outfall, proportional to its rate of flow. A weekly screening sample (4 L), representative of effluent released from the Outfall during the preceding week, is collected and submitted for uranium and gross beta analysis and scanned by gamma spectrometry.

Monthly composite samples (at least 32 L) are gathered for analysis of total uranium, gross alpha, gross beta, tritium, radio strontium and other radionuclides (Am-241, Cs-137) by gamma spectrometry. Starting in 2017, 3 month composite samples were collected for Pu-239/240, Pu-238 and Pu-241 isotopic analyses. Monitoring for Carbon (C-14) and tritium in Outfall samples was initiated in 2020 because they are known to exist in WR-1, and decommissioning activities have a potential for releasing these isotopes. The activities of tritium and C-14 at the Outfall continued to be below the lower limits of detection.

The secondary source of liquid effluent is the Sewage Lagoon (Lagoon). The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. The minimum residence time for the lagoon is equal to the amount of time the secondary cell is isolated from the primary cell, to allow for biodegradation and settling. This is typically around 45 days. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in detail later). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon’s north side. In 2021, the lagoon was not discharged at all because there was enough freeboard that a discharge was not necessary.

Whenever there is a discharge, the outflow of the Lagoon is continuously sampled during the discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio strontium, and it is also scanned by gamma spectrometry.

Small quantities of radionuclides at levels seen at the Ditch 7 and Ditch 8 sampling locations, are also released to the Winnipeg River from the two ditches indicated in Figure 2. Water from the recharge area east of the WMA is diverted around the WMA to the west-flowing Ditch 9 and into the Winnipeg River. The other, Ditch 8, running northward, drains the land north of the WMA up to the site boundary and beyond. The volume of water in the ditches and resulting flow to the river is entirely dependent on rainfall and spring runoff. Precipitation (395 mm) in 2021 was less than in 2020 (441 mm), and in 2019 (646 mm). The winter of 2021 was very dry. The spring precipitation was normal, but the early summer was unusually dry. Normal amounts of precipitation were observed for August, October and November. Due to the low

precipitation, ditches were only sampled six times during March, April, May and June. The August and October precipitation was captured by the dry ground and there was no moving water in the ditches to be sampled any time after June.

One-litre water samples to be analyzed for radioactivity are collected from the two ditches carrying drainage from the WMA whenever there is sufficient flow from runoff to enable sampling of discharge to the river. At the same time, samples were also collected from the northern ditch bordering Highway 211. This is far enough from CNL's operation to be a reasonable background (Control) sample[7]. The samples are analyzed for gross alpha, gross beta, gamma spec and tritium. If the level of the gross beta measurement exceeds 10 Bq/L, the samples are submitted for radio strontium analysis. Uranium activities are calculated from uranium concentrations obtained from total metals analysis. Surface water samples are collected in and around the WL WMA from locations upstream from these two ditches. The results of these operational control samples are reported in Appendix D of this report.

Derived Release Limits for 63 radionuclides were calculated for liquid effluents at WL [30]. Gross alpha and gross beta measurements provide a quick measurement of the total alpha and beta radioactivity produced by a number of radionuclides, without having to test for those radionuclides. However, as in the case of airborne effluents, the most restrictive DRLs apply to gross beta and gross alpha activity: Cs-137 for beta activity and Pu-239 and Pu-240 for alpha activity. With the introduction of total uranium (U) and isotopic plutonium analysis for the processed outfall, a comparison can be made to the individual contributors to the gross alpha activity. Therefore the comparison to the %DRL of the individual isotopes is presented and the sum of those reported. This is also the case for gross beta.

9.4.1.3.2 Monitoring Results

The liquid emission results[8] are summarized in Table 26 and Figure 3 for the years 2016 to 2021. Average monthly emissions, in Becquerels, are shown for gross alpha, gross beta, total U (including U-234, U-235, and U-238), Am-241, Sr-90 and Cs-137 for the releases from the Outfall and the Lagoon. The monitoring of tritium from the Outfall began in 2019. In addition, quarterly activities of Pu-239/240 and Pu-238 were reported for Outfall effluents. A plot of the monthly Cs-137 and Sr 90 releases as Bq from the Outfall in 2021 is compared with radioactivity (Bq) discharged to the Outfall from the Low Level Liquid Waste (LLLW) treatment systems in Figure 4. Discharges to the Outfall from the LLLW treatment tanks occurred in all months. The total releases of Sr-90 and Cs-137 from the tanks in 2021 were 1.13E+06 Bq and 4.01E+06 Bq, respectively. These releases were only a fraction of the total Sr-90 (2.6E+07 Bq) and Cs-137 (1.3E+07 Bq) releases from the Outfall. There was little correlation between the patterns of

[7] The Control Ditch sample is collected from a location not influenced by CNL's operation, and therefore serves as an indicator of the natural background conditions in the area.

[8] As mentioned in Section 9.2, not all of the radiological results for 2021 have been received from the contract laboratories due to a number of issues, solely impacting the Outfall results for 2021 October through December. Once received, this document will be revised and reissued. The red font text in this section indicates text that will or may need to be updated.

releases from the tanks with the pattern of releases from the Outfall because the tank releases were only a small fraction of the total releases. The additional Sr-90 and Cs-137 activities noted at the Outfall may be from pre-existing contamination in the storm drain system from historical site contamination events and historical radioactivity disposition in the storm drain line from Building 200 LLLW discharges. Some of this contamination may have been from unplanned emissions from the Hot Cells in the 1970's, although more likely from the Building 200 drain line. The high Sr-90 and Cs-137 releases from the Outfall during April, May and August correlate with higher rainfall during these months. The periods of high precipitation are believed to flush contamination into the Outfall from storm drains and previously contaminated process piping.

Note, all monthly releases from the Outfall were well below the administrative release level[9]. Releases of gross alpha were less than the 2020 releases and the five year average. Gross beta releases in 2021 were also less than the 2020 releases and the five year average. Sr-90 releases in 2021 were lower than in 2020 and the five year average. The Cs-137 releases were similar to 2020 releases and below the five year averages. Am-241 releases were greater than 2020 releases. The total uranium releases were slightly lower than in 2020. The relatively constant emissions of gross alpha, gross beta, Sr-90 and Cs-137 from the Outfall over the years suggest a constant source, more like contaminated piping than the effects of recent decommissioning activities. Pu-239/240 and Pu-238 releases were very low, being based on detection level concentrations (% of the DRL less than 0.27). In 2021, Outfall water was also analyzed for the presence of C-14, which could be introduced by the discharge tanks from Building 100. C-14 was below detection levels (varying from 0.99 to 1.26 Bq/L) in Outfall samples. Given that the DRL for C-14 is 1.06E+08 Bq/month, the detection limit of 1.26 Bq/L would correspond to a %DRL value of 0.18. Measurements of C-14 in site intake water from Building 902 were also below detection values.

[9] An Administrative Level is a CNL internal reporting level for radioactive emissions by way of an individual effluent stream. The Administrative Levels are established and maintained by CNL to provide timely warning of above normal radioactive emissions, with the intent of aiding in the application of the ALARA process.

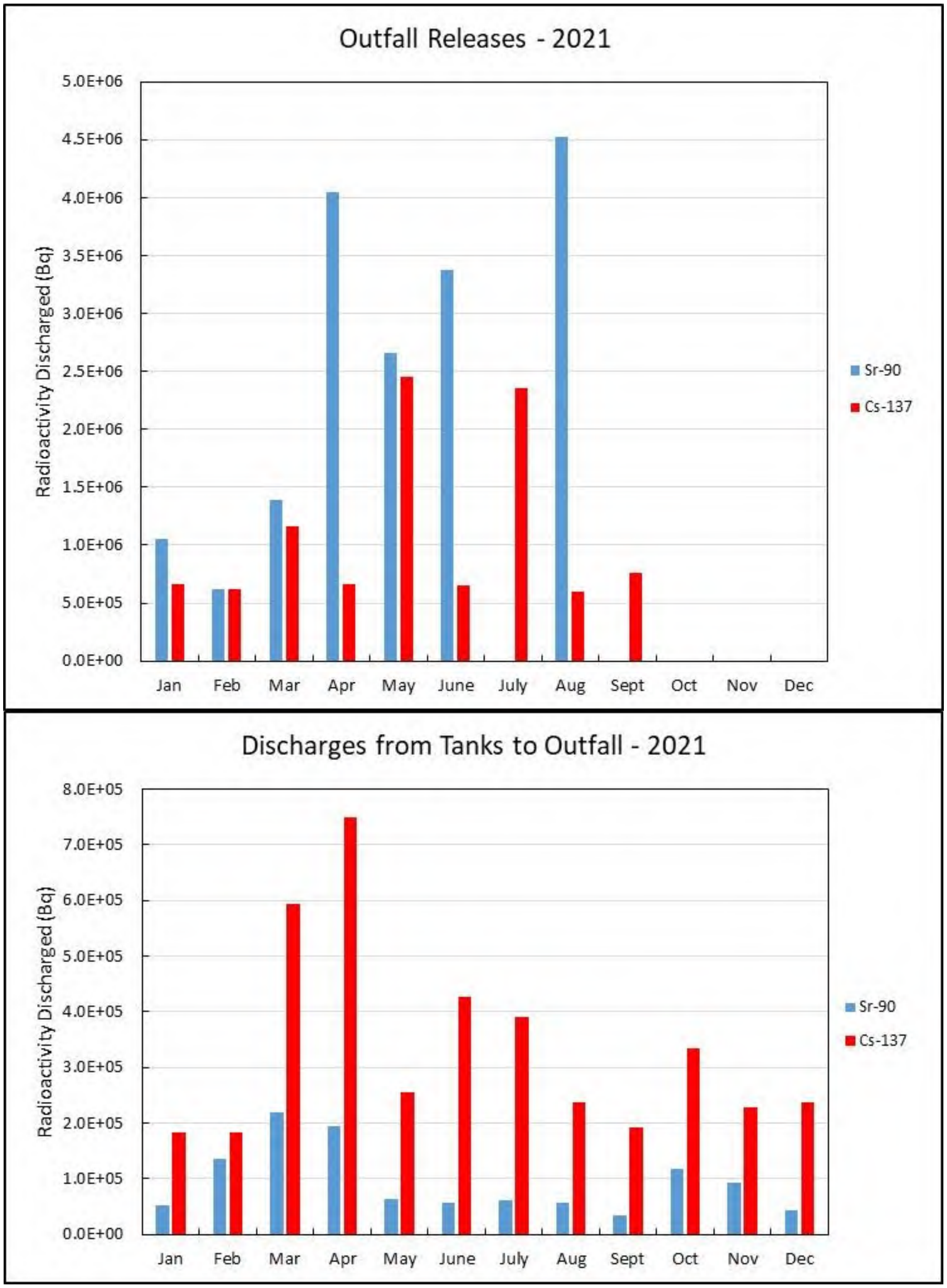


Figure 4: Radioactivity on Outfall Releases and Discharge from Active Liquid Waste Treatment Tanks for 2021

As stated above there were no Lagoon discharges in 2021 and so there are no results to report. In 2021 the lagoons did not contribute to the total liquid discharges from the site.

The averaged results for the two drainage ditches and control sample are shown in Table 25. The reported errors are the standard deviations of parameter values indicating their variability between different sampling events.

Table 25: Annual mean Radioactivity Surface Water Drainage Ditches Near WL WMA – 2016 to 2021

Activity (Bq/L)									
Location	**Drinking Water Screening Level[a]**	**LLD[b]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Five-Year Average**	**2021[c]**
8 - DITCH FROM WMA – North to WL Boundary									
Gross Beta	1	0.05	0.12	0.14	0.52	0.19	0.12	0.22	0.13 ± 0.04
Gross Alpha	0.50	0.07	0.17	0.11	0.18	0.15	0.10	0.14	0.05 ± 0.02
Tritium	7 000	3	4.4	4.8	5.3	5.5	4.3	4.9	4.6 ± 0.5
9 - DITCH FROM WMA – West to Winnipeg River									
Gross Beta	1	0.05	0.09	0.13	0.32	0.20	0.11	0.17	0.24 ± 0.34
Gross Alpha	0.50	0.07	0.09	0.09	0.16	0.20	0.06	0.12	0.07 ± 0.03
Tritium	7 000	3.00	17.4	21.1	9	10	6.5	13	4.7 ± 0.4
Control Ditch - Off Highway 211									
Gross Beta	1	0.05	0.10	0.15	0.14	0.19	0.11	0.14	0.17 ± 0.13
Gross Alpha	0.50	0.07	0.11	0.10	0.22	0.114	0.07	0.12	0.05 ± 0.01
Tritium	7 000	4	4.8	4.67	<4	<4	4.7	4.4	4.4 ± 0.4

a Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for the gross alpha and gross beta are less than 0.5 Bq/L and 1.0 Bq/L, respectively. LLD is based on a 1 L sample resulting in less than 100 mg of sample ash and counted for 100 minutes.
b LLD = Lower Limit of Detection.
c Uncertainties are expressed as the standard deviation of the average activity of the processed samples.

During 2021, the gross beta activities in Ditches 8 and 9 were higher than in 2020. The 2021 gross alpha activities were lower in Ditch 8 and slightly higher in Ditch 9 compared to 2020. The average gross beta values were similar to the control sample collected off of Highway 211, given the variability in their values. The gross alpha values were similar to the control ditch. The control sample is unaffected by CNL's operations. Compliance with the *Guidelines for Canadian Drinking Water Quality* [34] may be inferred for gross beta activity since the measurements are all less than 1.0 Bq/L. The gross alpha activity was below the drinking water screening level of 0.5 Bq/L for all samples. The local well waters within the Canadian Shield contain naturally occurring uranium [35] at levels ranging from 0.04 Bq/L to in excess of 2.5 Bq/L. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. Naturally occurring

uranium and its progeny are contributors to the total alpha activity, and could account for levels seen in some of the ditch water samples. In addition, naturally occurring alpha emitters may be present in suspended sediment in some of the samples.

As discussed in Appendix D of this report, the WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. The amount measured in drainage Ditch 8 (4.6±0.5 Bq/L) and Ditch 9 (4.7±0.4 Bq/L) were not significantly different from that noted at the control location (4.4±0.9 Bq/L). A number of ditches close to WMA are known to contain tritium. In 2021, the amount of tritium reaching the Ditch 8 and 9 locations was not significant. The tritium activities measured at all three ditch locations are much lower than the Guidelines for Canadian Drinking Water Maximum Acceptable Concentration for tritium (7000 Bq/L) [34].

Table 26 summarizes the data for releases of liquid effluents[10] for the years 2016 to 2021. The average monthly releases, expressed as a percent of the DRLs, are added for the various sources on site to provide a quantitative indicator of the performance of the site. The average total release for 2021 was 0.49% of the DRL, which is lower than 2020 and the five-year average (0.51%). The main reason for the higher 2019, 2020 and 2021 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. The highest monthly release from the Outfall in 2021 was Pu-239/240 at 0.29% of the DRL. There were no lagoon discharges in 2021.

9.4.2 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is determined for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results as a result of equipment failure, maintenance/calibration outages, or operator action requires “unavailability” to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) for monitoring equipment on effluent streams with effluent rates that are normally ≥ 0.5% of weekly DRLs are set more stringent (for unplanned unavailability) than for those streams with normal effluent rates < 0.5% of weekly DRLs. Unavailability is expressed in hours of unmonitored effluent releases per year, and applies separately to each monitored parameter, on each effluent stream.

10 The radioactivity from Ditches 8 and 9 was found to be below the Canadian Drinking Water Screening Level [34] for both gross beta and gross alpha activity, within the uncertainty of the analysis. Tritium levels were well below the Canadian Drinking Water Maximum Acceptable Level. The contributions were considered insignificant due to the small volume of release, and are not included in the liquid release table.

Table 26: Radionuclides in Liquid Effluents from WL – 2016 to 2021

Location/ Parameter	DRL (Bq/mo)	Action Level (Bq/mo)	2016 (Bq/mo)	2017 (Bq/mo)	2018 (Bq/mo)	2019 (Bq/mo)	2020 (Bq/mo)	Five-Year Average		2021		2021 Maximum	
								(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)	(Bq/mo)	(%DRL)
OUTFALL													
Gross Alpha[a]	1.11E+09	1.43E+08	2.43E+06	2.20E+06	2.86E+06	4.23E+06	3.99E+06	3.14E+06	2.71E-01	2.77E+06	-	5.31E+06	-
Uranium-total	1.25E+10	N/A	N/A	1.24E+06	9.13E+05	1.05E+06	9.65E+05	N/A		9.28E+05	7.42E-03	1.26E+06	1.01E-02
Plutonium-239/240	1.11E+09	N/A	N/A	5.76E+05	1.89E+06	3.19E+06	2.32E+06	N/A		1.86E+06	1.67E-01	2.98E+06	2.68E-01
Plutonium-238	1.16E+09	N/A	N/A	7.24E+05	1.53E+06	4.05E+06	1.99E+06	N/A		1.86E+06	1.61E-01	2.54E+06	2.19E-01
Americium-241	1.04E+09	N/A	N/A	1.49E+05	1.07E+05	1.06E+06	9.76E+05	N/A		1.16E+06	1.12E-01	3.66E+06	3.52E-01
Gross Beta[b]	-	5.00E+08	1.43E+07	2.06E+07	1.36E+07	2.06E+07	1.98E+07	1.78E+07	-	1.48E+07	-	2.44E+07	-
Strontium-90	1.30E+10	N/A	2.50E+06	4.83E+06	2.39E+06	3.11E+06	2.41E+06	3.05E+06	2.35E-02	1.96E+06	1.51E-02	4.53E+06	3.48E-02
Cesium-137	1.16E+10	N/A	1.31E+06	1.51E+06	1.26E+06	1.14E+06	1.03E+06	1.25E+06	1.08E-02	1.09E+06	9.36E-03	2.45E+06	2.11E-02
Tritium	6.80E+13					3.76E+08	4.09E+08	N/A		3.48E+08	5.64E-04	7.05E+08	1.04E-03
LAGOON													
Gross Alpha[a]	1.11E+09	5.84E+07	7.22E+05	1.03E+06	3.92E+05	6.17E+05	1.57E+06	8.65E+05	7.46E-02	N/A		N/A	
Uranium-total	1.25E+10	N/A	N/A	1.66E+05	5.49E+04	1.92E+05	1.19E+05	NA		N/A		N/A	
Americium-241	1.04E+09	N/A	N/A	2.76E+05	2.44E+05	6.17E+05	5.22E+05	NA		N/A		N/A	
Pu-239/240[a]	1.11E+09	N/A	N/A	4.22E+05	4.52E+04	7.28E+05	9.67E+05	NA		N/A		N/A	
Gross Beta	-	1.50E+08	5.76E+06	4.14E+06	2.53E+06	8.00E+06	1.04E+07	6.17E+06	-	N/A		N/A	
Strontium-90	1.30E+10	N/A	1.16E+06	7.26E+05	2.82E+05	1.85E+06	2.35E+06	1.27E+06	9.79E-03	N/A		N/A	
Cesium-137	1.16E+10	N/A	5.05E+04	6.43E+04	2.44E+02	6.17E+05	5.22E+05	2.51E+05	2.16E-03	N/A		N/A	
TOTAL as %DRL	**-**	**-**	**3.24E-01**	**2.61E-01**	**3.79E-01**	**9.27E-01**	**6.71E-01**		**5.10E-01**		**4.72E-01**		**9.06E-01**

a In 2018 monitoring for Outfall began for U-total, Pu-239/240 and Pu-238. In the Lagoon Pu-239/240 was calculated from gross alpha mass balance. The %DRL is reported for these isotopes instead of gross alpha. Note that Pu isotope activities are detection level values and Am-241 and Cs-137 activities are very close to detection levels.

b Gross beta releases are not included in the %DRL totals as the regulated components of the gross beta (Cs-137 and Sr-90) are already accounted.

Table 27: Effluents Monitoring Equipment Unavailability – 2021

	Unavailability Criteria[a]		Number of Exceedances
Air effluent streams with normal emission rate ≥ 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	84 hours/year/stream	0
Air effluent streams with normal emission rate < 0.5% of weekly DRL.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0
Continuously monitored liquid effluent streams.	Planned	168 hours/year/stream	0
	Unplanned	288 hours/year/stream	0

a See Table 7 in 900-509200-STD-009.

Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. In Building 100 there was one instance when the stack pump went down for a long weekend, resulting in 112.5 hours of unplanned loss of air monitoring. In the Shielded Facilities there were three instances of planned loss of monitoring because class III power was shut down for electrical equipment inspections. The total planned loss of monitoring, affecting the Hot Cells and IFTF was 6.5 hours. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities, this amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. There was one instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability was calculated as per procedure. In each instance, an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.4.3 Overall Performance

Figure 3 summarizes the data presented in Table 23 and Table 26 on site-wide airborne and liquid emissions, expressed as totals of percentages of DRLs (the lower rows of the tables) for the years 2016 to 2021. The average emissions for the past six years continue to be very small. Liquid emissions of radioactive material from WL in 2021 were below CNL's Administrative Levels and Action Levels, and continue to be very small compared with the applicable DRLs [30]. All air emissions were below CNL's Administrative Levels and Action Levels.

Total radioactive airborne emissions from the WL site during 2021 continue to be very low, averaging 0.00019% of the DRL, which is similar to 2020 and lower than in 2019.

Radioactivity in the WL liquid releases for 2021 was 0.47% of the DRL which is lower than in 2020 (0.67%) and the last five-year average (0.51%). The main reason for the higher 2019 to 2020 liquid releases was an increase in the detection limit values for Am-241 and Pu-239/240, since both isotopes were below detection limits. Pu-239/240, at detection limit values, was the primary contributor to the Outfall, averaging 0.17% of the DRL. The level of tritium activity noted in the two ditches carrying drainage from the WMA remains well below the Maximum Acceptable Concentration for Drinking Water.

The 2021 release results, as well as the previous years' trends, indicate that CNL has taken reasonable precautions to control the release of radioactive nuclear substances within the site, and into the environment, as a result of the licensed activity. All airborne and liquid release results are consistent with the clean-up and operational activities associated with decommissioning of the site.

The results of the monitoring program demonstrate that controls for the release of potentially hazardous substances currently in place at WL continue to provide substantial protection of the environment.

9.5 Effluent Monitoring – Non-Radiological

This section addresses the licence requirement on hazardous substances monitoring of liquid and airborne effluents for the WL site for 2021. It also fulfills similar effluent monitoring requirements listed under Work Package 1 of the *Environmental Assessment Follow-Up Program* [28].

9.5.1 Liquid Effluent Monitoring

9.5.1.1 Monitoring Points, Schedule, and Parameters

Whiteshell Laboratories staff members collect samples for non-radiological parameters from eight different monitoring points. The first four are the Sewage Lagoon (referred to as the Lagoon) at point of discharge to the Lagoon drainage ditch, the Process Outfall (referred to as the Outfall), the North drainage ditch (referred to as Ditch 8), and the West drainage ditch (referred to as Ditch 9). These effluents flow directly to the Winnipeg River. Two monitoring locations measure internal process wastes leaving the Low-Level Liquid Waste Treatment Systems (LLLWTS) from Building 300 and Building 100. The remaining two monitoring locations are used as background monitoring locations, and are the Intake water taken from the Winnipeg River at the Pump House (Building 902), and a control ditch on provincial Highway 211. More details for each monitoring area are provided in the sections that follow.

Referring to Section 9.4 of this report, Figure 2 shows the locations of the waste stream sources monitored, and where appropriate, their source or release points to the Winnipeg River. Ditch 8 meets the river some distance downstream (north) of the site boundary.

Table 28 lists the non-radiological parameters monitored at the inlet and effluent streams sampled, and the sampling schedule that is followed. The WL monitoring program follows the

protocols from the Ontario Ministry of Environment [36] in its Municipal/Industrial Strategy for Abatement program. Under that system, parameters that are normally measured by the same analytical technique are grouped into numbered Analytical Test Groups. These are described in Table 29, which includes information about the Regulatory Method Detection Limit (RMDL), Laboratory Method Detection Limit (LMDL) and the Smallest Reporting Increment (SRI). The LMDL and SRI were decided following protocol. The WL monitoring program also meets the requirements set out in the Federal Wastewater Systems Effluent Regulations [37], and the standards from CSA N288.5-11, *Effluent Monitoring Programs at Class 1 Nuclear Facilities and Uranium Mines and Mills* [20].

Table 28: Schedule for Non-Radiological Monitoring at WL

ATG[a]	Parameter	Intake[b]	Lagoon	Outfall	Ditches 8, 9 & Control	LLLWTS Tanks	
						Building 300-LLLWTS	Building 100-LLLWTS
--	CBOD	--	Pre-Discharge	--	--	--	--
--	Un-ionized Ammonia	--	Discharge	--	--	--	--
--	Total Residual Chlorine	--	Discharge	--	--	--	--
-	Acute Lethality Test	--	Pre-Discharge	Quarterly[c]	--	--	--
--	Fecal Coliforms	--	Pre-Discharge	--	--	--	--
--	Total Coliforms	--	Pre-Discharge	--	--	--	--
3	pH	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
5b	Total Organic Carbon	Monthly	-	Discharge	-	-	-
6	Phosphorus (Total)	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
7	Conductivity	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
8	TSS	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Chromium	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Copper	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9[a]	Iron	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9	Lead	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
9a	Magnesium	Monthly	-	Discharge	-	-	-
9	Nickel	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
-	Potassium	Monthly	-	Discharge	-	-	-
9	Strontium	Monthly	-	Discharge	-	-	-
9a	Uranium	Monthly	-	Discharge	-	-	-
9	Zinc	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
12	Mercury	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
14	Phenolics	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge
16	Bromodichloromethane	Monthly	-	Discharge	-	-	-
16	Chloroform	Monthly	-	Discharge	-	-	-
17	Toluene	Monthly	-	Discharge	-	-	-
25	Oil & Grease	Monthly	Discharge	Discharge	Discharge	Discharge	Discharge

a ATG = Analytical Test Group; BOD = Biochemical Oxygen Demand; CBOD = Carbonaceous Biochemical Oxygen Demand; TSS = Total Suspended Solids.

b The Monthly = grab sample taken once within each month.

Intake water was sampled each month as grab-samples are drawn from the wet well of the Pump House (Building 902).

In 2021, there was no discharging of the Lagoon.

At the Outfall, daily monitoring and weekly samples are collected for non-radiological parameters.

The ditches are sampled only when water is flowing freely within them, and at a maximum frequency of once per week. This occurs after snowmelt or significant rainfall, of which there were six events in 2021.

Whenever a tank was discharged at either of the Low Level Liquid Waste Treatment System's (LLLWTS), the effluent was sampled.

9.5.1.2 Analytical Protocol and Results Evaluation

With minor modification, the protocols for sample collection, and result reporting used here, are adopted from the Ontario Ministry of Environment publication *Protocol for the Sampling and Analysis of Industrial/Municipal Wastewate*r [36]. The protocols are used under Ontario's industry-specific effluent monitoring and limits regulations. The system supplies a justifiable set of methods to ensure that the final reported result is representative of the effluent sampled. Guidance is given on sampling of wastewater streams, sample handling including pre-treatment, and acceptable analytical techniques. Some of these are common to more than one parameter, so they are grouped into Analytical Test Groups, listed in Table 29. Ontario Ministry of Environment protocols were used again this year, as they have been historically. It should be noted that the Manitoba government has no such comprehensive protocols for sample collection, preservation, analyses, and result reporting.

Table 29: Listing of Analytical Test Groups

ATG	Parameter Name	Method[a]	Unit[b]	RMDL[c]	CNL LMDL[d]	CNL SRI[e]	Contracted Lab's LMDL
--	CBOD	Dissolved Oxygen Electrode	mg/L	--	--	--	2.0
--	Un-ionized Ammonia	Colorimetry	mg/L	--	--	--	0.001
--	Total Residual Chlorine	Colorimetry	mg/L	--	--	--	0.050
--	Total Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
--	Fecal Coliforms	Most Probable Number	MPNU/100 mL	N/A	--	--	3
3	pH	Glass Electrode	pH	N/A	--	0.02	N/A
5b	Total Organic Carbon	High Temperature Combustion	mg/L	-	-	-	0.5
6	Phosphorus	Colorimetry	mg/L	0.10	--	--	0.003
7	Conductivity	Cond. Meter	µS/cm	5	0.8	0.2	2.0
8	TSS	Gravimetry	mg/L	5	--	--	1.0
9	Chromium	ICP	mg/L	0.02	--	--	0.001
9	Copper	ICP	mg/L	0.01	--	--	0.0005
9a	Iron	ICP	mg/L	0.02	--	--	0.010
9	Lead	ICP	mg/L	0.03	--	--	0.0002
9a	Magnesium	ICP	mg/L	--	--	--	0.05
9	Nickel	ICP	mg/L	0.02	--	--	0.001
-	Potassium	ICP	mg/L	--	--	--	0.05
9	Strontium	ICP	mg/L	--	--	--	0.001
9a	Uranium	ICP	mg/L	--	--	--	0.0001
9	Zinc	ICP	mg/L	0.01	--	--	0.005
12	Mercury	Cold Vapour Atomic Absorption	µg/L	0.1	--	--	0.0019
14	Phenolics	Colorimetry	mg/L	0.002	--	--	0.0010
16	Bromodichloromethane	GC-MS	mg/L	--	--	--	0.0005
16	Chloroform	GC-MS	mg/L	--	--	--	0.0005
17	Toluene	GC-MS	mg/L	--	--	--	0.0004
25	Oil & Grease	Gravimetry	mg/L	1	--	--	1.0

a The method ICP = Inductively Coupled Plasma Spectrometry. This is a common method for metals analysis.

b The unit MPNU = Most Probable Number Unit, as reported by accredited contract laboratory. The MPNU is a common estimate of bacterial counts, especially for sewage effluent.

c RMDL = Regulation Method Detection Limit

d The LMDL = Laboratory Method Detection Limit ("MDL" also used).

e The SRI = Smallest Reporting Increment.

9.5.1.3 Unavailability of Effluent Verification Monitoring

The unavailability of effluent verification monitoring is found for all on-line Environmental Protection Program monitors as follows:

- Absence of monitoring or monitoring results because of equipment failure, maintenance/calibration outages or operator action requiring "unavailability" to be assigned.
- Routine sample media changes on the monitoring equipment are not considered to be part of unavailability of the equipment.
- Unavailability criteria (see Table 27) are set separately for planned and unplanned events.

Examples of planned unavailability include routine maintenance or inspections, and calibration activities, while unplanned unavailability includes events such as detection and repair of unexpected monitor or monitoring equipment failures.

In 2021, there were no instances in which the unavailability criteria (Table 27) outlined above were exceeded. There were no instances of non-radiological air monitoring unavailability. There were 3 instances of planned unavailability to Outfall monitoring that were due to required electrical power supply shut down to facilitate decommissioning activities. This amounted to a total of 5.2 planned hours of monitoring unavailability for liquids. One instance of unplanned Outfall monitoring, amounting to 14 hours, occurred when the motor on the sampling equipment at the outfall monitoring station failed and required replacing. In each instance an estimate of the release during unavailability is calculated per procedure (if the lost time is 5 percent or greater of the total monitoring interval).

9.5.1.4 Monitoring Results

In the following sections, there are two types of presentation formats used in reporting the results obtained in 2021. These include an averages summary table and a comparison against the CNL's Monthly Guideline Acceptance criteria, for the effluent at identified monitoring locations.

9.5.1.4.1 Averages Summary Table

Summarized results for 2021 are presented in Table 30 through Table 34. The first two columns in the tables identify the Ministry of Environment ATG and parameter names [36]. The next three give the CNL monthly guideline concentration, LMDL (Table 29) and units for each measurement. The next six columns provide comparison of the average concentrations reported for the five previous years, followed by their arithmetic mean. The next seven

columns have a summary of the results for the 2021 monitoring period (explained further below).

WL previously discontinued on-site analysis of most of the non-radiological parameters. The samples are now shipped to external ISO 17025 accredited laboratories through a sample management office. The LMDL for the laboratory analyzing the parameter is provided in Table 29.

Within the 2021 results section, the number of samples included in the average ("# Spl.") is reported. This number is not constant down the table. It depends on the sampling frequency chosen for each parameter, and sample mixing to prepare composites for analysis. The next column (labelled "ND's") gives the number of samples in which the analyte was not detected and was therefore deemed a "zero" result.

The minimum, maximum and average values of each parameter are based on individual results and not monthly averages. These results are given in the tables found at the end of the section, and include any results that were zero by virtue of being non-detectable in the laboratory. The relative standard deviation of all results is also reported, expressed as a percentage of the average. This number allows some evaluation of scatter inherent in the samples and measurement method. Usually, sample variability dominates (i.e., the effluent composition changes over time).

In Table 31 through Table 34, yearly average values for parameters marked with an asterisk show that a monthly guideline was exceeded for at least one month during the calendar year being presented.

For convenience, the total annual load to the environment (Winnipeg River) represented by each of the analytes is also presented, expressed in kilograms. The calculation process is described in detail in Section 9.5.1.5 (where the results for the Lagoon and Outfall monitoring points have been collected in Table 36, and compared to the previous five years).

Table 30: Averages Summary for Intake

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2021							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)
3	pH	6 to 9	N/A	pH	7.03	7.42	7.41	7.43	7.17	7.29	12	0	6.73	8.11	7.66	5.84	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	9.0	9.0	12	0	6.9	9.7	8.4	10.1	25000
6	Phosphorus	1.0	0.003	mg/L	0.040	0.026	0.020	0.017	0.014	0.023	12	0	0.010	0.019	0.014	21.4	46
7	Conductivity	N/A	2.0	µS/cm	104	93.0	107	107	98	102	12	0	97	110	101	4.26	N/A
8	TSS	25	1.0	mg/L	2.63	3.03	2.05	3.15	3.80	2.93	12	4	0	6.1	2.23	94.7	6205
9	Chromium	0.5	0.001	mg/L	0.0002	0	0.0001	0.0005	0.0006	0.0003	12	11	0	0.0062	0.0005	346	0.53
9	Copper	0.5	0.0005	mg/L	0.007	0.004	0.005	0.007	0.007	0.006	12	0	0.004	0.013	0.007	39.9	19
9a	Iron	1.0	0.01	mg/L	0.32	0.310	0.233	0.331	0.242	0.287	12	0	0.159	0.354	0.247	27.0	805
9	Lead	0.1	0.0002	mg/L	0.001	0.0002	0.0001	0.0001	0.0001	0.0003	12	5	0	0.0003	0.0001	89.2	0.65
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	3.62	3.62	12	0	3.34	4.13	3.70	47.7	11840
9	Nickel	0.5	0.001	mg/L	0.0008	0	0	0.0001	0.0002	0.0002	12	10	0	0.0272	0.0025	318	2.72
9	Potassium [f]	-	0.05	mg/L	-	-	-	-	0.823	0.823	12	0	0.735	0.859	0.810	5.27	2564
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	2.23	2.23	12	0	2.00	3.68	2.38	18.52	8190
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.023	0.023	12	0	0.022	0.025	0.024	3.81	75
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0000	0	12	8	0	0.0001	0.0000	148	0.10
9	Zinc	0.5	0.005	mg/L	0.0023	0	0	0	0.0022	0.0009	12	11	0	0.0072	0.0006	318	1.26
12	Mercury	1.0	0.002	µg/L	0.0016	0	0.0002	0	0.0016	0.0007	12	12	0	0	0	N/A	0
14	Phenolics	0.02	0.001	mg/L	0.0014	0.0017	0.0002	0.0007	0	0.0008	12	12	0	0	0	N/A	0
16	Bromodichloromethane [f]	-	0.0005	mg/L	-	-	-	-	0.0015	0.0015	12	3	0	0.0028	0.0017	68.79	4.33
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.068	0.068	12	0	0.001	0.120	0.053	75.71	139
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	12	12	0	0	0	N/A	0
25	Oil & Grease	15	1.0	mg/L	0.4	0.1	0.1	0	0	0.1	12	12	0	0	0	N/A	0

					Monitoring Point: Site Intake													
					Averages from Previous Five Years[a]						Results for Year 2021							
ATG	Parameter	Monthly Guide[b]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[c]	NDs[d]	Min.	Max.	Avg.[a]	RSTD (%)[e]	Load (kg)
--	Estimated Flow (total volume for year)			m^3	1.30E+06	1.21E+06	1.18E+06	1.01E+06	1.12E+06	1.16E+06	3.14E+06						

a Averages were calculated by setting to zero results reported as "< DL".

b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A not applicable

Table 31: Averages Summary for Lagoon

					Monitoring Point: Lagoon													
					Averages from Previous Five Years						Results for Year 2021							
ATG	Parameter	Monthly Guide[a]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[b]	NDs[c]	Min.	Max.	Vol. Wt. Avg.	RSTD[d] (%)	Load (kg)
-	CBOD	25	2.0	mg/L	0	2.5	17.7	0	0	4.0	0	0	0	0	0	0	N/A
-	Un-ionized Ammonia	1.25	0.0010	mg/L	0.0099	0.0100	0.0097	0.0011	0.0010	0.0063	0	0	0	0	0	0	N/A
-	Total residual Chlorine	0.02	0.05	mg/L	0.035*	0.017	0.018	0.022	0.057	0.030	0	0	0	0	0	0	N/A
--	Total Coliform	N/A	3	MPNUe/100 mL	35	534	330	200	763	372	0	0	0	0	0	0	N/A
--	Fecal Coliform	400	3	MPNU/100 mL	5	40	5	13.5	88	30	0	0	0	0	0	0	N/A
3	pH	6 to 9	N/A	pH	7.01	8.59	8.68	6.66	7.00	7.59	0	0	0	0	0	0	N/A
6	Phosphorus	1.0	0.003	mg/L	0.083	0.069	0.131	0.049	0.075	0.081	0	0	0	0	0	0	N/A
7	Conductivity	N/A	2.0	µS/cm	279	223	229	348	446	305	0	0	0	0	0	0	N/A
8	TSS	25	1.0	mg/L	1.92	4.807	3.8	1.2	3.9	3.1	0	0	0	0	0	0	N/A
9	Chromium	0.5	0.001	mg/L	0	0	0	0	0	0	0	0	0	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0016	0.0021	0.0015	0.0007	0	0.0012	0	0	0	0	0	0	N/A
9a	Iron	1.0	0.01	mg/L	0.245	0.283	0.370	0.119	0.116	0.227	0	0	0	0	0	0	N/A
9	Lead	0.1	0.0002	mg/L	0	0.0001	0	0	0	0	0	0	0	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.0005	0.0015	0.0015	0.0011	0	0.0009	0	0	0	0	0	0	N/A
9	Zinc	0.5	0.005	mg/L	0.0003	0	0	0	0	0	0	0	0	0	0	0	N/A
12	Mercury	1.0	0.002	µg/L	0.0006	0	0	0	0	0.0001	0	0	0	0	0	0	N/A
4	Phenolics	0.02	0.001	mg/L	0.0015	0.0017	0.0033	0	0	0.0013	0	0	0	0	0	0	N/A
25	Oil & Grease	15	1.0	mg/L	0.45	0.78	0.856	0	0	0.4172	0	0	0	0	0	0	N/A
--	Estimated Flow (total volume for year)[f]			m^3	7.46E+04	4.72E+04	1.22E+04	3.83E+04	3.08E+04	4.06E+04	0						
--	Number of Batches Discharged			--	2	2	2	1	1	2	0						

a Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

d RSTD = Relative Standard Deviation

e MPNU = MPN Units, as given by Most Probable Number bacterial estimation technique.

f The Lagoon discharges are considered to occur in two "months" – Spring and Fall. Note: There were no discharges in 2021 of the Lagoon.

Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

N/A = not applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Table 32: Averages Summary for Outfall

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.50	7.81	7.76	7.67	7.50	7.65	52	0	6.79	8.30	7.66	4.67	N/A
5b	Total Organic Carbon [f]	-	0.5	mg/L	-	-	-	-	13.4	13.4	51	0	7.4	21.0	10.2	31.5	12230
6	Phosphorus	1.0	0.003	mg/L	0.040	0.035	0.030	0.022	0.021	0.030	52	1	0	0.074	0.022	57.5	25.9
7	Conductivity	N/A	2.0	µS/cm	130	139	131	164	134	140	52	0	110	790	149	63.0	N/A
8	TSS	25	1.0	mg/L	2.35	2.97	1.5	4.2	5.4	3.3	52	3	0	18	5.3	74.6	6630
9	Chromium	0.5	0.001	mg/L	0.0001	0	0.0001	0.0006	0.0005	0.0003	52	43	0	0.0062	0.0003	307	0.035
9	Copper	0.5	0.0005	mg/L	0.006	0.006	0.005	0.005	0.010	0.006	52	0	0.002	0.016	0.007	67.6	8.44
9a	Iron	1.0	0.01	mg/L	0.316	0.262	0.186	0.218	0.302	0.257	52	0	0.107	1.300	0.271	65.7	322
9	Lead	0.1	0.0002	mg/L	0.0004	0.0003	0.0002	0.0002	0.0004	0.0003	52	17	0	0.0015	0.0003	102	0.303
9a	Magnesium [f]	-	0.05	mg/L	-	-	-	-	5.46	5.46	52	0	3.82	8.05	5.18	16.4	6118
9	Nickel	0.5	0.001	mg/L	0.0009	0.0020	0.0006	0.0005	0.0007	0.0009	52	25	0	0.0273	0.0017	322	1.49
-	Potassium [f]	-	0.05	mg/L	-	-	-	-	1.111	1.11	52	0	0.85	2.25	1.10	25.7	1302
9	Sodium [f]	-	0.05	mg/L	-	-	-	-	4.40	4.40	52	0	2.68	21.3	4.34	71.9	5086
9	Strontium [f]	-	0.001	mg/L	-	-	-	-	0.033	0.033	52	0	0.026	0.044	0.034	10.5	39.3
9a	Uranium [f]	-	0.0001	mg/L	-	-	-	-	0.0004	0.0004	52	0	0.0002	0.0007	0.0004	27.0	0.461
9	Zinc	0.5	0.005	mg/L	0.003	0.001	0.001	0.004	0.006	0.003	52	15	0	0.026	0.006	84.3	7.88
12	Mercury	1.0	0.002	µg/L	0.001	0	0.0006	0.0009	0.0002	0.0005	52	47	0	0.0033	0.0003	314	0.0003
14	Phenolics	0.02	0.001	mg/L	0.0017	0.004	0.0001	0.0003	0.0000	0.0012	52	52	0	0	0	N/A	0
16	Bromodichloro methane [f]	-	0.0005	mg/L	-	-	-	-	0.0005	0.0005	52	52	0	0	0	N/A	0
16	Chloroform [f]	-	0.0005	mg/L	-	-	-	-	0.0259	0.0259	52	9	0	0.019	0.0072	78.3	8.82
17	Toluene [f]	-	0.0004	mg/L	-	-	-	-	0	0	52	52	0	0	0	N/A	0

					Monitoring Point: Process Outfall [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	**Parameter**	**Monthly Guide [b]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[c]**	**NDs[d]**	**Min.**	**Max.**	**Avg.**	**RSTD[e] (%)**	**Load (kg)**
25	Oil & Grease	15	1.0	mg/L	0.82	0.19	0.10	0.02	0	0.226	52	50	0	6.80	0.15	627	188
--	Estimated Flow (total volume for year)			m^3	1.41E+06	1.13E+06	1.16E+06	1.25E+06	1.21E+06	1.23E+06	1.15E+06						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Monthly Guide is from WL's non-radioactive effluent limits procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified.

c # Spl. is the number of samples analyzed and reported.

d NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).

e RSTD = Relative Standard Deviation

f New parameter (2020) being tracked by the effluent monitoring program

N/A = Not Applicable.

Acute lethality test results are discussed in Section 9.5.1.4.5.1

Note: There were no monthly guideline exceeds for any monitored parameter.

Table 33: Averages Summary for Ditches 8, 9 and Control

					Monitoring Point: DITCH 8 (Northbound)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	Parameter	Monthly Guide[c]	LMDL	Unit	2016	2017	2018	2019	2020	Average	# Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.50	7.88	7.81	7.73	7.64	7.71	5	0	7.5	8.00	7.81	2.39
6	Phosphorus	1.0	0.003	mg/L	0.049	0.071	0.045	0.043	0.135	0.069	5	0	0.031	0.059	0.041	27.2
7	Conductivity	N/A	2.0	µS/cm	571	445	690	586	451	549	5	0	330	700	454	33.4
8	TSS	25	1.0	mg/L	2.3	1.4	1.65	1.92	3.4	2.1	5	2	0	3.0	1.26	103
9	Chromium	0.5	0.001	mg/L	0.0004	0	0	0.0005	0.0002	0.0002	5	5	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.002	0.0015	0.0015	0.0013	0.0010	0.0015	5	0	0.0008	0.0019	0.0014	29.1
9a	Iron	1.0	0.01	mg/L	0.208	0.192	0.083	0.147	0.205	0.167	5	0	0.089	0.274	0.141	54.5
9	Lead	0.1	0.0002	mg/L	0.0002	0	0	0	0	0	5	5	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.005	0.004	0.003	0.003	0.003	0.004	5	0	0.002	0.004	0.003	25.8
9	Zinc	0.5	0.005	mg/L	0.004	0.002	0.001	0.001	0.001	0.002	5	1	0	0.006	0.004	58.4
12	Mercury	1.0	0.002	µg/L	0.0055	0	0.0020	0.0009	0.0014	0.0020	5	0	0.0029	0.0044	0.0037	18.0
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0070	0.0002	0.0006	0.0008	0.0022	5	4	0	0.0011	0.0002	223
25	Oil & Grease	15	1.0	mg/L	0.85	0.4	0.13	0.17	0.08	0.33	5	5	0	0	0	N/A

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ATG	Parameter	Monthly Guide[c]	LMDL	Unit	Monitoring Point: DITCH 9 (Westbound)[a] Averages from Previous Years[b] 2016	2017	2018	2019	2020	Average	Results for Year 2021 #Spl.[d]	NDs[e]	Min.	Max.	Avg.[b]	RSTD[f] (%)
3	pH	6 to 9	N/A	pH	7.05	7.67	7.69	7.58	7.32	7.46	6	0	7.23	8.08	7.57	22.0
6	Phosphorus	1.0	0.003	mg/L	0.053	0.045	0.042	0.004	0.039	0.037	6	1	0	0.440	0.097	174
7	Conductivity	N/A	2.0	µS/cm	193	214	538	400	224	314	6	0	200	600	300	50.3
8	TSS	25	1.0	mg/L	2.4	2.1	2.1	2.7	3.3	2.5	6	1	0	4.9	2.3	73.98
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0005	0.0004	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0008	0.0013	0.0021	0.0018	0.0018	0.0016	6	0	0.0014	0.0029	0.0019	29.8
9a	Iron	1.0	0.01	mg/L	0.575	0.326	0.315	0.250	0.558	0.405	6	0	0.251	0.710	0.382	44.1
9	Lead	0.1	0.0002	mg/L	0	0	0	0	0.0000	0.0000	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.003	0.003	0.004	0.003	6	0	0.002	0.006	0.003	95.8
9	Zinc	0.5	0.005	mg/L	0.006	0.002	0.004	0.003	0.006	0.004	6	0	0.004	0.061	0.015	153
12	Mercury	1.0	0.002	µg/L	0.0087	0	0.0021	0.0016	0.005	0.0035	6	0	0.0029	0.0410	0.0109	136
14	Phenolics	0.02	0.001	mg/L	0.0021	0.0086	0	0.0005	0.0002	0.0023	6	5	0	0.0011	0.0002	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0	0	0.1	0.24	6	5	0	1	0.2	245

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					Monitoring Point: CONTROL DITCH (North side of Highway 211)[a]											
					Averages from Previous Years[b]						Results for Year 2021					
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**
3	pH	6 to 9	N/A	pH	7.22	7.76	7.83	7.72	7.54	7.61	6	0	7.27	8.07	7.76	4.02
6	Phosphorus	1.0	0.003	mg/L	0.148	0.083	0.065	0.104	0.071	0.094	6	0	0.03	0.14	0.06	65.8
7	Conductivity	N/A	2.0	µS/cm	347	380	939	579	385	526	6	0	280	550	415	26.0
8	TSS	25	1.0	mg/L	3.28	6.2	2.9	7.0	3.1	4.5	6	0	1.4	20	5.63	128
9	Chromium	0.5	0.001	mg/L	0.0003	0	0	0.0008	0.0001	0.0002	6	6	0	0	0	N/A
9	Copper	0.5	0.0005	mg/L	0.0005	0.0010	0.0015	0.0018	0.0009	0.0011	6	0	0.0009	0.0017	0.0013	21.3
9a	Iron	1.0	0.01	mg/L	0.714	0.594	0.674	0.762	0.464	0.642	6	0	0.357	0.769	0.509	37.9
9	Lead	0.1	0.0002	mg/L	0.0005	0.0002	0	0.0002	0.0000	0.0002	6	6	0	0	0	N/A
9	Nickel	0.5	0.001	mg/L	0.003	0.002	0.005	0.003	0.002	0.003	6	0	0.002	0.003	0.002	19.5
9	Zinc	0.5	0.005	mg/L	0.003	0	0.013	0.011	0.001	0.006	6	2	0	0.014	0.004	117
12	Mercury	1.0	0.002	µg/L	0.0127	0	0.0004	0.0007	0.0008	0.0029	6	0	0.0022	0.0040	0.0031	25.11
14	Phenolics	0.02	0.001	mg/L	0.0022	0.0074	0.0001	0.0007	0.0006	0.0022	6	5	0	0.0022	0.0004	245
25	Oil & Grease	15	1.0	mg/L	1.1	0	0.3	0	0.01	0.28	6	6	0	0	0	N/A

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.

b Averages were calculated by setting to zero results reported as "< W."

c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified

d # Spl. is the number of samples analyzed and reported.

e NDs is the number of samples in which analyte was not detected (i.e., Code = "< W," result = 0).

f RSTD = Relative Standard Deviation

N/A = not applicable

Table 34: Averages Summary for the Low-Level Liquid Waste Treatment Systems

					Monitoring Point: Building 100 & 300 LLLW Treatment Systems [a]													
					Averages from Previous Five Years[b]						Results for Year 2021							
ATG	**Parameter**	**Monthly Guide[c]**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Spl.[d]**	**NDs[e]**	**Min.**	**Max.**	**Avg.[b]**	**RSTD[f] (%)**	**Load (kg)**
3	pH	6 to 9	N/A	pH	7.50	7.52	7.39	7.54	7.69	7.53	33	0	2.58	8.01	7.55	12.5	N/A
6	Phosphorus	1.0	0.003	mg/L	0.145	0.370	0.327	0.554	0.503	0.380	33	0	0.011	2.00	0.810*	64.9	0.0719
7	Conductivity	N/A	2.0	µS/cm	326	267	348.84	352	473	353	33	0	240	1800	527	57.4	N/A
8	TSS	25	1.0	mg/L	4.38	14.67*	16.28*	8.25	15.0*	11.7	33	0	1.50	24.0	10.2	65.7	0.8968
9	Chromium	0.5	0.001	mg/L	0.0016	0.0007	0.0006	0.0009	0.0011	0.0010	33	25	0	0.0250	0.0021	255	0.0001
9	Copper	0.5	0.0005	mg/L	0.128	0.509*	0.516*	0.512	0.423*	0.418	33	0	0.011	1.660	0.333*	102	0.0296
9a	Iron	1.0	0.01	mg/L	9.37*	3.39*	1.660*	0.465	1.77*	3.33	33	0	0.42	6.05	1.57*	81.7	0.1379
9	Lead	0.1	0.0002	mg/L	0.006	0.014	0.0112	0.0057	0.0047	0.0083	33	0	0.0008	0.2020	0.0143	253	0.0013
9	Nickel	0.5	0.001	mg/L	0.0180	0.0066	0.0055	0.003	0.0040	0.0074	33	0	0.0037	0.0420	0.0117	85.1	0.0010
9	Zinc	0.5	0.005	mg/L	0.096	0.180	0.272	0.152	0.124	0.165	33	0	0.027	1.210	0.175*	151	0.0156
12	Mercury	1.0	0.002	µg/L	0.161	0.130	0.060	0.030	0.010	0.078	33	1	0	0.071	0.023	88.3	0.0000
14	Phenolics	0.02	0.001	mg/L	0.007	0.007	0.01*	0.005	0.005	0.007	33	7	0	0.010	0.004	82.8	0.0003
25	Oil & Grease	15	1.0	mg/L	0.60	0.73	0.88	0.59	0.70	0.70	33	30	0	2.50	0.18	326	0.0164
--	Estimated Flow (total volume for year)			m^3	2.30E+02	1.72E+02	1.32E+02	1.89E+02	1.07E+02	1.66E+02	8.82E+01						
--	Number of batches discharged			--	14	24	50	68	40	39	33						

a All results below the LMDL, originally flagged as "< DL" when reported, are only estimates.
b Averages were calculated by setting to zero results reported as "< DL."
c Monthly Guide is from CNL's limits for non-radiological parameters in liquid effluents procedure. For mercury, the Daily Guideline is given instead, as there is no Monthly Guideline specified
d # Spl. is the number of samples analyzed and reported.
e NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL," result = 0).
f RSTD = Relative Standard Deviation
N/A = not applicable
Notes: Any averages with an asterisk show that a monthly guideline was exceeded in one or more months for the given parameter in the year.

Discharges of effluent coming from the new low level liquid waste treatment systems are being combined, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.2 Monthly Guideline Acceptance

CNL guidelines were used as the basis against which emissions from WL were evaluated. They are not regulatory requirements, but instead have been adopted by CNL to routinely evaluate the environmental significance of both process-type and non-process type discharges from WL. Table 35 supplies a summary of each of the liquid effluent parameters that had exceeded its CNL monthly guideline in 2021 or at any time during the previous five years.

As with the average summary table provided, for each monitoring point, the first two columns in the table identify the Ministry of Environment ATG and parameter names. The next three columns give the CNL monthly guideline concentration, LMDL, and the units of measurement. The next six columns present the monthly guideline acceptance for each of the five previous years and the average of those five years expressed as a percentage. The last three columns show the number of months during which discharges occurred, the number of times the monthly guideline was exceeded for each parameter, and the subsequent percent of times the parameter levels met the acceptance criteria.

To assess any significant level of change and evaluate program performance, this table will be referred to in each section discussing monitoring point results.

Table 35: Parameters that Failed to Conform to CNL Monthly Guidelines

						Monthly Guideline Acceptance (%) for Previous Five Years						Results for Year 2021		
Effluent Stream	**ATG**	**Parameter**	**Monthly Guide**	**LMDL**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	**# Mth.**	**> Monthly Guide**	**Accept (%)**
LLLWTS /ALWTC	6	Phosphorus	1.0	0.003	mg/L	100	100	100	83	100	96.6	12	4	67
	8	TSS	25	1.0	mg/L	100	78	92	100	92	92.4	12	0	100
	9	Copper	0.5	0.0005	mg/L	100	67	33	42	58	60.0	12	2	83
	9a	Iron	1.0	0.010	mg/L	67	44	50	83	42	57.2	12	8	33
	9	Zinc	0.5	0.005	mg/L	100	100	100	100	100	100	12	1	92
	14	Phenolics	0.02	0.0010	mg/L	100	100	92	100	100	98.4	12	0	100

Notes:

- Effluent stream parameters which have not exceeded a monthly guideline in the current year or in the previous five years have not been included to this table.
- Discharges of effluent coming from the new low level liquid waste treatment systems are being considered as emanating from the ALWTC, as it allows for comparisons to the data collected over the previous 5 years

9.5.1.4.3 Monthly Guideline Plots

For parameters that have a value higher than a CNL monthly guideline, the monthly plot of values is shown for that parameter at the monitoring point. This year there were 9 months when one of four parameters (Iron, Copper, Phosphorous and Zinc from the LLLWTS had monthly values higher than CNL monthly guidelines. Figure 5 shows the number of times the monthly guidelines have been exceeded at any monitoring point over the last five years. Plots are displayed in Figure 6, Figure 7, Figure 8 and Figure 9 for each parameter, and the explanations for the observed high values can be found in Section 9.5.1.4.6. The monthly or daily guideline limit for the parameter in question is shown by a broken red line in the corresponding figures.

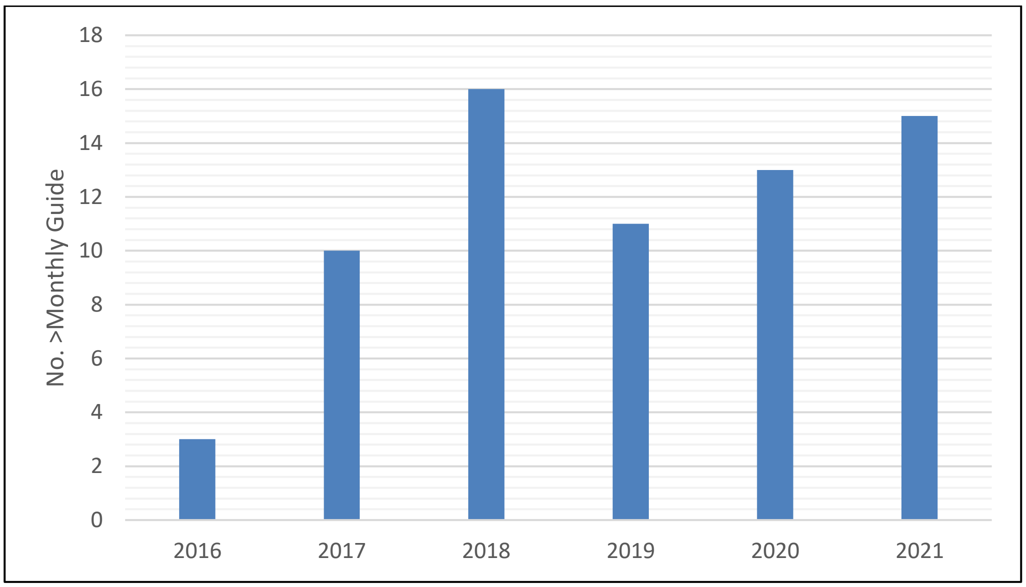

Figure 5: Non-Radiological Monitored Effluent Parameters Above Monthly Guidelines

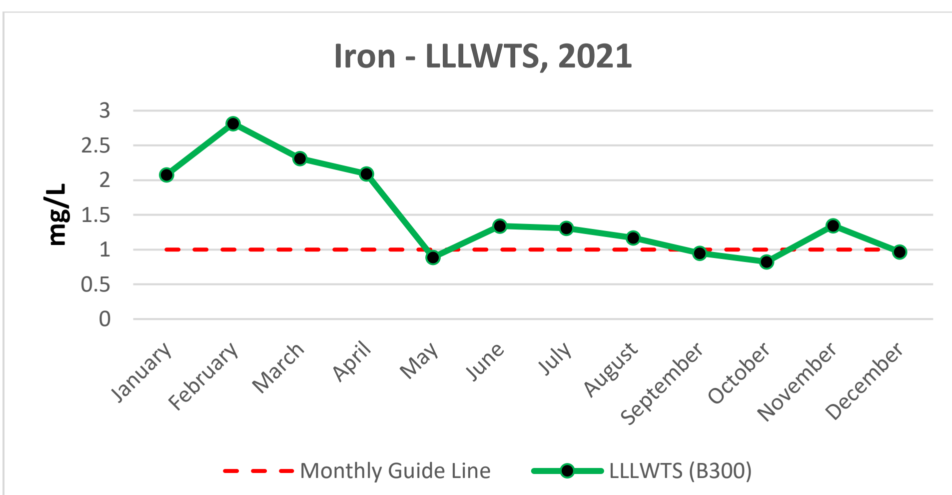

Figure 6: Monthly Average Iron Concentrations of Effluents from the Low-Level Liquid Waste

Treatment System for 2021

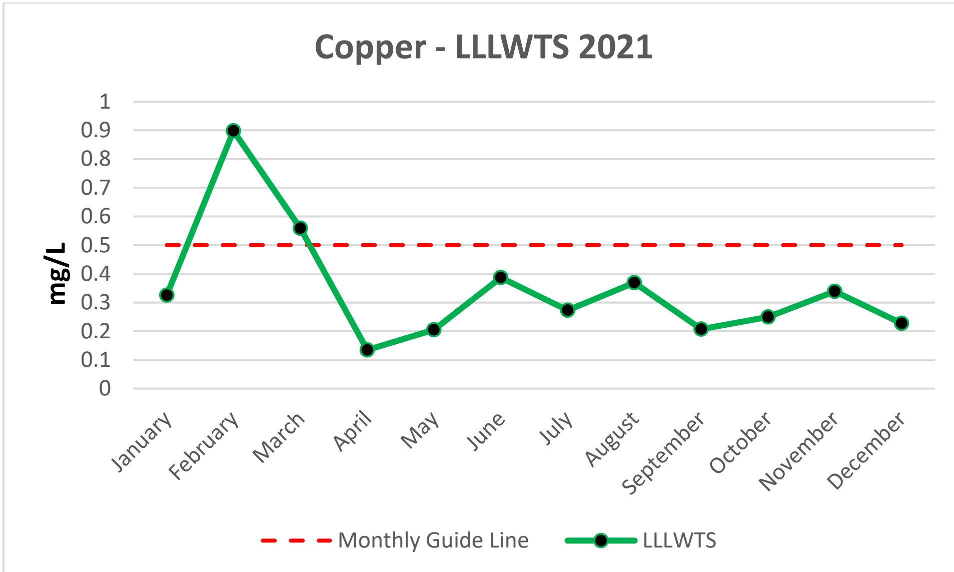

Figure 7: Monthly Average Copper Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

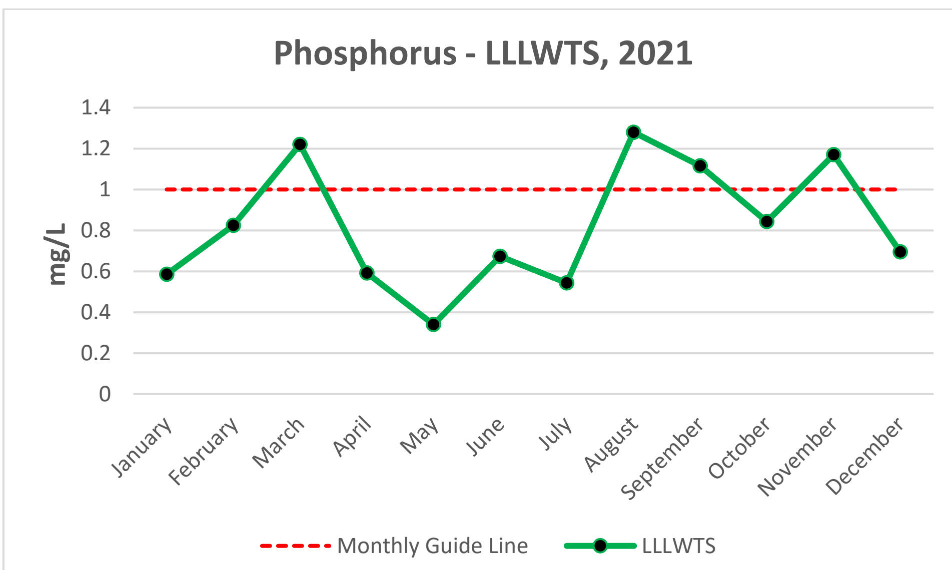

Figure 8: Monthly Average Phosphorus Concentration of Effluents from the Low-Level Liquid Waste Treatment Systems for 2021

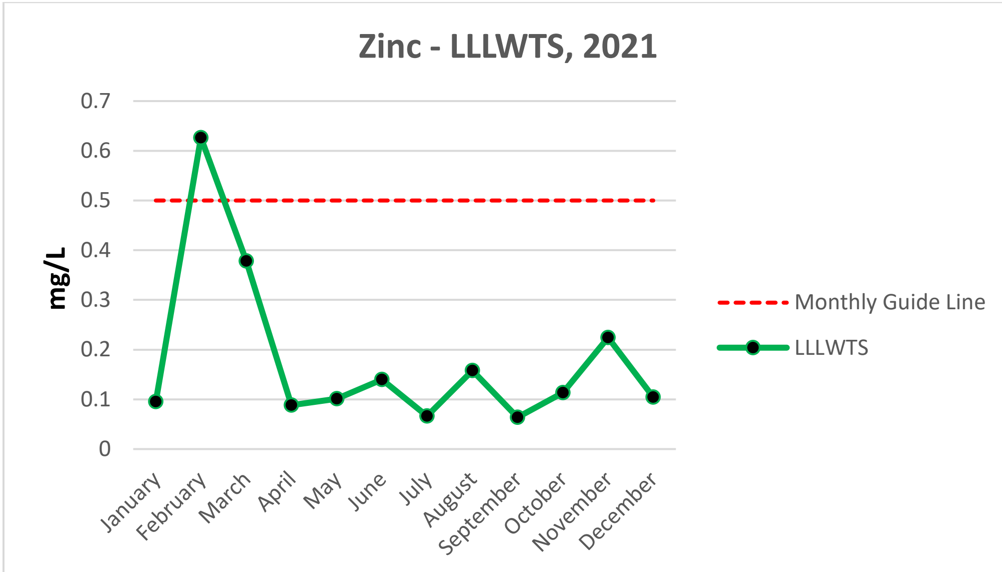

Figure 9: Monthly Average Zinc Concentrations of Effluents from the Low-Level Liquid Waste Treatment System for 2021

9.5.1.4.4 Monitoring of Intake Water from the Winnipeg River

Except for bottled drinking water, all the water needed to run the WL site is drawn from the neighbouring Winnipeg River at the Intake. The amount of water drawn from the Winnipeg River varies from year-to-year.

Grab-samples are collected each month from the Building 902 wet well to assess the levels of certain parameters that may be entering the site directly from the Winnipeg River. The measurements are summarized in Table 30, where they are compared to available data for the previous five years. Figure 10 shows the estimated amount of water used monthly for 2021.

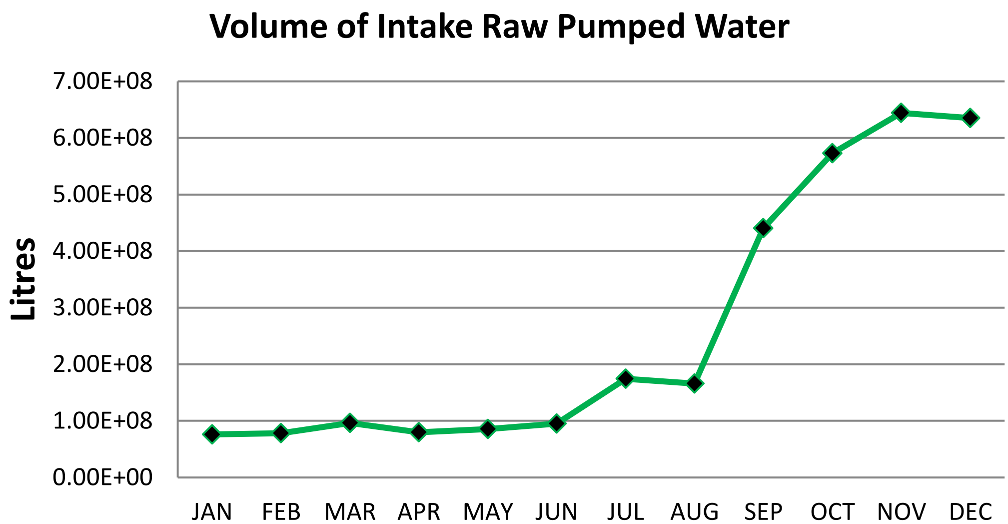

Figure 10: Monthly 2021 Intake Raw Pumped Water for the WL Usage

The following are notable points for the 2021 Intake water from the Winnipeg River:

- The Pump House flow meter recorded that 3.14E+06 m^3 of water was pumped from the river over the year.
- Compared to the five-year average, increased concentrations (> 10%) were seen for Chromium, Copper, Nickel, and Bromodichloromethane.
- Parameters that had their concentrations improve (> 10% decrease) this year compared to the average seen for the last five years are Phosphorus, TSS, Iron, Lead, Mercury, Phenolics, chloroform, and Oil & Grease.
- Water consumption for the site drastically increases during misting operations that are employed during building demolition. As these operation progress into sub-zero temperatures, a further increase is also observed, as a high flow of water is utilized to ensure the water lines do not freeze.

Intake water results can have a significant impact on the environmental performance of the WL site and they will continue to be monitored closely.

9.5.1.4.5 Monitoring of Liquid Effluents to the Winnipeg River

Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches 8 and 9. Results from monitoring each of these sources are discussed below.

9.5.1.4.5.1 Lagoon

The WL Lagoon secondary cell was not discharged during 2021. With reduced personnel on site due to the COVID-19 pandemic, the occupancy of Building 540 (modular office complex) which

has its bio-waste diverted offsite, and the low level of precipitation observed in 2021, the lagoon had enough freeboard to allow the site to operate into 2022 without discharging.

The total amount of effluent discharged from the Lagoon in 2021 was 0 m^3.

If the lagoon was discharged, the Lagoon would be tested for CBOD, fecal and total coliform bacteria, and acute lethality (a biological assessment on the survivability of trout in the proposed effluent). These samples are collected by the Lagoon operators at defined areas in the secondary cell after isolation of the cell occurs. During discharge, grab-samples would be collected close to the pipe emptying into the receiving ditch that leads to the Winnipeg River. Individual samples for most parameters would be collected on a weekly basis during the discharge.

The vertical scale from which surface height is found was carefully adjusted to read absolute depth from the original floor of the Lagoon. This was done because the equation for calculating the contained volume in the secondary cell for any depth is derived from the calculation for the volume of a rectangular trapezoidal trough:

Volume (in L) = Height x [Width_Bottom x Length_Bottom
+ 0.5(Width-Width_Bottom) Length_Bottom
+ 0.5(Length-Length_Bottom) Width_Bottom
+ (1/3) (Width-Width_Bottom) (Length-Length_Bottom)]

Knowing the dimensions and geometry, the contained volume in the secondary cell can be calculated accurately for any depth using the following equation:

Volume (in L) = $636\,655 \cdot d + 206.886 \cdot d^2 + 0.02133 \cdot d^3$ for depth “d” (in cm)

The position of the Lagoon’s water surface would be recorded once or twice daily while emptying. The daily flow would then be calculated from changes in the contained volume. This permits the calculation of volume-weighted concentrations and overall loads (see Section 9.5.1.5). Volume-weighted averages for a given period (month or year) are given by summing the product of the concentration for each day multiplied by the volume released that day, then dividing that sum by the total volume discharged during the period. Unlike other monitoring points (which are continuous or batch releases of fixed volume), the Lagoon discharge flow rate can vary widely. The variation makes weighting corrections highly significant in deciding meaningful average concentrations.

Discharging of the secondary cell is only allowed to proceed after initial testing. Once discharging begins, the pH is checked daily throughout the discharge period.

Table 31 summarizes the results of the fall discharge. Some notable points are:

- There was no effluent discharged from the lagoon in 2021.

9.5.1.4.5.2 Process Outfall

The Outfall monitoring station functioned as expected during 2021. The total discharge volume was 1.15 GL. This volume is lower than the previous five-year average of 1.23 GL.

The Outfall discharges continuously. Measurements were performed on the samples weekly. This provided 52 samples of each parameter for the year.

Table 32 summarizes the results obtained, and compares them to averages for the previous five years. Notable results for the Outfall are:

- There were no instances of CNL's monthly guidelines being exceeded at the Outfall monitoring station.
- The only parameters that had a significant increase (> 10%) compared to the 5-year average were TSS, Copper, Nickel, and Zinc. The increased TSS loads are a reflection of the demolition activities occurring on site, while sediment controls are put in place to mitigate the impact, an increased load of sediments are entering the storm drain system. The increase in nickel and copper concentrations being observed are related to the elevated levels being observed at the intake this year. Zinc is being detected close to the detection limit, a slight increase seen in the concentrations is having a significant percentage increase being measured in the Outfall, especially since the 5-year average concentration is below the method detection limit.
- Compared to the five-year average, Phosphorus, bromodichlormethane, chloroform, Phenolics, and Oil and Grease concentration levels significantly decreased (>10%).
- Quarterly Acute Lethality Testing on the Outfall effluent was not successful in 2021, as CNL missed collecting samples for the second and third quarter of the calendar year. A corrective action plan has been developed to prevent reoccurrence.
- Acute Lethality Testing for the outfall effluent in first and fourth quarter showed no mortality on the rainbow trout tested.

Overall, there were no concerns about the effluent discharged from Outfall during 2021.

9.5.1.4.5.3 Drainage Ditches

Much of the land surrounding key remote facilities at WL is drained by two structures. Ditch 8 drains the land north of the WMA up to the northern site boundary and beyond. Water from the landfill and recharge area on the east is diverted instead around the WMA to the west-flowing Ditch 9, and into the Winnipeg River. These ditches are monitored for radiological and non-radiological content. The radiological part is discussed in Section 9.4 of this report and the non-radiological part is discussed here.

Ditches 8 and 9 were grab-sampled each time water was flowing off-site. This was after heavy rainfalls, of which there were six events from 2021 April to October. At these same times, a sample was collected from the northern ditch bordering Highway 211. This is far enough from CNL operations to be a reasonable background (Control). It was not possible to measure the

flow rates at any of the locations, or to sample representatively over entire rain events; therefore, no loads can be calculated.

Comparison is made to CNL guidelines (although they are intended for process discharges). All values were below CNL monthly guidelines this year. The measurement data are summarized in Table 33. The following are notable points for the 2021 ditches results:

- There were only six sampling events for the ditches. The sample events were also predominately influenced by the spring melt as four of the six events were related to water flows experienced during this period, in other years rain fall events made up the majority of the sampling events.
- Zinc and Mercury were the parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 8. The parameters that had a significantly higher concentration (>10%) than the previous five-year average for Ditch 9 were Phosphorus, Copper, Zinc, and Mercury. The control ditch had TSS and Copper being observed at significantly higher concentrations (>10%) than the previous five-year average.
- Metal concentrations detected are very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase being observed in Ditch 8 and Ditch 9.
- The five year average for phosphorus in ditch #9 was higher this year due to the reduced sampling. It is not uncommon for the spring melt to observe elevated phosphorus concentrations due to the decaying vegetation from the fall, but the phosphorus concentrations throughout the summer during rainfall events are typically lower and would drive the average down.
- All concentrations remain well below the CNL's monthly guideline limit and pose no concern.
- All parameters measured in Ditch 8 and Ditch 9 are comparable to those measured within the Control Ditch, indicating that WL had negligible effects on the environment through these two pathways.

It should be noted that sediment control measures were put in place for projects in the WMA in 2021, as was the case in previous years.

9.5.1.4.6 Internal Liquid Discharge Monitoring

Building 300 and Building 100 both have a LLLWTS; each system represents a major area that generated low-level radioactive liquid wastes. Individual tank releases are monitored for operational control purposes.

A full tank must be emptied while a second tank is being filled. When full, tanks are sampled; if the pH and radioactivity levels meet discharge criteria, they are discharged. The LLLWTS tank pre-discharge criteria do not include all parameters listed in CNL's non radiological guideline limit values; however, the post-discharge analysis includes all these parameters. CNL staff have

determined, through historical data analysis from post-discharge samples, if the pH in the tank is adjusted to neutral, all other parameters will normally meet the guideline limit values. All post-discharge data is reviewed to ensure this process is working as intended, and program requirements are met. All effluents pass through a 5-micron bag filter to the Process Outfall, leading via the Outfall to the Winnipeg River.

The tanks in the new system have a smaller holding capacity so the frequency of discharges has increased. The new system was designed with a shorter life span in mind than the earlier system that was employed by CNL. This was done to align with the decommissioning schedule being implemented by CNL. Discharging requires a day or less to complete, and can be more gradual if needed.

Grab-samples are taken after the filter, and at the beginning of each release from the individual tanks. Measurements are performed on the effluent of each discharge to measure pH and conductivity. For other analytes, grab-samples are collected and analyzed by a designated laboratory to complete the characterization of the effluent being discharged.

In regards to monitoring the non-radiological parameters of the effluent for this reporting period, discharges of the new systems are being compared to the discharges from the ALWTC that was used in previous years. This allows for comparisons of the previous 5-years of effluent to continue to be made, as the effluent streams emanating from the Research and Development (R&D) Complex in Building 300 and Building 100 should still be similar enough that a comparison is worthwhile.

In 2021, 0.09 ML was discharged from the LLLWTS.

The weighted averages of the joint releases from the LLLWTS are presented in Table 34 and monthly plots for the parameters that exceed the monthly guidelines are in Figure 6, Figure 7, Figure 8, and Figure 9.

The following are notable results for 2021:

- None of the monthly exceedances that occurred at the LLLWTS resulted in exceedances being observed at the Outfall monitoring location downstream in the process.
- There were increases (> 10%) in the annual average concentrations of Phosphorus, Chromium, Lead, Nickel, and Oil and Grease, compared to the previous five-year average results.
- The Iron concentration coming from the LLLWTS exceeded the CNL monthly guidelines eight times (January, February, March, April, June, July, August, and November). The overall Iron concentration seen for the year is lower than the previous 5-years. The introduction of the environmental laboratories in Building 300 at the end of 2019 increased the amount of Iron being introduced into the system (through the lab processing soil samples), as a number of the drain lines in the environmental laboratories are being directed to the LLLWTS in the facility. The majority of the effluent being generated by the environmental laboratories does not require the treatment

operations offered by this system, but it is possible it is affecting the effluent stream non-radiological characteristics.

- Early in 2021 (January-March), it was identified that the environmental laboratories and sample management office practises were having a negative impact on the effluent, as acid wash water and the clean out of expired acid-preserved sampling bottles was not properly being neutralized prior to disposal down the drainage system. In Figure 6, the drop in iron concentrations in the LLLWTS effluent can be observed when cleaning practises were improved. The improper disposal of the acidified wash water is being identified as the major cause of the increased metal concentrations being observed in the first four months of the calendar year.
- The Copper concentration coming from the LLLWTS exceeded the CNL monthly guidelines two times in 2021 (February and March). Frequent exceedances are being seen in relation to the new tank systems that were installed in Building 300 as a decision was made to use copper piping in the new system instead of the stainless steel that was used in the old system. As soon as the new tanks were commissioned and used, the copper concentrations of the generated effluent noticeably increased to the guideline limit, but the concentration seen at the Outfall is still well below the monthly guideline limits.
- The Zinc concentration coming from the LLLWTS exceeded the CNL monthly guidelines a single time in February.
- The phosphorus concentration in the Building 300 effluent has effectively doubled, and exceeded the CNL monthly guideline limit four times throughout the calendar year (March, August, September, and November). As this trend did not exceed a monthly administrative level it was not identified until all the data was compiled for the year, and the cause of this increase is currently unknown. The plot of the monthly concentrations for phosphorous appears to be correlated with the increased cleaning frequency (due to muddy work boots) that would be associated with the spring and the fall periods. CNL will begin with reviewing the current selection of cleaning products being utilized in Building 300.

9.5.1.5 Loading Calculations

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter.

Table 36 shows the results from the calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

Note that LLLWTS discharges are not included here, as they are reflected in the Outfall loads, and ditches are also not included as lack of flow data prevents their calculation.

When examining the WL site total loads, notable results are:

- The Lagoon did not contribute to the observed loads in 2021 as it was not discharged.
- TSS, Nickel and Zinc are the parameters that had a load increase greater than 10% when compared to the five-year average.
- Unlike 2020, this increase in overall load for TSS is not tied to a similar increase being observed at the intake and is directly tied to demolition work occurring on site for 2021.
- The increase in the Nickel load is related to the increase in Nickel concentrations being observed in the Intake water being utilized by the site.
- The increase in Zinc is being attributed to the results at the Outfall over the years being detected very close to the detection limit, so a slight increase seen in the concentrations has a significant percentage increase.
- Phosphorus, Chromium, Mercury, Lead, and Oil and Grease had a significant decrease of 10% or more in their loads when compared to the 5-year average.

Table 36: Loading for the Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	0	132	216	0	0	69.6	0	0	0
		Site Total	**0**	**132**	**216**	**0**	**0**	**69.6**	**0**	**0**	**0**
-	Un-ionized Ammonia	Lagoon	0.74	0.46	0.118	0.042	0.043	0.281	0	0	0
		Site Total	**0.74**	**0.46**	**0.118**	**0.042**	**0.043**	**0.281**	**0**	**0**	**0**
-	Total residual Chlorine	Lagoon	2.6	0.808	0.220	0.831	1.743	1.24	0	0	0
		Site Total	**2.6**	**0.808**	**0.220**	**0.831**	**1.743**	**1.24**	**0**	**0**	**0**
5b	Total Organic Carbon	Outfall	-	-	-	-	16814	16814	51	0	12230
		Site Total	-	-	-	-	**16814**	16814	**51**	**0**	**12230**
6	Phosphorus	Lagoon	6.2	3.29	1.59	1.90	2.30	3.06	0	0	0
		Outfall	55.4	38.0	42.6	27.7	25.2	37.8	52	1	25.9
		Site Total	**61.6**	**41.3**	**44.2**	**28.6**	**27.5**	**40.6**	**52**	**1**	**25.9**
8	TSS	Lagoon	143	227	46.4	44.7	120	116	0	0	0
		Outfall	3504	3142	2031	5764	6657	4220	52	3	6630
		Site Total	**3647**	**3369**	**2077**	**5809**	**6777**	**4336**	**52**	**3**	**6630**
9	Chromium	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.35	0	0.06	0.818	0.651	0.376	52	43	0.035
		Site Total	**0.35**	**0**	**0.06**	**0.818**	**0.651**	**0.376**	**52**	**43**	**0.035**
9	Copper	Lagoon	0.12	0.10	0.018	0.027	0	0.053	0	0	0
		Outfall	9.5	6.61	7.63	7.03	13.5	8.85	52	0	8.44
		Site Total	**9.6**	**6.71**	**7.65**	**7.06**	**13.5**	**8.90**	**52**	**0**	**8.44**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9a	Iron	Lagoon	18.3	13.34	4.52	4.56	3.57	8.86	0	0	0
		Outfall	417	291.1	258	296	381	329	52	0	322
		Site Total	**435**	**304**	**263**	**301**	**385**	**338**	**52**	**0**	**322**
9	Lead	Lagoon	0	0.003	0	0	0	0	0	0	0
		Outfall	0.55	0.312	0.23	0.220	0.481	0.359	52	17	0.303
		Site Total	**0.55**	**0.32**	**0.23**	**0.220**	**0.481**	**0.360**	**52**	**17**	**0.303**
9	Nickel	Lagoon	0.035	0.069	0.019	0.042	0	0.033	0	0	0
		Outfall	1.4	1.349	0.836	0.742	0.972	1.06	52	25	1.49
		Site Total	**1.4**	**1.42**	**0.855**	**0.784**	**0.972**	**1.09**	**52**	**25**	**1.49**
9	Potassium	Outfall	-	-	-	-	1348	1348	52	0	1302
		Site Total	-	-	-	-	**1348**	1348	**52**	**0**	**1302**
9	Sodium	Outfall	-	-	-	-	5223	5223	52	0	5086
		Site Total	-	-	-	-	**5223**	5223	**52**	**0**	**5086**
9	Strontium	Outfall	-	-	-	-	39.9	39.9	52	0	39.3
		Site Total	-	-	-	-	**39.9**	39.9	**52**	**0**	**39.3**
9a	Uranium	Outfall	-	-	-	-	0.485	0.485	52	0	0.461
		Site Total	-	-	-	-	**0.485**	0.485	**52**	**0**	**0.461**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2021		
			2016	2017	2018	2019	2020	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0.024	0	0	0	0	0.005	0	0	0
		Outfall	6.3	1.167	1.77	6.13	0.306	3.13	52	15	7.88
		Site Total	**6.4**	**1.17**	**1.77**	**6.13**	**0.306**	**3.15**	**52**	**15**	**7.88**
12	Mercury	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.005	0	0.001	0.001	0.0003	0.0015	52	47	0.0003
		Site Total	**0.005**	**0**	**0.001**	**0.001**	**0.0003**	**0.0015**	**52**	**47**	**0.0003**
14	Phenolics	Lagoon	0.13	0.155	0	0	0	0.057	0	0	0
		Outfall	2.1	4.024	0.0001	0.0003	0	1.22	52	52	0
		Site Total	**2.2**	**4.18**	**0.0001**	**0.0003**	**0**	**1.28**	**52**	**52**	**0**
16	Bromodichloromethane	Outfall	-	-	-	-	0.547	0.547	52	52	0
		Site Total	-	-	-	-	**0.547**	0.547	**52**	**52**	**0**
16	Chloroform	Outfall	-	-	-	-	31.4	31.4	52	9	8.82
		Site Total	-	-	-	-	**31.4**	31.4	**52**	**9**	**8.82**
17	Toluene	Outfall	-	-	-	-	0	0	52	52	0
		Site Total	**-**	**-**	**-**	**-**	**0**	**0**	**52**	**52**	**0**
25	Oil & Grease	Lagoon	59	40.40	0	0	0	19.9	0	0	0
		Outfall	1147	163.5	124	19.1	0	291	52	50	188
		Site Total	**1206**	**204**	**124**	**19.1**	**0**	**311**	**52**	**50**	**188**

a Averages were calculated by setting to zero results reported as “< DL.”
b # Spl. is the number of samples analyzed and reported.
c NDs is the number of samples in which analyte was not detected (i.e., Code = “< DL”, result = 0).

9.5.2 Airborne Effluent Monitoring

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas (GHG) report. These emissions are also recorded for trending and improvement purposes. Radiological releases are covered in Section 9.4 of this report. Only non-radiological releases to the air will be covered in the following sections.

9.5.2.1 Fuel Use for Building Heating

Historically, the main stationary source for non-radiological emissions to air from the WL site was the Powerhouse which supplied district heating to various buildings on the site (see Figure 2). Starting in 2013, use of, and emissions from Number 2 fuel oil heating operations at the Powerhouse, ceased due to the completion of building conversions to either propane or electrical heating. Subsequently, a substantial increase was seen for cleaner burning propane used on site. Table 37 presents WL heating fuel consumption from 2016 to 2021. Fuel consumption continues to trend downward (see Section 9.7.2 and Figure 11).

Table 37: Fuel Use for Building Heating from WL

		Data for Previous Five Years						Data for 2021
Parameter	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**Average**	
Fuel Burned								
Number 2 Fuel Oil	L	0	0	0	0	0	0	0
Propane	L	361,110	287,982	209,158	243,268	190,372	258,378	160,159
Energy Released								
Number 2 Fuel Oil[a]	TJ	0	0	0	0	0	0	0
Propane[b]	TJ	9.815	7.827	5.685	6.612	5.1743	7.0227	4.3531
Total	**TJ**	**9.815**	7.827	**5.685**	**6.612**	**5.1743**	**7.0227**	**4.3531**
Heating Demand								
Heating Degree Days	HDD	5573	5403	5855	6079	5615	5705	5233

a Energy released calculated from consumption at 3.868E-05 TJ/L for Number 2 fuel oil.

b Energy released calculated from consumption at 2.718E-05 TJ/L for propane

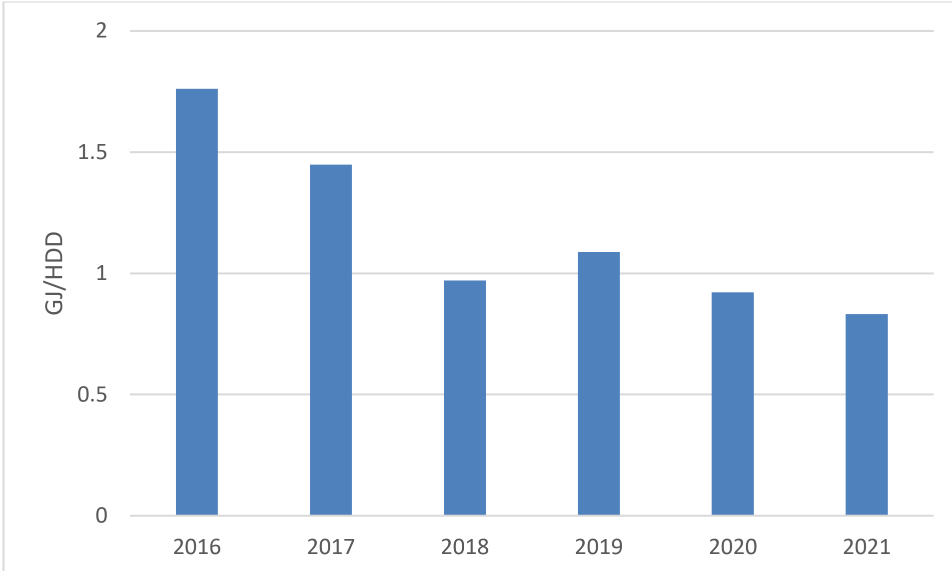

Figure 11: Annual Heating Energy Use from Fossil Fuels (per Heating Degree Days)

9.5.2.2 Reporting Under the National Pollutant Release Inventory

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38], WL currently calculates releases of Part 4 substances for the NPRI program, using government reporting guidelines [39]. These releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating (as discussed above), as well as diesel fuel used from site generators, dust emissions from unpaved roads, and excavation projects.

Emission factors are applied to fuel consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2021 will be captured in the *2021 Progress Report on the Environmental Assessment Follow-up Program for Whiteshell Laboratories* [28].

Table 38 outlines the annual CACs generated from site activities, and shows a small decrease in emissions seen in 2021 compared to the 5-year average for the values for total particulate matter, PM_{10}, and $PM_{2.5}$. The PM_{10} value met the NPRI reporting threshold this year, and is reported to Environment and Climate Change Canada. Road dust emissions were the major contributor to meeting these reporting thresholds.

Table 38: Stationary Combustion Data and Emissions from WL

Parameter	Unit	Data for Previous Five Years						Data for 2021	NPRI Reporting Threshold
		2016	2017	2018	2019	2020	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	0.908	0.753	0.536	0.621	0.602	0.684	0.331	20
SO_2	Mg	0.023	0.020	0.014	0.016	0.017	0.018	0.005	20
CO	Mg	0.399	0.348	0.233	0.271	0.256	0.301	0.162	20
TPM	Mg	15.022	13.651	14.562	10.574	8.883	12.538	8.174	20
PM_{10}	Mg	3.853	3.499	3.726	2.712	2.281	3.214	2.091	0.5
$PM_{2.5}$	Mg	0.415	0.376	0.391	0.292	0.249	0.345	0.218	0.3
Volatile Organic Compounds	Mg	0.071	0.059	0.042	0.049	0.048	0.0538	0.026	10

9.5.2.3 Greenhouse Gas Emissions

Under the authority of the *Canadian Environmental Protection Act*, 1999 [38] WL must calculate releases under the GHGs emissions notice [40] providing the facility emits over 10,000 tonnes of carbon dioxide equivalent or more within the calendar-year.

Greenhouse Gas emissions from WL include carbon dioxide, methane, and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill, and open-pit wood burning. They are measured in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

Table 39 outlines the GHG emissions from the WL site for the last six years. These emissions from the site have decreased significantly from 2020. This decrease can be attributed to the decrease in propane needed to heat the site in 2021 as shown in Table 37. There was a decrease in the number of heating degree days (i.e., decreased demand for building heat based on temperature) in 2021, this combined with the fact Building 200 did not require any building heating during the calendar year, and Buildings 402 and 305 no longer had to be heated starting in the fall of 2021 due to demolition activities. Overall, greenhouse gases in 2021 are 29% less than the average for the last 5 years.

Table 39: Greenhouse Gas Emissions

Parameter	Releases from Previous Five Years						2021 Releases
	2016	2017	2018	2019	2020	5-yr. Avg.	
GHG CO_2e tonnes	1883	1873	1678	1756	1692	1776	1177

Note: GHG CO2e tonnes - A unit of measure used to compare between gases that have different GWP. For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide.

9.5.2.4 Halocarbons

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, following the Federal Halocarbon Regulations [41]. All releases greater than 10 kg are considered reportable.

As seen in Table 40, there were two reportable releases of halocarbons in 2021. Both releases were related to the Building 100 chiller system. The first release occurred in 2021 April. During maintenance activities it was discovered that 15.5 kgs of R-134a refrigerant escaped from the chiller system through a leak of one of the shut off values on the equipment. Upon replacement of the shut off valve it was observed that the threads of the valve were compromised. The second leak occurred in 2021 October. During maintenance activities to take the equipment offline for the season, it was discovered that 16.3 kgs of R-134a refrigerant escaped from the chiller system through a faulty solenoid valve.

Table 40: Halocarbon Losses from WL

			Losses from Previous Five Years (kg)					Losses in 2021	
Type	**Global Warming Potential[b]**	**Ozone Depleting Potential[c]**	**2016**	**2017**	**2018**	**2019**	**2020**	**Number of Losses**	**Annual Loss (kg)**
Refrigerants[a]									
CFC (R-11)	4 600	1	0	0	0	0	0	0	0
CFC (R-12)	10 600	1	0	0	0	0	0	0	0
CFC+HCFC (R-502)[d]	4.1	0.28	0	0	0	0	0	0	0
HCFC (R-22)	1 700	0	0	0	0	0	0	0	0
HFC (R-134a)	1 300	0	0	12.47	0	0	0	2	31.8
Fire Suppressants									
Halon (R-1301)	6 900	10	0	0	0	0	0	0	0

a CFC = Chlorofluorocarbons; HCFC = Hydrochlorofluorocarbons; HFC = Hydrofluorocarbons
b GWP per unit mass, compared to CO2 = 1.00
c Ozone Depleting Potential per unit mass, compared to CFC R-11 = 1.00
d The data for the CFC+HCFC(R-502) is from [41]

9.5.3 Overall Performance

The non-radiological effluent monitoring program set up by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment.

There were no discharges from the Outfall and Lagoon which exceeded the current monthly guideline limits placed on CNL in 2021.

9.6 Regulatory Limit Exceedances and Contamination Incidents

There were no Regulatory Limit exceedances or reportable events in 2021.

9.7 Discussion of Improvement Initiatives

The following sections describe some of the ongoing efforts the WL site is undertaking to enhance the effluent verification monitoring program.

9.7.1 Monitoring Site Intake Water and Outfall Effluent

In 2020, the WL site expanded the monitoring program to encompass additional parameters at the site's Intake and Outfall monitoring station. This expansion resulted from the enhanced monitoring that was performed on the Intake and the Outfall in 2019 to address the gaps in baseline data when assessed against the monitoring criteria in Table 19-1 of the *WL Effluent Verification Monitoring Plan* [25]. It was decided that when there was a 20% change in concentration when comparing the results for a given parameter at the Intake and Outfall, that these parameters would be incorporated in the effluent verification monitoring program.

Under this criteria, Total Organic Carbon, Strontium, Uranium, Magnesium, Potassium, Sodium, and the volatiles Bromodichloromethane, chloroform and Toluene have been added to the list of parameters being measured at these stations. Currently, CNL can show that the source of the Potassium and Sodium being introduced to the Outfall is a result of the sanding/salting activities that occur on site as the weather transitions into and out of sub-zero temperatures. The Bromodichloromethane and chloroform are by-products resulting from the site's chlorination practises. The remaining parameters are currently not tied to a source, and CNL is planning to do temporary upstream process monitoring (monitoring at LLLWTS in Buildings 100 and 300) to try to be able to explain the operational source of the increase.

In order to be compliant with REGDOC-2.9.1 [42] it was determined that the effluent verification monitoring program needed to include acute lethality testing at the Outfall monitoring station.

Although the need to monitor for these parameters is currently captured in *WL Effluent Verification Monitoring Plan* [25], WL laboratories acknowledges that the plan needs to be updated to reflect that these parameters are actively being monitored, and plans to revise Reference [25] in 2022.

9.7.2 Reducing Energy Use from Fossil Fuels

The largest quantity of non-radiological effluents to air comes from burning fossil fuels, to heat the site buildings. Starting in 2013, use of and emissions from Number 2 fuel oil heating operations at the Powerhouse ceased due to the completion of building conversions to either propane or electrical heating.

Figure 11 shows the annual fossil energy consumption since 2016, relative to the number of Heating Degree Days in each year. Heating Degree Days are calculated for each day as the difference between 18°C and the median ambient temperature.

From Figure 11, it is apparent that energy use has started to stabilize and any further reductions will be resulting from final closure of site buildings, reducing or removing their heating supply. Beginning in 2020 October, Building 200 no longer had to be heated as demolition activities on the building began at this time. In 2021 September, Buildings 305 and 402 no longer required to be heated as demolition activities began on these buildings.

9.8 Environmental Assessment Follow-Up and Monitoring

Details about the Environmental Assessment Follow-Up and Monitoring Program are discussed in the *2021 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories* [28] (to be issued to the CNSC by 2022 June 30).

10 Emergency Management and Fire Protection

10.1 Emergency Preparedness Program

Whiteshell Laboratories adheres to the Corporate Emergency Preparedness Functional Support Area. See Section 10.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The WL program continues to adapt to the changes on site, including the demolition of buildings/assets, the construction of temporary structures, the number and composition of staffing levels, and the organisational structure. Vacated buildings are transitioned from building emergency procedures to construction/demolition oriented emergency placards.

Planning for and responding to COVID-19 continued as a primary focus for the Emergency Preparedness Functional Support Area at WL in 2021, providing procedures and guidance to enable work to continue safely in this dynamic situation. This was safely managed, without an outbreak at WL, despite the pandemic impact on Manitoba.

10.1.1 Drills and Exercises

The ongoing COVID-19 Pandemic continues to make running in-person emergency scenarios a challenge, especially with our external partners. For 2021, drill and exercise development focused on scenarios that allow for adequate physical spacing and still yield quality learning and evaluation potential.

In 2021, a total of 143 exercises and drills were delivered at WL. This is a significant step up from the 94 drills/exercises delivered in 2020. While not quite back to pre-pandemic levels, this increase signifies an adjustment in the program to the new normal of the current environment. Table 41 provides details on the number and type of the exercises and drills conducted in 2021.

Table 41: WL Emergency Preparedness Exercises – 2021

Type of Drill or Exercise	Number Completed in 2021
Fire Drills	2
Site-wide Specialty Drills	106
Table Top Exercises [a]	5
Targeted Communication Exercise	17
Site-wide Communication Exercise	12
Field Exercises (Functional)	1

a Table Tops include specific EOC Skill workshops as well. Each workshop focuses on a unique aspect of the EOC and includes a small practice scenario.

10.1.2 Training

There was no change to the Emergency Operations Centre (EOC) staff structure in 2021. Building emergency teams are being maintained for all occupied structures on site. Fewer occupied structures has resulted in a decrease in the number of team members required.

10.1.3 Status of Emergency Resources and Facilities

Whiteshell Laboratories maintains a physical EOC, and conducts monthly tests of the technical equipment stored for use in that location. Repairs, improvements and updates are requested as required and when identified. All checks were completed in 2021. A cache of emergency food rations is also maintained at WL, which have a five year shelf life. The rations were replaced in 2019. The cache is stored in a secure location and the condition of the cases is checked annually.

10.1.3.1 Emergency Operation Center

As part of WL's EOC framework, there are two teams of EOC staff, and an alternate person for each of the team positions that can be engaged to cover for members of either of the two teams. These two teams operate on a two week on-call rotation. One EOC member retired in 2021 and his trained alternate was able to step straight into this position.

There were no emergency events requiring activation of the EOC in 2021.

10.1.3.2 Mobile Nuclear Laboratory

Canadian Nuclear Laboratories continues to maintain the Mobile Nuclear Laboratory (MNL) for response both on-site and off-site. The unit continues to be maintained by WL Radiation Protection staff and is inspected at a regular interval to maintain control of inventory and equipment.

There were no emergency events requiring the activation of the MNL in 2021.

10.1.3.3 Equipment Checks

Respirators make up the majority of the equipment in the strategically placed emergency cabinets that remain on site. These cabinets are opened and inspected monthly by Radiation Protection staff. Once a satisfactory inspection is complete, the cabinets are re-sealed and signed off by the inspector. All scheduled checks were completed in 2021.

There were no emergency events requiring the use of this equipment in 2021.

10.1.3.4 Public Address System

The Public Address (PA) system is the primary system used for communicating emergency events to WL employees. The system functioned normally in 2021.

10.1.3.5 Secondary Emergency Signals

The WL site still employs an exterior siren as a redundant form of emergency alerting. The system is no longer required and was replaced by the PA system as the primary alerting system. This system will continue to be used as a redundant alerting system until either the equipment fails completely (there have previously been some issues with the equipment) or the building it is mounted to is decommissioned and demolished.

10.1.3.6 EOC Notification System

WL continued to use the Everbridge Mass Notification system in 2021. The system continues to perform well, with a 100% response rate to all monthly communication tests (see Table 42) for the third year in a row.

Table 42: WL EOC Communication Tests: 2021

Y= Yes N= No	January	February	March	April	May	June	July	August	September	October	November	December
EOC Commander	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Liaison Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Env. Protection Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Safety Officer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Planning Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Logistics Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Operations Section Chief	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Nuclear Facilities Representative	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

In addition to these regularly scheduled monthly drills, a random quarterly drill is conducted. These drills are scheduled for random times and dates, including weekends, evenings and work hours. These random drills include the expanded EOC teams, including all alternates and non-routine staff. Table 43 identifies the response rates of the 2021 WL EOC Staff to the Quarterly Random EOC call out drills, with an average of 94% response. Only responses received within an hour of the notification being sent out are considered a positive response, the rest are considered 'no response'.

Table 43: WL EOC Random Quarterly Communication Tests: 2021

	Q1	Q2	Q3	Q4
Response Percentage	96%	100%	88%	92%

10.1.4 External Collaborations

In 2021 contact was maintained with a variety of external emergency response/management organizations and interested public groups. Due to COVID-19 many of these were once again virtual meetings or connections. WL EmP:

- Engaged with the LGD of Pinawa Emergency Operations Centre staff for local response planning purposes.
- Participated in the Manitoba Provincial Flood and Forest Fire forecasting sessions.
- Continued to participate on the Manitoba Municipal Relations Governance COVID-19 teleconference meetings throughout 2021, though with decreasing frequency as the year progressed.
- Maintained working relationships with Manitoba Emergency Measures Organization staff through less formal interactions this year, including regional response officers and the Critical Infrastructure protection program staff.
- Attended the Provincial emergency management conference, which brought many Local, Provincial and Federal stakeholders together to share best practices and lessons learned on a variety of relevant topics.
- Maintained membership with the Prairie Region (Manitoba and Saskatchewan) of the Federal Coordination Working Group. The Federal Coordination Working Group helps WL maintain ties with representatives from multiple federal agencies including (but not limited to) Public Safety Canada, the Royal Canadian Mounted Police (RCMP), Health Canada, Department of Defence, Public Health Agency of Canada, and Environment & Climate Change Canada, in order to support organizational planning and response.

10.1.5 Unplanned Emergency Events

There were no incidents requiring initiation of the WL Site Emergency Plan occurred during 2021.

10.2 Fire Protection Program

Whiteshell Laboratories adheres to the Corporate Fire Protection Functional Support Area. See Section 10.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

There were no reportable fire events at WL in 2021.

10.2.1 Fire Response Drills

In 2021, WL was unable to conduct all the fire drills that it identifies as an annual requirement in accordance with the National Fire Code of Canada [43] and CSA standard N393-13 Fire Protection for Facilities that Process Handle, or Store Nuclear Substances [44]. This deviation has been captured as part of an internal self-assessment and a corrective action plan is being developed to ensure these are adequately planned and executed.

10.2.2 External Collaborations

Whiteshell Laboratories and the Town of Pinawa signed a Fire Protection Service Agreement in 2019 to improve Mutual Aid support capabilities. The agreement is still in effect. Interdepartmental training has been interrupted by the COVID-19 pandemic, but will be resumed as soon as it is safe to do so.

10.2.3 Third Party Audits & Inspections

As per the requirements of CSA N393-13, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Material Substances* [44], a third party Fire Protection Audit was conducted in 2021. The findings are being collated and their resolution will be tracked through the corrective action program (see also Section 1.2.1.1).

10.2.4 Fire Hazard Analysis

All fire hazard analysis documentation for buildings requiring a fire hazard analysis have been reviewed and are being evaluated against the decommissioning schedule. A corrective action plan was developed and submitted to the CNSC outlining the timeline for Fire Hazard Analysis documentation review and revisions.

11 Waste Management

11.1 Waste Management Program

Whiteshell Laboratories adheres to the Corporate Waste Management Functional Support Area. See Section 11.1 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Waste Management Program continues to provide effective and efficient delivery of Waste Management services.

Significant activities for the Waste Management Program include:

- Continued to refine and communicate the Integrated Waste Strategy to integrate waste lifecycle management across all CNL-operated sites and to capture the CNL baseline waste strategies and defined pathways for all CNL wastes.
- Collaboration between CRL and WL Programs to effectively disposition radioactive wastes, leading to the advancement of remediation and transportation projects.
- Enhanced support to existing activities and new activities in support of the new schedule for the WL Closure Project. The support improved segregation protocols and ensured continued adherence to waste processes.

The waste acceptance criteria for three of the waste receiving facilities on-site (including the Waste Handling Area and the WMA storage facilities) remained unchanged for 2021.

11.1.1 Waste Management Operations

Radioactive, clearable and hazardous wastes were generated from both ongoing operational activities and decommissioning projects. The packaged solid radioactive wastes were stored in designated storage facilities in the WL WMA depending on the hazard level and packaging, as well as dispositioned to CRL for interim storage.

Demolition of Buildings 402 and 305 began in 2021 and is on target to be complete early 2022. A total of 2,246 m^3 clean waste was generated in 2021; 1,290 m^3 of concrete material was dispositioned to an off-site receiver for future re-use, 450 m^3 of metal was recycled, while 483 m^3 of asbestos-containing material and 17 m^3 of polychlorinated biphenyl (PCB) contaminated materials were dispositioned to appropriate off-site waste receivers.

Decommissioning on the south area of the WL main campus continued, which involved asbestos abatement and remediation of high temperature water lines, generating approximately 188 m^3 of clean concrete waste; 28.5 m^3 of this volume contained asbestos-containing materials which was sent to an approved off-site licensed facility.

Building 200 Active Liquid Waste Treatment Centre demolition was completed. A total of 1,077 m^3 of Low-Level Waste (LLW) and 77.5 m^3 of Intermediate - Level Waste[11] (ILW) waste

[11] In this context, ILW refers to any waste that does not meet the proposed Near Surface Disposal Facility (NSDF) Waste Acceptance Criteria (WAC) and requires storage in ILW facilities at CRL.

was generated; of this LLW total, 876 m³ has been safely dispositioned to CRL, with the remaining 201 m³ and 77.5 m³ of ILW waste safely stored in certified transportation packages awaiting shipment to CRL in 2022.

De-inventorying efforts of legacy waste stored in LLW Bunker 5 began. Wastes are undergoing additional qualification and inspection to ensure transportation and waste criteria compliance are met. This activity has generated 360 m³ of LLW to date, which are safely stored in certified transportation packages awaiting shipment to CRL in 2022.

Table 44 summarizes the quantities of radioactive waste generated in 2021 that was sent to each storage location. Table 45 summarizes the volumes of solid low-level radioactive waste originating from each facility in 2021. Table 46 summarizes the volumes of solid intermediate-level radioactive waste originating from facilities in 2021. Table 47 summarizes the volumes of solid low-level and intermediate-level radioactive waste transported to CRL for disposition.

Table 44: Radioactive Waste by Storage Location

Storage Facility	Volume (m³)	
	2020	2021
Low-Level Quonsets	32.3	0
Intermediate-Level Waste Bunkers	0	2.5
SMAGS[a]	4.1	0
Soil Storage Compound	0	0
Total	36.4	2.5

a Shield Modular Above Ground Storage (note: SMAGS is no longer used for waste storage)

Table 45: Low-Level Radioactive Waste Generated by Facility

Facility of Origin	2020		2021	
	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)	Compactable Waste Volume (m³)	Non-Compactable Waste Volume (m³)
Building 100	0.8	9.2	1.5	0.0
Building 200	7.2	198.9	0.0	875.6
Building 300	0.3	0.0	0.0	0.0
Building 303	0.0	0.0	0.0	0.0
Building 304	0.0	0.0	0.0	0.0
Building 402	0.2	0.0	0.8	0.0
Building 421	0.0	0.0	0.0	0.0
Concrete Canister Storage Facility	0.0	0.0	0.0	0.0

Shielded Facilities (HCF & IFTF)	10.8	0.1	45.6	0.0
Waste Handling Area	0.0	0.0	0.0	0.0
Waste Management Area	2.5	0.0	14.2	0.0
LLW Bunker 6	0.8	0.0	0.0	9.0
LLW Bunker 5	0.0	0.0	0.0	360.0
Affected Lands	0.2	0.0	0.0	0.0
SSC	0.0	0.0	0.0	0.0
Total	**22.7 (5.0)[a]**	**208.2**	**62.1 (5.0)[b]**	**1244.6**
Total after Compaction	**213.2**		**1249.6**	

a This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

b This volume of compactable waste was reduced to 5.0 m³. It is not possible to determine accurate post-consolidation volumes attributed to individual facilities because all of the waste is being combined during the compaction process.

Table 46: Intermediate-Level Radioactive Waste Generated by Facility

Facility of Origin	Volume (m^3)	
	2020	2021
Affected Lands	0.0	0.0
Building 200	5.8	77.5
Total	5.8	77.5

Table 47: Radioactive Wastes Transported to CRL for Disposition

Facility of Origin	2020		2021	
	LLW Volume (m^3)	ILW Volume (m^3)	LLW Volume (m^3)	ILW Volume (m^3)
Building 402	0.0	0.0	0.0	0.2
WMA (Legacy Sources)	112.5	0.0	39.0	0.0
Soil Storage Compound	0.0	0.0	0.0	0.0
SMAGS[a]	14.0	7.7	0.0	0.0
LLW Bunker 6	182.0	0.0	6	3
LLW Bunker 5	0.0	0.0	0.0	0.0
Building 200	198.8	5.8	876	0
LLW Quonsets (B431, B432, B433)	20.4	12.8	0	0

Total	527.7	26.3	921	3.2

a Shielded Modular Above Ground Storage – legacy waste generated from various decommissioning projects.

Clearable waste from Controlled Areas was monitored in-situ. Clean bagged waste was monitored using the bag monitor located in Building 300 where WL's laundry facility is now stationed; all bagged waste met the screening criteria and was deemed to be suitable for unrestricted release in 2021.

Whiteshell Laboratories continued to reuse or recycle as much material as practicable; this includes both recyclable materials sent to the municipal recycling facility and other material-specific facilities throughout Manitoba. Waste Management Program representatives exercised a proactive approach to ensure waste was properly segregated at the source of origin to maximize the amount of material that could be reused or recycled.

Table 48 summarizes the disposition pathway of non-active wastes, while Table 49 summarizes the amount, by material type, of recyclable waste shipped off-site.

Table 48: Non-Active Waste Disposition Pathways

Disposition Location	Volume (m^3)	
	2020	2021
WL Asbestos Disposal Site [a]	0	0
WL Burn Pit	247	189
WL Inactive Landfill	0	0
Recycling[b] Sent Off-Site	513	271
Off-Site Landfill [c]	1,256	1,352
Total	2,016	1,812

a The WL Asbestos Disposal Site stopped receiving waste in 2019 to support the environmental risk assessment. Non-active asbestos is directed to off-site licensed landfills.

b This recycling waste pertains to office recycling that is generated on a daily basis that is accepted at municipal recycling facilities.

c WL Inactive Landfill stopped receiving waste mid-2019 to support the environmental risk assessment. Non-active waste is directed to off-site licensed landfills.

Table 49: Recycled Waste Shipped Off-Site

Material[a]	Weight (kg)	
	2020	2021
Aluminum	0	0
Batteries Shipped	0	0
Batteries Recycled	227	0
Cardboard[b]	0	0

Copper and Brass	0	0
E-Waste Shipped	347	3,464
E-Waste Sold	0	0
Ferrous Metals	108,457	26,231
Glass	0	0
Lumber	0	0
Plastic Shipped	0	0
Plastic Sold	0	0
Stainless Steel	0	0
Lead	0	7,450
Total	109,031	37,145

a This recycling waste pertains to material that is sold or charged to be taken to a material specific recycling facility.

b Cardboard is sent to a municipal recycling facility and inclusive in Table 48.

Improvements were made in preventing waste accumulation inside of buildings and transferring the waste to appropriate waste facilities immediately after generation. Improvements continue to be addressed in reference to the lack of processing and storage space for non-routine waste materials (e.g., mixed waste and large contaminated items), as well as large volumes radioactive wastes generated from decommissioning activities. Mitigation measures put in place in 2021 included finalizing a Nuclear Safety Note for the interim storage of cargo containers containing radioactive wastes in the WMA. This area is referred to as the Recoverable Surface Storage and Staging Area (RSSSA), and consists of an outdoor, above ground storage pad to enable the storage and loading of solid low-level waste in sea land containers and storage of oversize LLW items which are awaiting further processing, characterization and/or packaging to be considered compliant for off-site disposition. Additionally, satellite transshipment areas were established north of the WMA and one by the B200 demolition to reduce additional handling and improve efficiencies with off-site disposition of waste.

11.1.1.1 Liquid Waste Generation

During 2021, 78.9 m^3 of low-level liquid was processed in the Building 300 LLLWTS and 9.9 m^3 in the Building 100 LLLWTS, for a total of 88.8 m^3 of low-level liquid waste processed through the two systems.

11.2 Decommissioning Plan

Whiteshell Laboratories adheres to the Corporate Cleanup Functional Support Area. See Section 11.2 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

11.2.1 Program Overview, Achievements and Accomplishments

As per the Licence Conditions Handbook for WL [2], CNSC have been notified of revisions to the Detailed Decommissioning Plan (DDP) for WL [45].

11.2.2 Land Use Program

Table 50 provides a summary of the status of the WL Site's Overview DDP.

Table 50: Overview Decommissioning and Cleanup Plan Updates for WL in 2021

Document Reference	Key Activity Status in Year	Effective Date (if applicable)
WLDP-02000-DDP-001	Approved by Regulator	December, 2021

The Overview DDP was revised, submitted to the CNSC, and approved for use in 2021.

11.2.3 Decommissioning and Demolition Program

Table 51 lists the WL DDPs and their status as of 2021.

Table 51: Overview of WL Detailed Decommissioning Plans

Facility	DDP Document Title	Document #	Status
Shielded Facilities	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 2 - Shielded Facilities	WLDP-21400-DDP-001, Revision 1, 2016	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
Van de Graaff Accelerator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 3 - Van de Graaff Accelerator	RC-2143-3, Revision 1, 2000	Facility has been decommissioned.
Neutron Generator	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 4 - Neutron Generator	RC-2143-4, Revision 1, 2000	Facility has been decommissioned.
Active Liquid Waste Treatment Centre	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 5 - Active Liquid Waste Treatment Centre Building 200	WLDP-25400-DDP-001, Revision 0, 2011	Facility has been decommissioned. End-state report in development.
Whiteshell Reactor-1 (WR-1)	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 6 - Whiteshell Reactor-1: Building 100	WLDP-26400-DDP-001, Revision 3, 2015 (Complete Dismantlement and Removal Approach)	Facility has been shut down and currently under monitoring and surveillance. Complete Dismantlement and Removal approach has been

Facility	DDP Document Title	Document #	Status
		WLDP-26400-DDP-001, Revision 5, 2021 (In Situ Decommissioning Approach)	approved by the CNSC (Revision 3). EA process for ISD is in progress, Revision 4 to be revised with final EA submission (note: copy of Revision 5 submitted for review of comment disposition to CNSC prior to final EA submission). DDP Volume (Revision 3) is available for use.
Concrete Canister Storage Facility	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 7 - Concrete Canister Storage Facility	WLDP-22500-DDP-001, Revision 1, 2017	Facility is operational. DDP was sent to the CNSC and comments received (to be dispositioned).
Waste Management Area	Volume 8 - WMA Part 1: Standpipes Area	WLDP-36500-DDP-001	Facility is operational DDP under development.
	Volume 8 - WMA Part 2: Intermediate - Level Waste Bunkers, Building 417 and Amine Tanks	WLDP-24900-DDP-001	Facility is operational. DDP under development.
	Volume 8 - WMA Part 3: Low Level Waste Liabilities	WLDP-24400-DDP-001, Revision 5, 2021	Facility is operational and decommissioning activities ongoing. DDP Volume is available for use.
R&D Facilities Complex	Volume 9 - Building 300	WLDP-23500-DDP-001 (RC-2143-9), Revision 0, 2007	Facility is operational. DDP Volume is available for use.
	Volume 9 - Building 300_Addendum	WLDP-23500-DDP-001_AD, Revision 2, 2018	
Decontamination Centre	Volume 10 - Decontamination Centre Building 411	WLDP-27400-DDP-001, Revision 0, 2011	Facility has been decommissioned.
Health and Safety Facilities	Volume 11 - Building 402 and 305	WLDP-37000-DDP-001	Decommissioning activities ongoing. DDP Volume is available for use.
DP Volume 12	Volume 12 - WL Licensed Site Supporting and General Infrastructure: North-Side	WLDP-32000-DDP-001, Revision 0, 2009	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 1: South-Side Buildings	RC-2143-12, Revision 1, 2006	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 3: Outer	WLDP-33000-DDP-001, Revision 1, 2008	Operational and decommissioning activities ongoing. DDP Volume is available for use.

Facility	DDP Document Title	Document #	Status
	Area Buildings and Facilities		
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 4: Site Services	WLDP-34000-DDP-001, Revision 1, 2013	Operational and decommissioning activities ongoing. DDP Volume is available for use.
	Volume 12 - WL Licensed Site Supporting and General Infrastructure-Part 5: Site Affected Lands and Contaminated Structures	WLDP-35000-DDP-001, Revision 1, 2012	Decommissioning activities ongoing. DDP Volume is available for use.

11.2.3.1 Detailed Decommissioning Planning and Execution

Table 52 provides a summary of WL facility DDPs that were revised in 2021.

Table 52: Summary of WL Detailed Decommissioning Plans in 2021

Facility	Document Status	Document Name and Reference	Effective Date	Document Highlights
WMA	Current Published	Whiteshell Laboratories Detailed Decommissioning Plan: Volume 8 - WMA: Part 3 - Low Level Waste Liabilities, WLDP-24400-DDP-001, Revision 5	April, 2021	DDP was submitted to and accepted by CNSC staff.

Table 53 provides a summary of decommissioning and demolition statuses for WL in 2021.

Table 53: Summary of WL Decommissioning and Demolition Status by Facility in 2021

Facility	Decommissioning and Demolition Status
B402	Active Decommissioning
B200	Building Demolished
B413	Active Decommissioning
B420	Active Decommissioning
B426	Active Decommissioning
B429	Active Decommissioning
WMA	Active Decommissioning
Site Affected Lands and Contaminated Structures	Active Decommissioning

Several buildings and structures were decommissioned in 2021, where operational wastes were dispositioned, building services isolated and industrial hazardous materials removed prior to demolition where feasible.

Demolition of Buildings 402 and 305 began, and is expected to be completed early 2022. The demolition of the buildings included remediation and abatement of asbestos-containing materials, specifically the mastic tar adhered between the masonry and exterior wall, and PCB's found within window glazing and exterior caulking and general demolition of construction and demolition materials.

Remediation of the south-side of the main campus continued. Phase one field work was completed, which consisted of remediating the high temperature water lines. Phase two field work to excavate and remove underground electrical bus ducts, isolate fire water, domestic water, storm drains and sanitary drain systems will commence in 2022. The exterior of Buildings 413, 420, 426 and 429 were radiologically surveyed for clearance, with interior portions to be completed in 2022.

Building 200 was successfully demolished, which involved the above and below grade structure, while the building footprint was backfilled. Remediation of this footprint was strategically adjusted to align with future remediation of the surrounding lands known to be contaminated from historical spills associated with the building. This will ensure remediation of the known contamination is completed in one phase, avoiding the potential of creating additional volumes of waste that may be generated from migration of contaminants within the soil.

Legacy wastes stored in the LLW Quonsets (Building 431, 432 and 433) and LLW Bunker 5 began to be retrieved in 2021. Wastes are undergoing visual examination, destructive and non-destructive characterization, and packaging to ensure transportation and waste criteria compliance are met, before waste can be dispositioned to CRL. This work is scheduled to be complete in 2022.

Decommissioning progress is also discussed in the facility sections (Appendix A through Appendix G).

11.2.3.2 End State Reporting

Table 54 provides a summary of end-state reports completed for WL in 2021.

Table 54: Summary of WL Decommissioning and Demolition End-State Reports in 2021

Facility	Document Type	Document Status	Document Name and Reference	Submission Date (if applicable)
Building 514 (WMA)	End State Report	Submitted to CNSC	Decommissioning and Demolition of Organic Coolant Incinerator Complex (B514), WLDP-24400-ESDR-001, Revision 1	July, 2021

12 Security

12.1 Security Program

Whiteshell Laboratories adheres to the Corporate Security Functional Support Area. See Section 12 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Whiteshell Site Security Report [46] outlines the security arrangements that are in place at the WL site. The Security Functional Support Area consists of processes, procedures, and staff to manage the continuous operation and response to security incidents; the Security Functional Support Area and procedures are reviewed and updated as required to address operational requirements.

Nuclear Security Officers assigned regular duties continued to meet the physical and psychological fitness requirements for Security Officers stated in REGDOC-2.2.4, *Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical and Psychological Fitness* [47].

Hours of Work Exceedances

As per REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* [47] Sections 4.2 and 4.3, CNL has recorded all exceedances of hours of work for Security's safety-sensitive positions. See Table 55 below for a list of exceedances for 2021. NOTE: COVID pandemic had a direct contribution to Table 55 in order to ensure minimum shift complement.

Table 55: Hours of Work Exceedances for Nuclear Security Officers and Tiered Response Force Personnel at WL in 2021.

Limits:			2021			
			Q1	Q2	Q3	Q4
4.2	**1.**	**>16 hrs in a 24-hour period**	3	4	7	4
4.2	**2.**	**> 28 hrs in a 48-hour period**	15	21	28	11
4.2	**3.**	**> 120 hrs in a 14-day period**	6	4	1	1
4.3	**2. d.**	**Min recovery 48 hrs after 2 consecutive nights**	19	11	5	15
4.3	**2. d.**	**Min recovery 72 hrs after 3 consecutive nights**	2	5	3	2
		Total	45	45	44	33

A CNSC Type II Security Compliance Inspection was carried out - see Section 1.2.2. A corrective action plan was submitted to the CNSC to address findings.

CNL-WL received notification from the CNSC on the closure of one (1) enforcement item, Directive WL-SEC-19-T2-001-D01 – Training. The Directive closure was granted as CNL-WL completed all actions required to address the enforcement items listed in the Directive.

12.1.1 Security Events

In 2021, there were no security events that affected the Whiteshell Laboratories.

13 Safeguards and Non-Proliferation

13.1 Safeguards Program

Whiteshell Laboratories adheres to the Corporate Nuclear Materials and Safeguards Management (NM&SM) Functional Support Area. See Section 13 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

13.1.1 IAEA Activities

The IAEA conducted various types of activities as part of the safeguards approach for CNL, including, but not limited to, IAEA safeguards seals changes, human surveillance, implementation and/or maintenance of IAEA safeguards monitoring equipment, and technical visits. A list of IAEA inspections conducted at all CNL sites can be found in Section 1.2, Management System of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

In 2021 May-June, 14 of 16 WL concrete canisters were re-welded, during which the IAEA provided oversight. The IAEA also verified and changed the IAEA seals attached to the canisters to maintain continuity of knowledge. Minor difficulty was encountered during resealing of one canister and the IAEA inspector decided to employ an alternate sealing arrangement. In 2021 September, the other two canisters were re-welded, during which IAEA provided oversight, including resealing the one canister into the original configuration as it was operationally preferable.

A Physical Inventory Verification (PIV) inspection was completed by an attending IAEA inspector on 2021 May 25. This inspection was a sampling of accessible items containing Special Fissionable Material.

The IAEA also completed a Design Information Verification (DIV) inspection on 2021 May 25 - 27. The activities associated with the DIV included:

- Verification of the Design Information Questionnaire:
- Verification of the site and general building design;
- Verification of containment integrity; and
- Verification of operational status of the facility.

14 Packaging and Transport

14.1 Packaging and Transport Program

Whiteshell Laboratories adheres to the Corporate Transportation of Dangerous Goods (TDG) Functional Support Area, which includes the requirements of the Packaging and Transport SCA. See Section 14 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances and radiation devices. The TDG Functional Support Area applies to any activities involving the transportation of dangerous goods to or from CNL sites. The TDG Functional Support Area provides an operational framework for the safe off-site transport of dangerous goods by conforming to all applicable laws and regulations, as well as company policies and procedures.

The Waste Certification & Transportation branch is a centralized organizational department responsible for planning, coordinating and executing radioactive waste shipments from the WL site to the off-site disposal or storage facilities in a safe and compliant manner, including having fully trained Radioactive Material Shippers as authorized under the CNL TDG Functional Support Area.

Significant activities in 2021 included:

- Transportation of 921 m³ of low-level waste and 3.2 m³ intermediate-level waste sent off-site and safely delivered to CRL;
- Throughout 2021, additional technical assessments and studies on the WL used fuel inventory were completed in support of the licensing application of the Used Fuel Transportation Package (UFTP). These assessments were focused on the WL mixed fuel types (i.e., enriched and experimental fuel types, including Uranium Carbide and Uranium Metal fuel types) and the physical operation of the UFTP. The UFTP, which is owned by the Nuclear Waste Management Organization, has been leased with the intention that the UFTP will be the Type B Transportation Package for high-level waste transportation operations starting in 2022 (due to the COVID-19 Pandemic, these transportation operations were delayed and subsequently pushed out from 2020). There is a two-step licensing strategy for the UFTP, with the first phase focusing on licensing the UFTP for non-enriched CANDU fuels and the second phase focusing on WL's inventory of mixed fuel types. The phase UFTP Safety Analysis Report (SAR) Addendum was submitted to the CNSC in 2019 May, with updates provided throughout 2020, and acceptance is anticipated in early 2022. The UFTP SAR for Mixed Fuel Types (representing phase two) will be submitted in 2022, following the CNSC's acceptance of the phase 1 SAR addendum. Additional accomplishments throughout 2021 include the revision and acceptance of the revised UFTP pre-shipment leak tests, the progression of detailed planning and operational readiness deliverables, and the completion of field trials with the UFTP, Shielded Interface Module (SIM) and Fuel Transfer Flask.

- Award of the subcontract to Nuclear Assurance Corporation (NAC) to design and fabricate Type B casks, cask handling equipment and on-site services needed to support ILW transport to CRL was completed. Two versions of the OPTImal Modular Universal Shipping (OPTIMUS) casks, the OPTIMUS-H and OPTIMUS-L were accepted for use after their licence review and received. Personnel from WL and CRL participated in a week long training session, qualifying them on the use, loading and transport of the casks.
- Extensive training was conducted to site personnel responsible for the handling and packaging of radioactive waste materials, which included Class 7 RAM Material – Handler Training, as well as Waste Management and Packaging Fundamental Training, which was developed to capture the requirements to compliantly process, load, and handle waste materials into certified transport packages, as well as the various waste receivers' waste acceptance criteria.

14.1.1 Shipments

At WL, 68 radioactive transport packages making up 53 loads were safely and successfully sent off-site in 2021. One reportable event occurred in 2021 (see ImpAct ERM-21-1036 in Table 5) where a consignment of waste material was misclassified in accordance with the Packaging and Transport of Nuclear Substances Regulations [48] and IAEA Safe Transport of Radioactive Material [49], due to an incomplete inventory of the package's contents. Several corrective and remedial actions were completed to address the event.

15 Other Matters of Regulatory Interest

15.1 Public Information and Disclosure Program

Whiteshell Laboratories adheres to the Corporate Public Information Program. See Section 15 of the *Annual Compliance Monitoring Report for Canadian Nuclear Laboratories* for details [4].

The Public Information Program document [50] is intended to cover communication activities that occur within CNL's immediate neighbouring communities. This document was prepared in accordance with CNSC regulatory document REGDOC-3.2.1, *Public Information and Disclosure* [51].

15.1.1 Outreach and Stakeholder Engagement

WL shares information with the public through a number of activities including conducting public information sessions, media releases, the corporate website, a toll-free line, social media accounts and involvement in community events. As employees are CNL's greatest ambassadors, they are kept informed of developments so that they can also share information with their relatives, friends, and neighbours.

CNL engaged with the public on WL using a number of tactics. During the COVID-19 pandemic, engagement followed public health and corporate guidelines and was primarily virtual. Table 56 presents public engagements from 2021.

Table 56: Public Engagements for Whiteshell Laboratories

Date	Location	Activity
March 2, 2021	Pinawa, MB	Presentation and meeting with Local Government District of Pinawa Council and Mayor
April 20, 2021	Webinar	WL Closure Project: Environmental Protection
May 18, 2021	Webinar	WR-1 Reactor Decommissioning Fact or Fiction Webinar
September 21, 2021	Webinar	WL Closure Project: Project update
November 16, 2021	Webinar	WL Closure Project: Environmental Protection
November 24, 2021	Winnipeg, MB	Emerging issues conference 2021: The net-zero future investing in sustainability

15.1.2 Public Consultation

CNL actively works to engage local stakeholders on matters related to WL activities. In 2021, a number of methods were deployed to gain feedback from and create discussion with interested parties including: breakfast sessions, social media, and feedback forms available online and at external events, and responses provided to inquiries. CNL strives to create open and transparent communication with all identified stakeholders, and to address concerns and respond to all inquiries.

Throughout 2021, CNL received 21 community inquiries related to WL (Table 57), largely through the WR-1 Breakfast Session/Webinar series.

Table 57: Whiteshell Laboratories Closure Project Public Inquiries

Nature of Enquiry	Number
Transportation	3
Environmental protection	7
Whiteshell Laboratories Closure Project	11

15.1.3 Traditional and Online Communications

15.1.3.1 Website

CNL's Whiteshell Decommissioning web page had 1,667 page views in 2021.

To support the Whiteshell projects and site, CNL has used social media to promote events, share and receive information, and generally engage with the public. As Table 58, Table 59 and Table 60 show that social media has been an effective tool to reach and engage stakeholders. Table 61 shows that CNL also shared information through a community information bulletin.

Definitions:

Engagements - Measures how much and how often others interact with you and your content in social media.

Shares or retweets - Measures how often the message was shared or forwarded on the twitter website.

Table 58: Facebook Metrics for WL-related Posts*

Date of Post	Engagement	Shares
February 16, 2021	3	0
March 29, 2021	3	1
April 14, 2021	20	11
May 5, 2021	34	19
September 14, 2021	38	4

Table 59: Twitter Metrics for WL-related Posts*

Date of Post	Engagement	Retweets	Clicks
April 14, 2021	1	0	0

Table 60: YouTube Videos

Date of Post	Engagement	Views
April 21, 2021	Webinar: WL Closure Project (April 2021)	163
April 21,2021	Webinar: Déclassement des Laboratoires de Whiteshell (2021 avril)	12
May 20, 2021	Déclassement du réacteur WR-1 Webinaire "Mythe ou Réalité" – 2021 mai	27
May 20, 2021	WR-1 Reactor Decommissioning Fact or Fiction Webinar – 2021 May	42
July 12, 2021	CNL Live Event: CNL's major projects and opportunities for supply chain engagement	224
October 1, 2021	Whiteshell Closure Project Webinar – 2021 September	56
October 1, 2021	Déclassement des Laboratoires de Whiteshell Webinaire - 2021 septembre	12
November 22, 2021	Overview of Environmental Protection at Whiteshell Laboratories	34
November 22, 2021	Un aperçu de la protection de l'environnement à les Laboratoires de Whiteshell	25

Table 61: Community Information Bulletins

Date	Bulletin
January 28, 2021	Whiteshell Monitoring

15.1.3.2 Newsletters

CONTACT is CNL's external, bilingual newsletter. It is distributed to community stakeholders, businesses and approximately 8,000 homes in the region surrounding WL, and is available on www.cnl.ca. This publication informs the reader on activities undertaken at CNL's Whiteshell Laboratories and profiles CNL's community activities. Two issues of *CONTACT* were distributed in 2021 and included the following topics:

- WL Closure Project and WR-1 updates
- Highlights of public and Indigenous engagement activities
- CNL initiatives in the community, demonstrating commitment to economic generation, sponsorship, donations and participation in community events
- CNL's COVID-19 response
- Employee transition
- Environmental stewardship, including steps CNL has taken to reduce greenhouse gas emissions, protect wildlife and minimize waste.

15.1.3.3 Media Releases

During 2021, there were seven articles written by media on the Whiteshell Closure Project (see Table 62).

Table 62: Media Coverage for 2021

Date	Article	Title of Publication
January 2021	Canada's Radioactive Waste Policy Review	LGD of Pinawa Municipal Quarterly Newsletter
January 20, 2021	O'Regan All In On Unnatural Resources	Winnipeg Free Press
March 18, 2021	CNL contributes to Pinawa daycare upgrades	The Clipper
March 24, 2021	Who decides where nuclear waste goes	Winnipeg Free Press
March 26, 2021	Nuclear waste solution	Winnipeg Free Press
July 15, 2021	Pinawa erosion responsibility in question	The Clipper
September 2, 2021	CNEA continues funding North Forge East with three-year deal	The Clipper

15.1.4 Ongoing Projects

15.1.4.1 WR-1 In-Situ Decommissioning Environmental Assessment

The proposed WR-1 in situ decommissioning project (also referred to as in situ disposal) is a key part of CNL's overall integrated approach to safely manage and reduce Canada's legacy liabilities. The Environmental Assessment (EA) process for the project includes a requirement that WR-1 project information be made available to neighbouring communities, Indigenous communities and organizations, and stakeholder groups through a variety of mechanisms to ensure accessibility of fact-based information. Engagement activities conducted in support of this requirement included social media and website content, presentations, meetings, site tours and fulfilling stakeholder requests for information.

Project-specific webpages and content were produced for the WR-1 Project and included: fact sheets, info-graphics, downloadable posters, project descriptions and quick reference material. All information is available in both official languages at www.cnl.ca/wr-1.

15.2 Indigenous Engagement

CNL follows CNSC REGDOC-3.2.2 *Indigenous Engagement* [52] which sets out requirements and guidance for licensees on Indigenous engagement. CNL recognizes and values ongoing engagement with Indigenous communities and organizations in the spirit of truth and reconciliation.

15.2.1 Engagement Objectives

As part of its corporate, environmental, and social responsibility, CNL recognizes and encourages the ongoing engagement of the First Nations and the Red River Métis (represented by the Manitoba Métis Federation) through the course of the environmental assessment process for the WR-1 Project and engagement on the overall site closure project. Through information-sharing and engagement activities, CNL seeks to build awareness and learn about interests and concerns in an effort to strengthen mutual understanding and pursue

opportunities for collaboration and long-term relationships. CNL engages with First Nations and Red River Métis leadership, representatives and members on the potential effects of the WR-1 Project and the Whiteshell Laboratories Closure Project (WLCP) on the environment and on Indigenous and/or treaty rights including rights to trap, hunt, fish, gather and conduct cultural ceremonies.

CNL has five overarching Indigenous engagement goals:

- **Build awareness and mutual understanding** by supporting and facilitating opportunities for mutual learning on topics including current and traditional use, values and perspectives on nuclear decommissioning, environmental remediation and radioactive waste management, in order to demonstrate CNL's long-term commitment and approach to safe and responsible management of radioactive waste and decommissioning liabilities (e.g., through site monitoring activities).
- **Share information on the project**, including the potential effects on the environment. This includes developing meaningful, user-friendly information and communication products for the First Nations and the Red River Métis, and providing accessible and current information on project activities.
- **Seek input and feedback from the First Nations and the Red River Métis** on project-related activities, and traditional and current uses of the land surrounding the WR-1 project site. Initiate early and meaningful two-way communication between CNL and the First Nations and the Red River Métis to determine the best methods for sharing information and to provide opportunities for Indigenous Peoples to give input on project considerations including design, the EA process, and assessment of impacts.
- **Develop long-lasting relationships with the First Nations and the Red River Métis** to support their continued involvement in the project, community healing and reconciliation. This will extend beyond the scope of the EA process for WR-1.
- **Meet or where possible exceed all regulatory-based communication and engagement requirements** and facilitate engagement that reflects current memorandums of understanding and contribution agreements, and that takes into account the interests, needs and schedule of each Indigenous Nation.

15.2.2 Identified Indigenous Communities

CNL developed a list of the First Nations and the Red River Métis with a potential interest in the WR-1 Project and the WLCP. The identification of the First Nations and the Red River Métis was based on consultation with the CNSC, through CNL's previous Indigenous engagements, and through the use of publicly available sources of information including:

- First Nation and the Red River Métis and organization websites;
- The Aboriginal and Treaty Rights Information System (ATRIS; Government of Canada and INAC 2016); and
- Crown-Indigenous Relations and Northern Affairs Canada First Nation community profiles.

The list was based on the identified potential or established Indigenous or treaty rights of the First Nations and the Red River Métis and is provided in Table 63 with a brief rationale for inclusion. The inclusion of specific Nations considers the nature of the established and/or claimed rights and potential effects on those rights caused by the proposed project, based on a preliminary assessment of existing and available information. As such, the working list is subject to change based on information and dialogue with the identified First Nations, the Red River Métis, and Indigenous organizations.

Table 63: Identified Indigenous Communities

First Nations, the Red River Métis or Organizations	Identification Rationale
Sagkeeng First Nation (Treaty No. 1 and 3)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve located 52 kilometres (km) north of the WL site, and downstream along the Winnipeg River. Existing relationship and interest in the Whiteshell Laboratories site.
Brokenhead Ojibway Nation (Treaty No. 1)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy three reserves: 44 km northwest, 55 km northwest and 73 km southwest of the Whiteshell Laboratories site respectively. Interest expressed comments on Project Description.
Manitoba Métis Federation (MMF)	The MMF is the official democratic and self-governing political representative for the Métis Nation’s Manitoba Métis Community. The MMF is considered the government of the Red River Métis. Potential asserted and/or established Métis harvesting rights in the vicinity of the Project. Interest expressed comments on Project Description.
Black River First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Proximity to the Whiteshell Laboratories site. Occupy one reserve 75 km north of the Whiteshell Laboratories site.
Hollow Water First Nation (Treaty No. 5)	Asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Occupy one reserve, 113 km north of the Whiteshell Laboratories site.
Shoal Lake No. 40 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 94 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Iskatewizaagegan No. 39 Independent First Nation (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.

First Nations, the Red River Métis or Organizations	Identification Rationale
	Occupy four reserves: 93 km southeast, 102 km southeast, 110 km southeast and 140 km southeast of the Whiteshell Laboratories site, respectively.
Northwest Angle No. 33 (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy three reserves: 111 km southeast, 140 km southeast and 176 km southeast of the Whiteshell Laboratories site, respectively.
Wabaseemoong Independent Nations (Treaty No. 3)	Potential asserted and/or established Aboriginal and Treaty rights exist in the vicinity of the Project. Treaty No. 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site. Occupy four reserves: 80 km east, 85 km east, 95 km east and 140 km southeast of the Whiteshell Laboratories site, respectively.
Grand Council of Treaty 3	Umbrella treaty organization which represents 28 First Nations and 5 with potential interest in the Project. Treaty 3 territory includes parts of eastern Manitoba, including the Whiteshell Laboratories site.
Chiefs of Ontario	First Nations umbrella organization that represents 133 First Nations and 4 with potential interest in the Project

15.2.3 Summary of Engagement

Table 64 lists CNL's Indigenous engagement activities related to the WLCP from 2021. Further details on Indigenous engagements are available in the Indigenous Engagement Report [53].

Table 64: CNL Indigenous Engagement Activities for 2021

Date	Event	Location
Sagkeeng First Nation (SFN)		
January 5	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 18	Discussion on the application of Free Prior and Informed Consent on the WR-1 Project	Teleconference
March 9	Discussion with Chief and Council on engagement with Sagkeeng's members	Teleconference
April 6	Leadership discussion on Sagkeeng's Psychosocial Impact Assessment Report	Teleconference
April 15	Site Tour with Sagkeeng's Liaison Officer	On-Site Visit
June 16	CNL, AECL, and Sagkeeng participated in first Technical Working Group meeting	Teleconference
June 17	Sagkeeng's Liaison Officer visits the site to record video for National Indigenous Peoples Day	On-Site Visit
July 14	Sagkeeng's Liaison Officer participated in a bat survey on site	On-Site Visit
July 19	CNL, AECL, and Sagkeeng participated in second Technical Working Group meeting	Teleconference
August 11	Sagkeeng's Liaison Officer participated in a site tour	On-Site Visit
August 12	Sagkeeng's participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 17	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
August 24	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 7	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
September 14	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
September 22	Sagkeeng's Liaison Officer participated in Trauma-informed Engagement Training with CNL, AECL, and the CNSC	In-person, Winnipeg
September 28	Sagkeeng's participated in the second preliminary discussion of the Indigenous Advisory Committee	In-person, Winnipeg
November 10	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
November 15	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
December 15	CNL, AECL, and Sagkeeng participated in a Technical Working Group meeting	Teleconference
Manitoba Metis Federation		
January 6	WR-1 Environmental Impact Statement Section Review Meeting	Teleconference
February 8	Technical Workshop on WR-1 Groundwater Monitoring	Teleconference
February 18	Environmental Monitoring and MMF Green Initiatives Discussion	Teleconference

Date	Event	Location
March 2	Technical Workshop on Alternative Means Assessment and VC Components	Teleconference
March 9	Discussion on developing a relationship agreement	Teleconference
March 17	Overview presentation on the site's Environmental Protection Program	Teleconference
May 11	Wrap-up Meeting for Technical Workshops	Teleconference
May 25	Discussion on participation in site field monitoring	Teleconference
June 2	Discussion on WR-1 draft commitments and relationship agreement	Teleconference
June 3	Update on Whiteshell Laboratories Closure Project	Teleconference
June 14	MMF participated in groundwater monitoring, a songbird survey, and a turtle search at the site	On-Site Visit
June 18	Discussion on developing a relationship agreement	Teleconference
June 22	MMF participated in a bat survey on site	On-Site Visit
June 23	MMF participated in the a second bat survey on site	On-Site Visit
July 14	MMF participated in the a third bat survey on site	On-Site Visit
August 12	MMF participated in the preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 13	MMF hosted a leadership discussion with CNL's President and AECL's	In-person, Winnipeg
August 16	MMF observed river sediment, soil, and vegetation sampling	On-site Visit
August 19	MMF, CNL, and the CNSC participated in a trilateral meeting	Teleconference
August 19	Discussion on collaborating on a green initiative	Teleconference
September 8	MMF participated in Mushroom collection at site	On-Site Visit
September 21	Discussion on developing a relationship agreement	Teleconference
September 28	MMF participated in a second preliminary discussion on developing the Indigenous Advisory Committee	In-person, Winnipeg
October 20	Alpha Targeted Therapy Discussion	Teleconference

Date	Event	Location
November 17	Alpha Targeted Therapy Discussion	Teleconference
November 22	Discussion on developing a relationship agreement	Teleconference
December 2	Discussion on developing a relationship agreement	Teleconference
Black River First Nation, Hollow Water First Nation, Brokenhead Ojibway Nation		
February 1	Discussion on developing a relationship agreement	Teleconference
April 1	CNL, Black River First Nation, and Hollow Water First Nation sign a relationship agreement	E-mail
May 18	Discussion on onboarding the newly appointed liaison officer	Teleconference
May 25	Liaison officer participated in a site tour	On-Site Visit
June 1	Liaison officer onboarding discussion	Teleconference
June 23	Participating in site monitoring discussion	Teleconference
July 6	Participating in site monitoring discussion	Teleconference
July 14	Liaison officer participates in bat survey	On-Site Visit
August 12	Communities participate in preliminary discussion of the Indigenous Advisory Committee	On-Site Visit
August 16	Liaison officer participates in observation of river sediment, soil, and vegetation sampling	On-Site Visit
August 19	WR-1 Environmental Impact Statement Document review discussion	Teleconference
September 20	Update on Site Decommissioning Activities	Teleconference
September 28	Communities participate in second preliminary discussion of the Indigenous Advisory Committee	Teleconference
November 10	Six-month Relationship Agreement Discussion	Teleconference
December 13	Update meeting of community liaison committee development	Teleconference

15.2.4 CNL's Long-Term Relationship with Indigenous Peoples

CNL recognizes First Nations and the Red River Métis as stewards of the land and is working towards developing meaningful long-term relationships with each Nation that occupies and has traditional territories and/or modern-day interests near its site operations. CNL recognizes each Nation has its own unique set of interests and concerns associated with both the WR-1 decommissioning project and the WLCP is committed to taking a distinctions based approach to engagement to ensure each Nation's interests and concerns are addressed. CNL also takes a

holistic, relationship-based approach to engagement with each Nation, working closely with AECL, to help address interests and concerns regarding all aspects of the WLCP.

This shift in CNL's Indigenous engagement approach from project based engagement to a holistic, relationship and distinction-based approach will support meaningful actions to build foundations for trust, understanding, and mutually beneficial relationships, including addressing broader issues and concerns such as the historical siting of the Whiteshell Laboratories site.

CNL is currently working with each Nation to formalize these relationships through relationship-building and corresponding agreements. These agreements are intended to help enable greater integration of Traditional Knowledge, ceremony, and cultural and stewardship practices in the decommissioning, monitoring, and closure of the project. These agreements will also enable dialogue and participation through the development of monitoring programs, culturally appropriate communications, and trauma-informed engagement. In addition, the agreements help to enhance community engagement, build trust and strengthen relationship-building, and provide mechanisms that facilitate Indigenous participation and input into CNL's environmental monitoring program, economic development and procurement opportunities, future land use, and other areas of collaboration.

CNL has signed a relationship agreement with Black River First Nation and Hollow Water First Nation. Relationship agreements with Sagkeeng First Nation and the Red River Métis are contemplated, and steps are being taken to negotiate such agreements. CNL is committed to ongoing engagement and finalizing these agreements.

CNL continues to build relationships with local First Nations and the Red River Métis to support overall decommissioning of the Whiteshell Laboratories site, including the WR-1 Project. CNL is committed to learning about Indigenous values through ceremony and ongoing dialogue, and discussing, incorporating, and addressing concerns to the extent possible.

16 Acronyms

α	Alpha
ACMR	Annual Compliance Monitoring Report (formerly Annual Safety Review (ASR) or Annual Compliance Report (ACR))
AECL	Atomic Energy of Canada Limited
ALWTC	Active Liquid Waste Treatment Center
β/γ	Beta-Gamma
CCSF	Concrete Canister Storage Facility
CNEA	Canadian National Energy Alliance Limited
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
COVID-19	Novel Coronavirus Disease 2019
CRL	Chalk River Laboratories
DRL	Derived Release Limits
EM	Environmental Monitoring
EmP	Emergency Preparedness
EnvP	Environmental Protection
GHG	Green House Gases
HCF	Hot Cells Facility
ImpAct	Improvement Action
LCH	Licence Conditions Handbook
LLD	Lower Limit of Detection
LLW	Low-Level Waste
LLLW	Low-Level Liquid Waste
LLLWTS	Low-Level Liquid Waste Treatment System
LMDL	Laboratory Method Detection Limit
NEW	Nuclear Energy Worker
OPEX	Operating Experience
OSH	Occupational Safety & Health
REGDOC	Regulatory Document

R&D	Research & Development
RP	Radiation Protection
SAR	Safety Analysis/ Assessment Report
SCA	Safety and Control Area
SF	Shielded Facilities
TLD	Thermoluminescent Dosimeters
WL	Whiteshell Laboratories
WLCP	Whiteshell Closure Project
WMA	Waste Management Area

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Appendix A Concrete Canister Storage Facility

A.1 Operations

The Concrete Canister Storage Facility (CCSF) is operated under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [54]. Concrete storage canisters located at the CCSF have been used at WL since 1975 to store irradiated fuel; there are currently 16 canisters in use.

During 2021, staff of the Site and Nuclear Operations Branch monitored the operation of the CCSF.

The CCSF was operated in compliance with practices and procedures approved for operation. All required surveys and inspections were completed in 2021.

Routine operations in the CCSF were carried out by staff in the Site and Nuclear Operations Branch.

With the recognition of increased work in the CSSF and WMA, three operator trainees were hired, with two of the trainees starting in late 2021. A senior operator was appointed as Facility Supervisor.

In 2021, the CCSF continued to maintain the minimum staffing requirements outlined in the CCSF Facility Authorization [54]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the CCSF in 2021. Procedures for the Facility began their updates as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

A.2 Compliance Monitoring

A.2.1 Air Effluent Monitoring of Canister Liners

Each canister has a closed air-circulating system to monitor the internal space between the canister liner and the sealed fuel basket for the presence of fission products and moisture. Canisters are monitored for one week per month between April and November, dependant on weather. This year readings began in May and concluded in October. Despite multiple attempts flow could not be established in the Canister 8 air lines, these air lines have had issues in previous years obtaining flow. The normal approach to establishing air flow through lines was unsuccessful. Attempts will be made in 2022 to clear the line again.

The gross beta activity was below or near the detection limit of 0.04 Bq/m^3 for all canisters that were measured.

There was no visible moisture detected from the internal canister space during 2021 monitoring, however, the silica gel used in the counting did change colour from blue to pink indicating moisture in the air is present.

A.2.2 Monitoring of Ground and Surface Water

Figure 12 shows the drainage area surrounding the CCSF. Further details on monitoring and results of monitoring ground and surface water can also be found in Sections 9.4.1.3 and 9.5.1.4, and compliance results for the CCSF are described below.

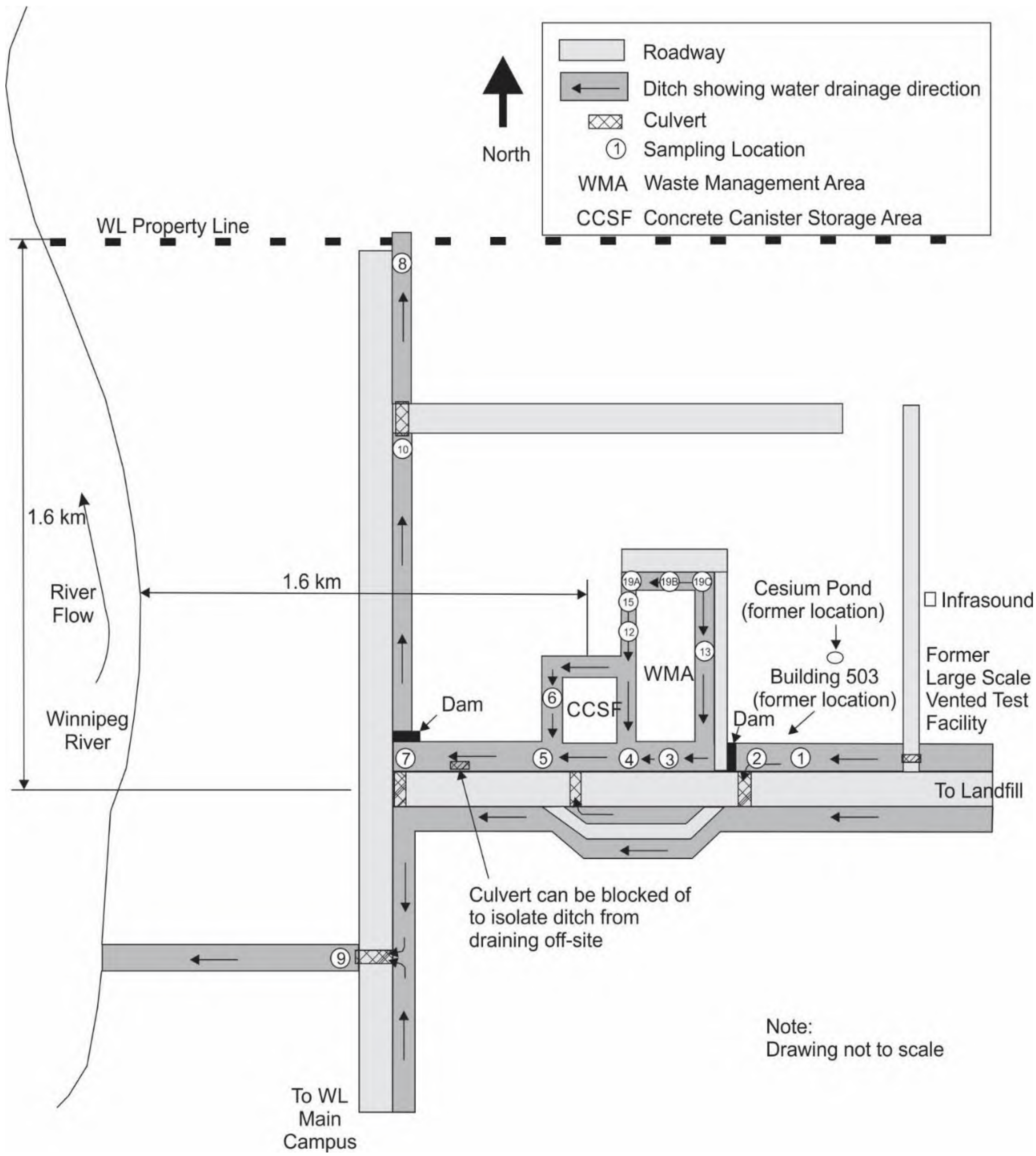

Figure 12: Surface Water Drainage Sample Points

Groundwater samples from deep-well sites in the vicinity of the CCSF are obtained twice yearly; the results are reported and discussed in Appendix D of this report.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the canisters. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period.

If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry analysis and processed for Strontium (Sr)-90. Gamma spectrometry analysis provides individual results for Cobalt (Co)-60, Niobium (Nb)-94, Antimony (Sb)-125, Cesium (Cs)-134, Cs-137 (Barium (Ba)-137m), Promethium (Pm)-147 and Americium (Am)-241.

If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry analysis and uranium analysis. Uranium analysis has also been conducted for other sampling locations below the limit this year. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration established by Health Canada [34]. If uranium is detected, the result is evaluated against the Maximum Acceptable Concentration for uranium (0.5 Bq/L).

Ditch Location 5 and Ditch Location 6 samples (see Figure 12 for sampling locations) could contain surface drainage from the CCSF, however, due to drought conditions and limited snow fall over the 2020/2021 winter, there was only one day with sufficient ditch water movement. This did not include Locations 5 and 6.

The alpha activities were below the trigger level of 0.5 Bq/L.

Table 65, Table 66, Table 67 and Table 68 list the results of the surface-water samples taken from the vicinity of the CCSF and WMA during 2021. Operational control-monitoring data from previous years has been included for completeness.

The ditch sample collected immediately downstream from the WMA (Location 7) contained elevated levels of tritium[12] (see Table 67), which did not exceed the associated Maximum Acceptable Drinking Water concentration of 7,000 Bq/L [34]. The activity seen is from the WMA as discussed in Appendix D.

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[12] Tritium analysis of samples from Ditch Locations 5 and 6 was previously discontinued due to the higher levels of tritium (~4000 Bq/L) noted at upstream locations associated with the WMA.

Table 65: Gross Beta Activity of Surface Water Sample from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.56	1.02	2.37	0.69	0.61	IF

a The reference nuclide for total beta is Sr-90.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 66: Gross Alpha Activity of Surface Water Sampled from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	0.25	0.24	0.29	0.27	0.36	IF

a The reference nuclide for total alpha is total Uranium.
b Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry
ND Sample not available for analysis

Table 67: Tritium Activity of Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2021
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	706	699	111	117	67	IF

a Arithmetic average of samples collected.
IF Insufficient flow, water was stagnant in the ditch or ditch was dry

Table 68: Uranium in Surface Water Samples from Ditches around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data[a] (Uranium ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
5	NR	NR	24.70[b]	13.8	11.3	IF

a Arithmetic average of samples collected.

b Single Value

IF Insufficient flow, water was stagnant in the ditch or ditch was dry

A.3 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13]. There were no major facility changes made in 2021.

A.4 Equipment Performance, Planned Maintenance Testing and Inspections

All canisters are checked for deviation from vertical annually. Out of 16 canisters, all displayed slight deviations from vertical in 2021. None of the canisters had a deviation greater than 1°. In 2021, Canister C5 had a deviation of 0.8° to the east. This deviation and those observed on other canisters show that they all display slight movements in response to changing soil moisture conditions and related swelling and contraction of the clay layer. If a canister was noted either through vertical deviation measurements or visually to be trending beyond a 2-3° deviation, corrective measures such as bracing would be considered.

There were no canister loading or unloading operations in 2021.

As required by Section 8 of the Facility Authorization [54], all routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, and all equipment tests were complete. The inspections were all completed.

Whiteshell Laboratories staff conducted general site inspections during each quarter of 2021. The general appearance and fencing were found to be satisfactory on each inspection. Minor infilling was done along the base of the fence to meet security requirements.

In most cases, quarterly inspections of fuelled canisters have shown no significant cracking or spallation of concrete, however, existing cracks and pour pockets were regularly checked for changes and it has been noted that edges of many pour pockets are more brittle as was noted in 2020. Selective patching is done of these pour pockets, only minor patching was conducted in 2021. No increased radiation field was noted from the canisters.

A.4.1 Canister Site Monitoring and Surveillance

GAMMA FIELD SURVEYS

Gamma exposure rates from the canisters were measured quarterly in 2021. These readings were taken in compass directions north-east-south-west, on contact, and 2.0 m from the canister wall at an elevation of 2.0 m above grade level.

No gamma field anomalies were found during 2021.

Table 69 shows the averaged gamma near contact exposure rates measured during 2021, and for the previous four years.

Table 69: Summary of Average Gamma Radiation for Near Contact Measurements from Fuelled Canisters (mrem/h)

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
C5	0.08	0.08	0.07	0.08	2021	C13	0.16	0.18	0.12	0.14	2021
	0.07	0.08	0.06	0.09	2020		0.16	0.25	0.15	0.14	2020
	0.11	0.08	0.10	0.12	2019		0.18	0.28	0.17	0.17	2019
	0.12	0.09	0.10	0.08	2018		0.20	0.28	0.16	0.15	2018
	0.08	0.08	0.09	0.08	2017		0.18	0.25	0.15	0.18	2017
C6	0.08	0.08	0.08	0.08	2021	C14	0.11	0.09	0.09	0.07	2021
	0.08	0.09	0.07	0.09	2020		0.11	0.17	0.15	0.13	2020
	0.09	0.11	0.10	0.08	2019		0.15	0.18	0.17	0.13	2019
	0.09	0.13	0.10	0.08	2018		0.14	0.19	0.16	0.13	2018
	0.08	0.10	0.08	0.06	2017		0.11	0.18	0.17	0.13	2017
C7	0.11	0.14	0.09	0.14	2021	C15	0.20	0.32	0.23	0.21	2021
	0.15	0.12	0.13	0.14	2020		0.29	0.37	0.27	0.29	2020
	0.18	0.16	0.14	0.16	2019		0.31	0.37	0.29	0.31	2019
	0.21	0.15	0.14	0.16	2018		0.32	0.35	0.30	0.34	2018
	0.20	0.16	0.14	0.14	2017		0.33	0.39	0.31	0.30	2017
C8	0.11	0.12	0.10	0.10	2021	C16	0.17	0.21	0.15	0.15	2021
	0.11	0.12	0.10	0.09	2020		0.16	0.21	0.15	0.17	2020
	0.11	0.13	0.11	0.11	2019		0.18	0.23	0.18	0.19	2019
	0.11	0.12	0.10	0.09	2018		0.18	0.27	0.17	0.16	2018
	0.10	0.10	0.10	0.09	2017		0.18	0.29	0.13	0.17	2017
C9	0.23	0.18	0.16	0.18	2021	C17	0.12	0.12	0.20	0.20	2021
	0.23	0.21	0.14	0.22	2020		0.15	0.13	0.23	0.22	2020
	0.26	0.23	0.17	0.21	2019		0.15	0.13	0.22	0.25	2019
	0.23	0.20	0.17	0.20	2018		0.17	0.14	0.24	0.26	2018
	0.25	0.19	0.20	0.22	2017		0.20	0.15	0.23	0.24	2017
C10	0.16	0.20	0.17	0.13	2021	C18	0.52	0.70	0.94	0.55	2021
	0.23	0.20	0.19	0.42	2020		0.67	0.49	1.05	0.55	2020
	0.24	0.28	0.22	0.21	2019		0.69	0.76	1.25	0.62	2019
	0.24	0.29	0.22	0.22	2018		0.69	0.76	1.31	0.68	2018

Canister Number	Contact Measurements[a]					Canister Number	Contact Measurements				
	Direction						Direction				
	North	East	South	West	Year		North	East	South	West	Year
	0.24	0.30	0.21	0.22	2017		0.70	0.70	1.22	0.70	2017
C11	0.25	0.17	0.21	0.27	2021	C19	0.16	0.18	0.16	0.17	2021
	0.19	0.21	0.23	0.28	2020		0.16	0.17	0.20	0.17	2020
	0.25	0.24	0.29	0.29	2019		0.18	0.18	0.22	0.20	2019
	0.26	0.26	0.29	0.29	2018		0.18	0.18	0.24	0.22	2018
	0.26	0.26	0.30	0.30	2017		0.18	0.18	0.25	0.22	2017
C12	0.16	0.15	0.12	0.08	2021	C20	0.11	0.09	0.13	0.13	2021
	0.16	0.19	0.10	0.13	2020		0.14	0.12	0.14	0.16	2020
	0.19	0.21	0.13	0.13	2019		0.16	0.14	0.18	0.16	2019
	0.22	0.22	0.14	0.14	2018		0.16	0.14	0.18	0.18	2018
	0.22	0.25	0.15	0.13	2017		0.16	0.11	0.18	0.18	2017

a The measurements were made using a BOT P200 survey meter. The instruments are calibrated in mR/h and it is assumed 1 mR/h =1 mrem/h

AIR MONITORING

Air monitoring was conducted on each of the canisters in the CCSF in 2021. This involved an air pump that circulates air from an outlet line on the canister through a Dexter filter and returns it through an inlet line. These readings are taken once per month over a period of approximately one work week during warm weather months. Typically this is the six months of the year when air temperatures are normally above zero. As 2021 was a drier, warmer year, 7 months of sampling were done. As discussed above in Section A.2.1, flow could not be established in the Canister 8 air lines.

One anomalous but still low reading was found in Canister 20 leading to an average of 1.8 Bq/filter for the year. As the other readings were zero, this reading was retained but it is not indicative of a trend. Canister 13 and 16 had single readings slightly greater at 1 Bq/filter. The values may also relate to some disturbances of contamination on the baskets by the previous year's visual observations and the air flow from sampling.

Table 70 shows the averaged beta readings on each filter measured during 2021, and for the previous four years.

Table 70: Summary of Average Beta Radiation Measurements from Fuelled Canisters (Bq/filter)

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
C5	7	<0.02	2021	C13	7	0.25	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	<0.02	2017		6	0.02	2017
C6	7	0.02	2021	C14	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	<0.02	2017
C7	7	<0.02	2021	C15	7	0.12	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C8	7	No Flow	2021	C16	7	0.16	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C9	7	0.02	2021	C17	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.02	2017
C10	7	<0.02	2021	C18	7	0.03	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018

Canister Number	Average Air Sampling Measurements			Canister Number	Average Air Sampling Measurements		
	Number of Readings	Average Value (Bq/filter)	Year		Number of Readings	Average Value (Bq/filter)	Year
	6	<0.02	2017		6	<0.02	2017
C11	7	0.03	2021	C19	7	<0.02	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	0.03	2018		6	<0.02	2018
	6	<0.02	2017		6	0.03	2017
C12	7	<0.02	2021	C20	7	1.81	2021
	6	<0.02	2020		6	<0.02	2020
	6	<0.02	2019		6	<0.02	2019
	6	<0.02	2018		6	<0.02	2018
	6	0.02	2017		6	0.03	2017

A.5 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the CCSF as part of routine operations.

See Section 11.1 Waste Management Program for summaries of any volume of radioactive solid and/or liquid waste generated in the CCSF in 2021.

A.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the CCSF as part of routine operations.

Releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix B Active Liquid Waste Treatment Center

B.1 Operations

The Active Liquid Waste Treatment Center (ALWTC) in Building 200 did not operate in 2021.

Previously, in 2020 October, CNL notified the CNSC that the ALWTC, Building 200 was being demolished and had requested that the Facility Authorization [55] and the Safety Analysis Report [56] associated with the ALWTC be removed from the Whiteshell Laboratories LCH [14]. CNSC granted this request in 2020 December [57].

In 2017, new LLLWTS began operation in Buildings 100 and 300. All of the Building 100 low level liquid waste is now being tested, treated and controlled release to the river in the Building 100 LLLWTS and likewise in Building 300.

In 2020 October, the last of the operating systems in Building 200 were shut down and isolated (ventilation and compressed air systems). The building was rendered cold and dark and demolition of the building started later in 2020 October. Demolition of Building 200 above grade and 1.5m below grade were completed in 2021 October. The demolition footprint is still fenced and protected. The fence will remain until the potentially contaminated ground can be remediated.

B.2 Facility Changes

The demolition of the building was completed in 2021 October.

B.3 Wastes Generated

No solid radioactive or hazardous waste was generated in the ALWTC as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the ALWTC during demolition activities in 2021.

B.4 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the ALWTC as part of routine operations.

Appendix C Shielded Facilities

C.1 Operations

The WL Shielded Facilities (SF) operates under the WL Site Licence [1], in accordance with the requirements of the Facility Authorization [58]. The SF, consisting of the Hot Cell Facility (HCF) and the IFTF, are located in the R&D Complex (Building 300), and are operated by personnel in the Site and Nuclear Operations Branch.

The HCF Cells 1 to 5 and IFTF Cell 13 remain operational while HCF Cells 6 to 11 have been shut down and partially dismantled. The Waste Handling Area, located in the IFTF, was operated for compaction and assaying of radioactive waste.

Operations and decommissioning activities were conducted throughout the year. Operations activities included:

- maintenance of HCF and IFTF ventilation system equipment;
- replacement of HEPA filters;
- packaging and storage of radioactive waste;
- cleanup activities; and
- routine maintenance to ensure compliance with the site licence.

Routine operations in the SF were carried out by operating staff from the Site and Nuclear Operations Branch.

There were no organizational changes in 2021. Although there was a reduction in the staffing for the operating staff responsible for the SF in 2021, the minimum staffing requirements outlined in the SF Facility Authorization [58] was maintained at levels to provide the needed operational and safety support.

No program changes were made for the SF in 2021. Procedures are being updated as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

C.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

C.3 Equipment Performance, Planned Maintenance Testing and Inspections

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Equipment tests and inspections were completed with the exception of a secondary Intermediate-Level Liquid Waste containment tank leak detector due to a defective probe. Compensatory measures were put in place until the detector was repaired. Monthly housekeeping and fire prevention inspections were completed.

VENTILATION SYSTEM

Maintenance activities requiring part of the ventilation system to be taken down occurred without incident.

The annual routine Poly-Alpha-Olefin testing of the HCF HEPA filters were successfully conducted.

C.4 Wastes Generated

See Section 11.1 Waste Management Program for WL summaries of the volume of radioactive solid and liquid wastes generated in the SF in 2021.

LOW-LEVEL SOLID WASTE

In 2021, the SF generated 45.6 m^3 of compactable low-level radioactive solid waste and no non-compactable waste.

The Waste Handling Area processed 62.1 m^3 of low-level radioactive solid waste which was reduced to 5 m^3. A portion of this waste was generated in the SF, and the remainder came from all of the nuclear facilities and decommissioning projects at WL where waste is being generated.

Table 71 lists the annual low-level solid waste generated in the SF for 2021 and the previous four years.

Table 71: Solid Wastes Generated

Total Volume	2017	2018	2019	2020	2021
Low-Level Solid Waste (m^3)	0.4	73.3	64.3	10.9	45.6
Medium-Level Solid Waste (m^3)	0	0	0	0	0

MEDIUM-LEVEL SOLID WASTE

In 2021 the SF generated no medium-level (intermediate-level) radioactive solid waste. Table 71 lists the annual medium-level solid waste generated for 2021 and the previous four years.

LOW-LEVEL LIQUID WASTE SYSTEM

In 2021, 99 m^3 of low-level liquid waste was processed through the Building 300 low-level liquid waste system (see Appendix E).

MEDIUM-LEVEL LIQUID WASTE SYSTEM

All the medium-level liquid waste (intermediate-level liquid waste) from the HCF cells collects in the HCF sump tank, AD Tank 1. The liquid is transferred via a manually controlled pump from AD Tank 1 through a filtration system to AD Tank 14 in the IFTF. The liquid from all other HCF medium-level liquid waste drains and all IFTF medium-level liquid waste drains flows by gravity to AD Tank 14.

In 2021, there was one transfer of 0.1 m^3 medium-level liquid waste to transportable totes that is being stored for future disposition.

Table 88 lists the annual aqueous waste generated for 2021 and for the previous four years.

C.5 Effluents Released

Liquid radioactive and hazardous effluents were discharged from the SF as part of routine operations are provided and discussed in Section 9, Environmental Protection.

Appendix D Waste Management Area

D.1 Operations

The Waste Management Area (WMA) operated under the WL Site Licence [1], in accordance with the requirements of the *Facility Authorization for the Operation of the Waste Management Area at the Whiteshell Laboratories* [59]. During 2021, the WMA at WL was operated and monitored by staff in the Site and Nuclear Operations Branch.

In 2021, the WMA was operated in compliance with approved practices and procedures.

Routine operations in the WMA were carried out by the Facility Manager, Facility Supervisor, WMA Operators and two WMA based utility workers, with support from other Site and Nuclear Operations personnel and Environmental Monitoring personnel as required.

In 2021, the staffing of the WMA was increased. A Facility Supervisor (Senior Operations Technician) was appointed and three additional Operations Technologist trainees were hired.

In 2021, the WMA continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Staffing was maintained at levels to provide the needed operational and safety support.

No program changes were made for the WMA in 2021. Procedures are being updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

D.1.1 Inventory Additions And Deletions

Changes in inventory are reported in Table 72 and for the purposes of reporting WMA inventory (fission products are defined as radioactive material originating from irradiated fuel).

Activation products are defined as any material that has been activated in a neutron flux, including corrosion products. The radioactivity values listed are those recorded at the time of storage.

D.1.2 Low-Level Solid Waste

Details of wastes transferred to the WMA are provided in Section 11.1.1. Waste generated from decommissioning work on the site was generally shipped to CRL for storage, although some waste was stored in the WMA. Some of the inventory of stored waste in WMA was sent to CRL for storage pending future disposal. The stored volume of waste is listed in Table 72.

D.1.3 Industrial Waste

There were no additions of industrial chemical waste during 2021.

Table 72: Additions to Low-Level Waste Inventory

Period	Storage Locations	Volume (m^3)	Fission Products (GBq)	Activation Products (TBq)
Total Accumulation to 2020 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433.	18,798.84	1,967.38	330.58
Additions for 2021	Building 431 to 433	0	0	0
Removals for 2021	LLW Bunker 6 Buildings 431 to 433	9 0	13 0	0 0
Total Accumulation as of 2021 December 31	Trenches 1 to 23, LLW 1 to 6, Buildings 431 to 433	18,789.84	1,954.38	330.58

D.2 Compliance Monitoring

D.2.1 Monitoring And Surface Water

SURFACE WATER

Figure 12 shows the drainage area surrounding the WMA.

Surface drainage water samples would provide the first indication of any abnormal activity levels attributed to the WMA. The WMA and CCSF share a network of perimeter compliance monitoring ditches with designated sampling locations. Water samples are collected in these sample locations for analyses when there is sufficient flowing water present. The frequency of surface drainage sampling is controlled by the amount of spring runoff and the amount of rainfall throughout the spring-to-fall period. In 2021, there was only one day where the ditch flow met the required flow conditions in some sample locations due to the light snow pack leading to limited snow melt, limited rainfall and dry soil conditions.

A recorded amount of precipitation of 395 mm occurred in 2021, which was less than the 441 mm recorded in 2020, and is a ten year low for recorded precipitation. The low precipitation is reflective of an ongoing drought in the area.

In an effort to streamline the operational environmental monitoring process, surface water samples are initially analyzed for gross beta, gross alpha, and tritium. The results are then evaluated using the following screening criteria:

- If the beta activity in the surface water is above 10 Bq/L, an aliquot of the sample is submitted for gamma spectrometry, and processed for Sr-90. Gamma spectrometry provides individual results for Co-60, Nb-94, Sb-125, Cs-134, Cs-137 (Ba-137m), Pm-147, Am-241.

- If the alpha activity in the surface water is above 0.5 Bq/L, the sample is submitted for gamma spectrometry and uranium analysis, however, as was the case last year, all water samples were tested for uranium. Any detected gamma isotopes are evaluated against the applicable Maximum Acceptable Concentration (MAC) established by Health Canada [34]. If uranium is detected, the result is evaluated against the MAC for uranium (0.5 Bq/L or 20 ppb).

Levels of beta activity at ditch sample Locations 1 to 7 (Table 73) all remained well below 10 Bq/L. Based on historical data, it is conservatively assumed that the beta activity in the surface water is Sr-90 in secular equilibrium with Y-90. Most beta activity levels in the ditch water remained below the drinking water screening level of 1 Bq/L, and below the drinking water limit of 5 Bq/L for Sr-90 and 10 Bq/L for Cs-137 [60]. Compliance with Guidelines for Canadian Drinking Water [34] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. There were no exceedances of the Canadian Drinking Water [34] standard of 1.0 Bq/L (Table 73) in 2021.

The alpha activity levels in the surface water are presented in Table 74, and were below the trigger level of 0.5 Bq/L. Uranium results are presented in Table 75.

There was no flow at Locations 19 A, B and C in 2021. In past years, the uranium values recorded at these locations are believed to result from the use of local Lac du Bonnet Batholith granitic rock as base material for the SMAGS foundation. This rock had been also used for berm support material for the Cesium Pond pile, however that material was removed from the WMA in 2018. The Lac du Bonnet Batholith granite is noted to have naturally occurring uranium.

As shown in Table 76, the tritium results are below the Maximum Acceptable Concentration of 7000 Bq/L [34] at all locations with only one result above near-detection limits of 124 Bq/L at Location 7 in 2021. Other locations had no flow or near non-detection of tritium. Locations 19 A, B and C were originally chosen for sampling for the potential migration of cesium-137 due to the presence of the Cesium Pond soil pile. Although the Cesium Pond soil has been removed, CNL will continue to monitor locations 19 A, B and C due to the elevated levels of tritium.

The WMA contains a number of trenches with varying amounts of low-level radioactive waste. Tritium was identified as potentially capable of migrating to the ditches surrounding the WMA. Based on the initial modelling [61], it was proposed that tritium would be present in the ditches (including the Locations 3 through 7 and 19 A, B and C) and possibly reach levels as high as 37 kBq/L. While tritium is slightly elevated immediately around the WMA, periodic monitoring of the ditches has indicated that the levels of tritium at the points (Locations 8 and 9) leaving CNL property remain quite low (below an average value of 4.7 Bq/L in 2021). With the low flow volumes, tritium was only detected in one location. Although the amount measured in Locations 1 to 7 are above that noted at the Control location, the levels are much lower than the Maximum Acceptable Concentration in drinking water for tritium (7000 Bq/L).

Table 73, Table 74, and Table 75 present the WMA surface-water sampling data. The data represents continuing documentation of a spill incident that occurred in 1979 near ILW Bunker 3, from the reference sample point (Location 3) in the southeast section of the WMA, as shown

in Figure 12 and Figure 13. In 2017, sampling Location 3 was reconfigured to allow preparations for future bunker and standpipe remediation, but the location was dry this year due to the dry summer. Surface water at this location serves as an indicator of movement of water from ILW Bunkers 1, 2 and 3. The most mobile radionuclide (tritium) is below the associated Maximum Acceptable Concentration. The levels of tritium in the surface water and groundwater are below the radiation screening criteria used for identifying contaminants of potential ecological concern (COPECs) of $1.27x10^7$ Bq/L [62]. These tables, and Table 76, have been expanded to include the historical monitoring at Ditch Locations 19 A, B and C, water flow permitting.

The Cesium Pond soil (Cs-137) that was stored in the WMA adjacent to SMAGS was removed in 2017. There was no flow recorded in the north WMA ditch in 2021 (Locations 19 A, B and C) (Figure 13). Table 77 reflects this circumstance and shows that previous years indicated no migration of Cs-137 to these ditches.

As Trench 16 has a known quantity of Technetium-99 (Tc-99), Tc-99 measurements were performed as part of ditch water monitoring in 2021. Only one value near the limit of detection was measured (Table 78) The Tc-99 limit for drinking water is 200 Bq/L [60] and the measurement is well below this level.

Table 73: Gross Beta Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Beta[a] Bq/L) in 2021
Locations	**25 May**
1	0.02
2	0.03
3	IF
4	IF
5	IF
6	IF
7	0.26
19 A	IF
19 B	IF
19 C	IF
Background	0.10

Historical Beta Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	1.23	1.62	1.24	IF	1.96	IF
19 A	0.40	0.69	0.36	0.44[c]	IF	IF
19 B	0.52	0.72	0.24	0.43[c]	IF	IF
19 C	0.39	0.58	0.38	IF	IF	IF

a The reference nuclide for total beta is Sr-90
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 74: Gross Alpha Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Alpha[a] Bq/L) in 2021
Locations	**25 May**
1	ND
2	ND
3	IF
4	IF
5	IF
6	IF
7	0.04
19 A	IF
19 B	IF
19 C	IF
Background	0.01

Historical Alpha Data (Average[b] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	0.64	0.28	0.31	IF	0.06	IF
19 A	0.34	0.53	0.92	0.26[c]	IF	IF
19 B	0.36	0.74	0.24	0.51[c]	IF	IF
19 C	0.40	1.05	0.39	IF	IF	IF

a The reference nuclide for total alpha is total Uranium
b Arithmetic average of samples collected
c Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 75: Uranium of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Uranium ppb) in 2021
Locations	**25 May**
1	1.06
2	1.48
3	IF
4	IF
5	IF
6	IF
7	3.51
19 A	IF
19 B	IF
19 C	IF
Background	1.38

Historical Uranium Data (Average[a] ppb)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	ND	NR	21	IF	10.06	IF
19 A	NR	24	52 [a]	13[b]	IF	IF
19 B	NR	39	NR	16[b]	IF	IF
19 C	NR	67	47 [a]	IF	IF	IF

a Arithmetic average of samples collected
b Based on single sample analyses
ND- Not Detected/Below Detection Limit
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
NR Analysis not required

Table 76: Tritium Activity of Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Tritium Bq/L) in 2021
Locations	**25 May**
1	4.21
2	4.22
3	IF
4	IF
5	IF
6	76.04
7	124.43
19 A	IF
19 B	IF
19 C	IF
Background	4.42

Historical Tritium Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
3	228	1335[b]	178	IF	348	IF
19 A	2324	5535	459	543[b]	IF	IF
19 B	4001	8123	325[b]	777[b]	IF	IF
19 C	4203	9610	405	IF	IF	IF

a Arithmetic average of samples collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry

Table 77: Cesium-137 Results from Sample Locations 19-A, B and C at the Waste Management Area

WMA Sample	Sampling Data (Total Cesium-137 Bq/L) in 2021
Locations	**25 May**
19 A	IF
19 B	IF
19 C	IF
Background	<1

Historical Cs-137 Data (Average[a] Bq/L)						
Sample Point	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
19 A	ND	ND	ND	<1[b]	IF	IF
19 B	ND	ND	ND	<1[b]	IF	IF
19 C	ND	ND	ND	IF	IF	IF

a Arithmetic average of sample collected
b Single data point
IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

Table 78: Technetium-99 Results from Surface Water Samples from Ditches Around the Canister and Waste Management Area

WMA Sample	Sampling Data (Total Technetium-99 Bq/L) in 2021
Locations	**25 May**
1	1.17
2	ND
3	IF
4	IF
5	IF
6	IF
7	ND
10	ND
13	IF

IF Insufficient flow, water was stagnant in the ditch, or ditch was dry
ND- Not Detected/Below Detection Limit

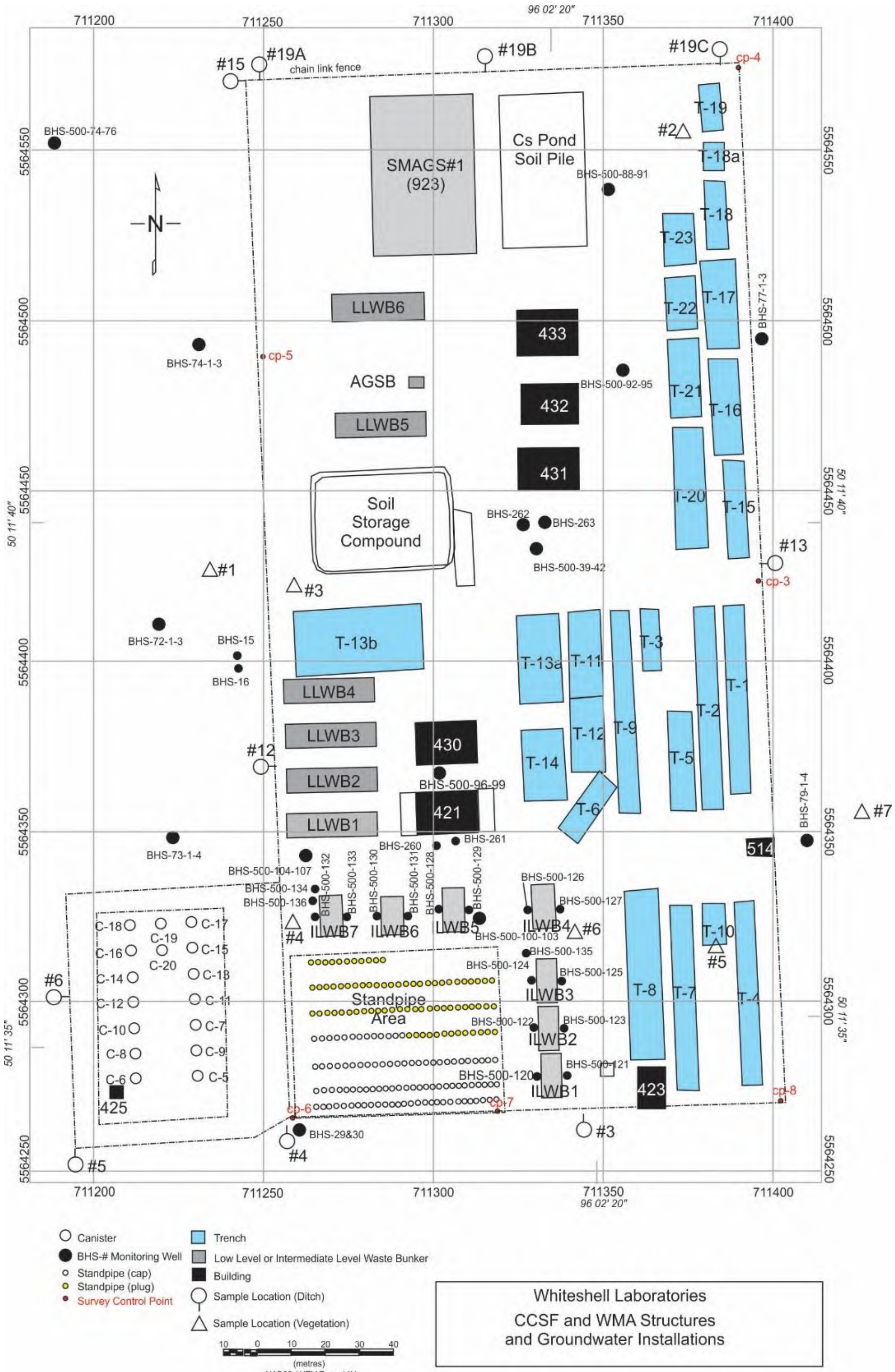

Figure 13: Ground Water Sample Points

INTERMEDIATE - LEVEL WASTE BUNKERS NEAR FIELD WELLS

A series of shallow near field wells were installed adjacent to the ILW bunkers in the WMA in 2015 (Figure 12). Groundwater samples were taken from the wells and from water in the ILW Bunkers for comparison. Cs-137, Sr-90, and tritium were selected as the radionuclides for monitoring of the potential for contaminant migration. Cs-137 was selected as the least mobile, with a high affinity for bonding with clay-based minerals, Sr-90 is more mobile but will bond with sand, and tritium is the most mobile that moves with water. Cs-137 and Sr-90 require a pathway (e.g., a construction joint or crack) to migrate from a bunker. In 2021, Sr-90 was noted to be a maximum of 34 Bq/L adjacent to ILW Bunker 1, and 20 Bq/L adjacent to ILW Bunker 3. For all other locations, the Sr-90 and Cs-137 levels were minor or negligible. Tritium can move through concrete without cracks by diffusion with water movement. The results indicate no migration of Cs-137 (Table 79) from the ILW Bunkers, and Sr-90 (Table 80) and tritium levels (Table 81) that are orders of magnitude below the levels observed in the water in the adjacent ILW Bunkers. At ILW Bunker 3, the tritium results remain high (126,326 Bq/L) and moderately high at ILW Bunker 5 (11,051 Bq/L).

A series of water measurements were made as a confirmatory check in 2020 for the presence of base neutral chemicals (e.g., benzenes, ethylenes) and PCBs. These measurements indicated these chemicals were not present in the water around the bunkers. The measurement was not repeated in 2021.

Table 79: Cesium 137 Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	31762					
BHS 500-120	-	<1	<1	<1	<1	<1
BHS 500-121	-	<1	<1	<1	<1	<1
ILW Bunker 2	1170					
BHS 500-122	-	<1	<1	<1	<1	<1
BHS 500-123	-	<1	<1	<1	<1	<1
ILW Bunker 3	413					
BHS 500-124	-	<1	<1	<1	<1	<1
BHS 500-125	-	<1	<1	<1	<1	<1
BHS 500-135	-	<1	<1	<1	<1	<1
ILW Bunker 4	12,240					
BHS 500-126	-	<1	<1	<1	<1	<1
BHS 500-127	-	<1	<1	<1	<1	<1
ILW Bunker 5	45,100					
BHS 500-128	-	<1	<1	<1	<1	<1
BHS 500-129	-	<1	<1	<1	<1	<1
ILW Bunker 6	1,363,275					
BHS 500-130	-	<1	<1	<1	<1	<1
BHS 500-131	-	<1	<1	<1	<1	<1
ILW Bunker 7	2,794,750					
BHS 500-132	-	<1	<1	<1	<1	<1
BHS 500-133	-	<1	<1	<1	<1	<1
BHS 500-136	-	<1	<1	<1	<1	<1

a Bunker values from 2015 samples
ND Not detected

Table 80: Strontium 90 Activity of Near Field Wells Adjacent to Intermediate - level Waste Bunkers

Wells	Bunker[a]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	98300					
BHS 500-120	-	32	15.30	22.10	24.9	33.9
BHS 500-121	-	1.31	4.44	2.92	5.19	4.15
ILW Bunker 2	865					
BHS 500-122	-	0.25	0.21	0.14	0.5	0.68
BHS 500-123	-	1.27	2.55	1.59	1.84	1.08
ILW Bunker 3	26950					
BHS 500-124	-	5.70	11.3	6.58	12.6	19.8
BHS 500-125	-	<0.20	<0.10	<0.10	<0.10	0.69
BHS 500-135	-	0.72	0.74	1.32	0.84	0.75
ILW Bunker 4	2485					
BHS 500-126	-	0.33	0.24	0.30	0.21	0.7
BHS 500-127	-	<0.20	0.28	0.35	0.24	0.56
ILW Bunker 5	3850					
BHS 500-128	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-129	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 6	157500					
BHS 500-130	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-131	-	<0.20	<0.10	<0.10	<0.10	<0.10
ILW Bunker 7	3335					
BHS 500-132	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-133	-	<0.20	<0.10	<0.10	<0.10	<0.10
BHS 500-136	-	<0.20	<0.10	<0.10	<0.10	<0.10

a Bunker values from 2015 samples
ND Not detected

Table 81: Tritium Activity of Near Field Wells Adjacent to Intermediate - Level Waste Bunkers

Wells	Bunker[(a)]	Well Sample Values (Bq/L)				
	Bq/L	2017	2018	2019	2020	2021
ILW Bunker 1	42000					
BHS 500-120	-	70	279	258	410	700
BHS 500-121	-	765	2788	2355	1509	1230
ILW Bunker 2	6100					
BHS 500-122	-	1877	475	4274	3587	966
BHS 500-123	-	1876	2554	2834	1640	2942
ILW Bunker 3	4600000					
BHS 500-124	-	158564	83604	128534	179094	126326
BHS 500-125	-	2956	2512	39	2484	2349
BHS 500-135	-	2404	3536	47	2737	3372
ILW Bunker 4	41000					
BHS 500-126	-	69	24	39	225	20
BHS 500-127	-	76	< 4	47	37	45
ILW Bunker 5	5500000					
BHS 500-128	-	2981	2674	2655	2793	2748
BHS 500-129	-	10700	9100	9633	9601	11051
ILW Bunker 6	210000					
BHS 500-130	-	310	29	5	37	50
BHS 500-131	-	22	19	5	38	4
ILW Bunker 7	970000					
BHS 500-132	-	49	131	100	NR	94
BHS 500-133	-	16	<4	6	158	20
BHS 500-136	-	36	78	72	58	97

a Bunker values from 2015 samples
ND Not detected

WATER TABLE WELLS AND DEEP WELLS

Water samples were collected from wells in and around the WMA (Figure 13) in the spring and fall of 2021. The gross alpha and gross beta results are summarized in Table 82. The beta activity levels in the clay, clay till and basal zone wells remained below the drinking water screening level of 1 Bq/L. All zones were below the limit for Sr-90 (5 Bq/L) and Cs-137

(10 Bq/L) [34]. The average alpha activity in the samples collected from the Basal zone wells was below the screening level.

Uranium concentrations in the basal zone wells ranged from 0 to 0.59 Bq/L. The concentrations in the Clay zone wells ranged from 0.19 to 3.60 Bq/L, and in the clay till from 0 to 1.61 Bq/L. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [63], the presence of uranium and its progeny are not unexpected and are considered to account for the levels of alpha. Low levels of tritium were noted in the clay (23.29 Bq/L) and clay-till (11.33 Bq/L). This is not unexpected as these overburden layers are impacted by tritium in the WMA.

Table 82: Monitoring Data Water Table Wells and Deep Wells

WMA Sample Locations	2017 Avg. (Bq/L)	2018 Avg. (Bq/L)	2019 Avg. (Bq/L)	2020 Avg. (Bq/L)	2021 Avg (Bq/L)	2021 Avg. Range (Bq/L)
Total Beta [a]						
Clay	0.35	0.29	0.42	0.26	0.43	0.19 to 1.39
Clay Till	0.36	0.25	0.26	0.30	0.45	0.09 to 1.06
Basal	0.16	0.13	0.34	0.11	0.25	0.11 to 0.91
Total Alpha [b]						
Clay	1.01	1.03	0.87	0.52	0.67	0.27 to 2.81
Clay Till	0.77	0.72	0.75	0.80	0.58	0.07 to 1.21
Basal	0.10	0.12	0.22	0.14	0.19	0.03 to 0.48
Total Uranium [c]						
Clay	0.90	0.88	0.86	0.70	0.82	0.19 to 3.60
Clay Till	0.52	0.62	0.60	0.71	0.55	0.003 to 1.61
Basal	0.01	0.04	0.01	0.06	0.03	0.003 to 0.59
Total Tritium						
Clay	11.60	11.36	8.07	7.56	10.37	3.11 to 55
Clay Till	13.36	13.51	14.07	21.31	11.33	3.32 to 65.21
Basal	4.08	4.63	5.66	3.48	3.59	3.16 to 4.62

a The reference nuclide for total beta is Sr-90
b The reference nuclide for total alpha is natural uranium
c The value calculated from the concentration of uranium in the water sample

HIGH-LEVEL LIQUID WASTE TRAY WATER

Monitoring of the high-level liquid waste tank tray water was carried out to confirm there is no leakage from the residue remaining in the storage tanks. This is sampled in the summer months. The sample results indicated no leakage has occurred from the tanks. The data are

summarized in Table 83. In the late fall of 2004, the high-level liquid waste had been removed from high-level liquid waste Tank 2 and transferred to the SF for cementation. A heel of waste remains to be removed. High-level liquid waste Tank 1 remains empty.

Table 83: Monitoring Data High-Level Liquid Waste Tank Tray Water

WMA Sample Locations	2017 Avg (Bq/L)	2018 Avg (Bq/L)	2019 Avg (Bq/L)	2020 Avg (Bq/L)	2021 Avg (Bq/L)	2021 Range (Bq/L)
Total Beta [a]						
Tank Tray Water	13.8	13.8	12.1	11.2	17.7	13.6 to 25.3
Total Alpha [b]						
Tank Tray Water	0.65	0.69	1.5	0.95	0.2	0.1 to 0.4

a The reference nuclide for total beta is Sr-90, gamma results indicate that approximately 13Bq/L of the gross beta activity is due to K-40.

b The reference nuclide for total alpha is Pu-239

D.2.1.1 RADIATION FIELD MEASUREMENTS

Radiation field measurements are taken semi-annually at established points (normally every 38 m) along the perimeter fence. The 2021 radiation field measurements were similar to those in 2020. The data is summarized in Table 84.

Table 84: Perimeter Fence Monitoring Data

WMA	Radiation Field (µSv/h)					
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021 Avg	2021 Range
Spring Survey						
South Fence	0.2	0.2	0.2	0.3	0.2	0.1 – 0.3
West Fence	0.4	0.4	0.4	0.3	0.3	0.1 – 0.6
North Fence	0.2	0.2	0.2	0.4	0.2	0.1 – 0.3
East Fence	0.3	0.3	0.3	0.2	0.4	0.1 – 0.5
Fall Survey						
South Fence	0.2	0.2	0.2	0.4	0.3	0.2 – 0.3
West Fence	0.4	0.4	0.5	0.3	0.4	0.2 – 0.6
North Fence	0.2	0.2	0.2	0.3	0.3	0.2 – 0.4
East Fence	0.3	0.3	0.4	0.3	0.2	0.1 – 0.5

D.2.1.2 VEGETATION

In 2021, vegetation samples were collected at monitoring locations within the WMA (Figure 13), and at a control location unaffected by WL operations. The gross beta results are

summarized in Table 85. Potassium (K)-40 represents the majority of gross beta activity in most of the samples. The levels of gross beta in the samples are due to a combination of K-40 and Sr-90/Y-90, with a minor contribution from Cs-137. The average Sr-90 contribution for the vegetation samples in the WMA is 6% (12% for Sr-90/Y-90). Results were historically reported as Bq/m^2 as there was the potential for deposition of radioactivity via airborne emissions from the former WL Incinerator and former Baler operations. The incinerator and baler have not been in operation for many years and have been decommissioned. The results are now presented as Bq/kg and represent the uptake of radioactivity from impacted areas near the sampling locations.

Table 85: Waste Management Area Vegetation Monitoring Data

WMA Sample Locations	Average Gross Beta[a] (Bq/kg)				
	2017 Avg	2018 Avg	2019 Avg	2020 Avg	2021Avg
North-East Area[d]	NA	672	450	196	207
Mid-West Area	1619	411	155	173	190
South-West Area	275	414	NA	296	243
South-East Area	460	409	441	230	246
Control Sample[b]	379	187	210	162	171
Background Sample[c]	419	324	317	203	157
East of ILW Bunkers 3 and 4	NA	672	450	NA	218

a The reference nuclide for beta is Sr-90
b Adjacent to the WMA outside of the fence boundary
c Ambient Radiation monitor Stations Background Samples
d Until 2012 this sampling point was in the North-West area after 2012 it was moved to the North-East area. Only a single set of vegetation samples was taken as of 2017 as uptake occurs over the summer. Range is no longer included because of this change.

In 2021, the Facility continued to maintain the minimum staffing requirements outlined in the Facility Authorization [59]. Three trainee operators were hired in 2021 to begin increasing staffing to meet with planned decommissioning activities. Staffing was maintained at levels to provide the needed operational and safety support.

D.3 Facility Changes

All facility changes are performed as per the approved Engineering Change Control procedure [13].

Work to prepare for extraction of waste from the Intermediate Level Bunkers and Standpipes was begun in 2017 and continued into 2021 with most of the physical preparatory work done with continued fabrication of extraction equipment off site.

The pad to the east of the north access road had the requisite safety analysis and procedural documents prepared. The pad is now designated as the Recoverable Surface Staging and Storage Area and will be placed into service in 2022 to store Seacan containers containing

waste and oversized items. The Seacan containers or items will be awaiting processing, characterization and packaging for off-site shipment. This was required to allow Building 923 (SMAGS) to be converted to a Cask Loading Facility (CLF).

Building 923 is in the process of being converted to the CLF. In 2021 this included installation of a 15 ton overhead crane, additional lighting and ventilation ducting and an air handling unit. Interior shielding walls were also erected. The current interior equipment is awaiting commissioning and connection of additional power. Further installation work will be done in 2022.

The WR-1 Phase 1 decommissioning waste material was stored in Buildings 432 and 433 in the WMA. Approximately 96% of the WR-1 Phase 1 decommissioning waste stored in Buildings 432 and 433 had been processed by the end of 2016. One oversized crate along with five asbestos crates remain in Building 433 at the end of 2021. Through 2021, work to characterize the contents of B431, B432 and B433 occurred. This effort will continue in 2022 with off site shipping planned.

The marine container used for storing sealed sources that was transferred from Building 430 in the WMA to the Standpipes Protected Area to meet revised security regulations from the CNSC in 2015, remained in place through 2021. Sources are still held pending future dispositioning.

The process to convert Low Level Waste Bunker #6 to the Intermediate-Level Liquid Waste Treatment Centre, Building 202, began in 2021. Work consisted of removal of waste that had been temporarily returned to the bunker due to restrictions in work crews and shipments related to the COVID-19 Pandemic. Once the waste was removed, interior surveys were conducted in preparation for the next phases of work in 2022.

Removal of waste from Low Level Waste Bunker #5 began in 2021. The waste removal is a component of the decommissioning effort for the WMA, and will extend into 2022.

The Waste Transshipment Area outside the northern perimeter of the WMA had its footprint extended and pad upgraded to improve areas of formerly soft ground. The Waste Transshipment Area allows for holding shipments of waste that are ready to be shipped. The larger area will support the planned pace of waste extraction from the WMA.

In 2021, the Waste Transshipment Area also provided access through a west gate in that area to allow for construction of a road along the west side of the WMA. Pads off the west side of that road will host transformers and generators to provide Class IV and Class III power to waste extraction and processing equipment to be installed in the WMA. A non-active organic material laydown area was established on the north end stub of the west road to allow for an area for organic material from the development of the Waste Transshipment Area pad improvement and west road to be retained.

A replacement section of the north fence running from the west side of Building 923 to the east edge of the Recoverable Surface Staging and Storage Area was installed. This fence included an expanded width north gate to allow shipping containers to be transported without having to

raise them above the fence. The fence replacement was done to correct fence sections that were leaning outwards.

On the south side of the WMA, a new well nest was installed to the south of the south road. This well nest was installed to provide groundwater measurements outside of the zone of influence of the work conducted at the WMA. The previous wells fulfilling this role are now too close to the Protected Area expansion to be considered outside the zone of influence and will be used as part of the monitoring network for that area.

A bedrock well was installed to the west of the WMA-CCSF. This provided improved coverage at depth to monitor for potential contaminant migration.

D.4 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the bunkers and other structures in the WMA remained fit for service. Building 923 and Low Level Waste Bunker #6 were removed from operations pending their conversion to the Cask Loading Facility and Intermediate Level Liquid Waste Treatment Centre respectively. Building 421 continued to operate as a waste examination and re-packaging area, making use of the Temporary Ventilated Enclosure.

Medium-Level Waste Bunker 4 did not have new waste placed in 2021 and remains ~70% full. Medium-Level Waste Bunker 6 is ~60% full; however it is not accepting waste due to water ingress issues. Medium-Level Waste Bunker 7 is ~86% full with one placement occurring. The percentage full values are estimates only. Road transportable totes of liquid waste remain in the heated Building 430 pending future processing. Building 431 contains historic waste which is in the process of being characterized and packaged. Building 432 and Building 433 also contain various historic wastes and wastes held in various stages of characterization and repacking operations.

A small seepage of an oily substance first noted in 2020 was again noted at the central gasket, near the south wall base of LLW Bunker 1. The substance was sampled in 2020 and found to contain oil and likely degraded liquid organic. The volume was small in 2020 and remained so in 2021. Seepage again only occurred during hot weather, and as weather cooled the seepage stopped. The area will continue to be monitored. The bunker is slated for remediation of its waste in the next few years.

The Soil Storage Compound remained empty of stored waste soil bags. There are three empty standpipes in the standpipe area.

In-service storage facilities were inspected for water ingress during routine waste emplacement operations. Filled storage facilities with accessible drainage sumps were inspected monthly during the summer months, when water ingress is most likely. Caulking of the roofs of all the WMA Quonset buildings with waterproof sealant was completed in 2010 resulting in reduced indications of water ingress during rainy weather. Re-caulking was done in 2014 and again in 2018 and 2021.

In 2015, shallow wells were installed beside each of the Medium/Intermediate Level Bunkers. These near field wells have been sampled annually. Results are discussed in Section D.2.1 under "Intermediate - Level Waste Bunkers Near Field Wells", and indicates limited migration of tritium beside the ILW bunkers, in particular ILW Bunker 3. There is no evidence that would lead CNL to conclude there is currently any significant contaminant migration pathway from the ILW Bunkers.

Compliance monitoring in the WMA and CCSF perimeter ditches have only found limited levels of contaminants, below drinking water guidelines, suggesting the waste storage structures and natural barriers of low permeability clay soil and upwards groundwater flow are performing as expected. In 2021, the weather was extremely dry and spring melt similarly limited to surface water in ditches was limited to a single set of measurements on one date in May.

As required by Section 8 of the Facility Authorization [59], most routine maintenance for systems required to be operational was carried out as per the facility maintenance plan, however, two tests, both on transformers were not completed in 2021. Monthly housekeeping and fire prevention inspections were completed. An annual inspection of WL WMA concrete bunkers was conducted, in accordance with the Periodic Inspection Plan [16], and is further discussed in Section 6.

D.5 Wastes Generated

Solid radioactive waste was generated in the WMA as part of routine operations. This was mostly bagged waste generated from routine operations.

See Section 11.1 Waste Management Program for summaries of the volume of radioactive solid waste generated in the Waste Management Area in 2021.

Liquid radioactive waste was generated in the WMA as part of routine operations.

In 2021, approximately 564 L of water was removed from ILW Bunker 4, 863 L of water was removed from ILW Bunker 6 and approximately 114 L of water was removed from ILW Bunker 7. Low Level Waste Bunker 1 had 8 L from the west sump and 227 L from the east sump removed, and Low Level Waste Bunker 2 had 84 L from the west sump and 202 L from the removed from the east sump. The sumps are pumped out by Site and Nuclear Operations personnel using a WMA tanker with pump rig. The water collected in the tanker is later transferred to double walled totes. There totes are retained pending future processing.

The Building 923 sump tank and the Soil Storage Compound were both sampled as required and their water found not to be active in all cases. Water was directed to the WMA ditches. No other storage facilities and collection sumps at the WMA required pumping.

D.6 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the WMA as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection. There are no liquid effluents generated from this facility.

Appendix E Auxiliary Operation Facilities

E.1 Operations

The Auxiliary Operating Facilities are operated under the WL Site Licence [1].

There were no changes in the staffing for the operating staff responsible for the auxiliary facilities in 2021. There were no organizational changes.

No program changes were made for the auxiliary facilities in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

Research and Development Facilities Complex (Building 300)

Building 300 was the primary research laboratory for the site, housing a wide range of nuclear R&D programs. The building comprised an area of ~17,000 m^2 and was built in seven stages from 1964 to 1982. The building contained 68 laboratories as well as numerous offices. The south end high-bay area contained experimental activities that required large areas and significant headroom; RD-14M and RD-17 experimental loops were located in the South High Bay.

The research program in the Stage 6 (RD-14M) area was completed in 2018, and operational shutdown was started. The operational shutdown, decontamination, and decommissioning of the remainder of the building was completed in 2015. The demolition of Stages 4 and 7 was completed in 2016. The demolition of Stage 6 was completed in 2019.

During 2021, WL Site and Nuclear Operation’s staff and user groups in Building 300 carried out routine operations which included:

- Non-radiological laundry activities.
- Respirator fit test / maintenance activities.
- Ongoing CNL Nuclear Engineering & Systems Analysis R&D activities.
- Cleanup activities associated with decommissioning.
- Routine building and system maintenance; and
- Surveillance to ensure compliance with the site licence.

Health and Safety Facilities (Buildings 402 and 305)

Building 402 has three floors comprising an area of ~2,162 m^2, housing WL dosimetry services and Environmental Management laboratories. The CNL facilities in Building 402 include a whole-body counting facility, TLD readers, environmental laboratories, and a Cs-137 Gamma Calibrator.

Environmental and Dosimetry services continued to operate in Building 402 until 2021 May.

In 2021, routine operations were carried out and supervised by Site and Nuclear Operations personnel. Operational cleanout of Buildings 402 and 305 continued and demolition of Building 402 started in 2021 November. Demolition of the building worked around the Whole Body Counter which was scheduled to move in early 2022.

E.2 Facility Changes

All facility changes were performed using the Engineering Change Control procedure [13]. The environmental and Dosimetry services were moved to Building 300. Building 402 was completely isolated and rendered cold and dark in 2021 July.

E.3 Equipment Performance, Planned Maintenance Testing and Inspections

All maintenance and non-routine work in these facilities that may affect the safe operation of facilities, systems, and laboratories, or that may present a hazard to the general public are conducted in accordance with CNL's work permit system.

All routine maintenance for systems required to be operational was carried out, and all equipment tests and inspections were completed up until Building 402 went cold and dark.

E.4 Wastes Generated

There were minimal amounts of radioactive and/or hazardous wastes generated in the facilities as part of routine operations.

See Section 11.1 Waste Management Program for WL summaries of any volume of radioactive solid and/or liquid waste generated in the facilities in 2021.

Building 300 generated 0.0 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

Building 402 generated 0.8 m^3 of compactable and no non-compactable low-level radioactive solid waste in 2021.

After processing at the Waste Handling Area, all waste was shipped to the WMA for storage.

See Table 86 for a summary of solid wastes for the last five years.

Table 86: Low-Level Solid Waste Generation – Buildings 300, 402,411

	2017	2018	2019	2020	2021
Building 300 (m^3)	14.7	4.5	0.4	0.3	0.0
Building 402 (m^3)	2.8	1	0.7	0.2	0.8
Building 411 (m^3)	355.1	7.6**	0.2**	0.0	0.0

* Volume prior to compaction, all compactable waste is consolidated at the Waste Handling Area.

** Legacy waste processed in 2018 for Building 411 that was decommissioned in 2017.

There was no liquid radioactive and/or hazardous waste generated in 2021 in this facility.

RESEARCH AND DEVELOPMENT (BUILDING 300) LOW-LEVEL LIQUID WASTE SYSTEM

Radioactive LLLW flows from the SF and Building 300 to the low-level liquid waste collection tanks, in Building 300 Room B-33. An accurate determination of the individual SF or Building 300 contribution cannot be made as both locations flow into these common tanks. The

sources of water from Building 300 are limited and the major contributor is the radiological decontamination service facilities in the IFTF.

During 2021, 78.3 m^3 of low-level liquid was processed through the Building 300 LLLWTS. Table 87 shows the historical volumes of LLLW processed through the Building 300 LLLWTS and also the total volume of Building 300 and Building 100 LLLW processed.

Table 87 - Historical Records of Low-Level Liquid Waste Processed

	2017	2018	2019	2020	2021
Total Combined Low-Level Waste Liquid Processed (m^3)[a]	172.3[b]	131.5[c]	189.3[c]	107	88.2
Low-Level Waste Liquid Processed in Building 300 (m^3)[d]	46	123	186.5	99	78.3

a All low-level liquid waste processed in Active Liquid Waste Treatment Centre for 2014-2016. This total includes laundry and decontamination and ALWTC facilities for 2014 and 2015. For 2016 the total is Building 100 and Building 300 and ALWTC. After 2017 all low-level liquid waste is processed in Building 100 and Building 300.

b This includes 126 m^3 of low-level liquid waste that was processed through the Active Liquid Waste Treatment Centre in Building 200.

c All Low-Level Liquid Waste processed through the low-level liquid waste treatment systems in Building 100 and Building 300.

d Building 300 LLLWTS came online in 2017 July.

The total activities given below are the combination of the Shielded Facilities, Building 300, and Building 100 active liquid effluents produced.

As determined by total-beta analysis, the beta radioactivity content in the effluent releases to the Outfall from the holding tanks at the Building 300 and Building 100 LLLWTS during 2021 was 0.01 GBq, compared with 0.01 GBq released during 2020. The maximum release in a month during the year was 0.001 GBq which is a small fraction of the administrative level of 0.48 GBq per month. This level conservatively assumes that all of the activity is due to Cs-137, which is the most restrictive isotope of those present, or potentially present.

As determined by total-alpha analysis, the alpha radioactivity content in effluent releases to the outfall was 0.001 GBq for 2021 compared with 0.001 GBq released during 2020. The maximum release in a month during the year was 1.4E-04 GBq which is a small fraction of the administrative level of 0.56 GBq per month. This level conservatively assumed that all the activity is due to Am-241 which is the most restrictive isotope of those expected to be present in this waste stream.

Table 88 provides a summary of the total activity released for both the Building 100 and Building 300 LLLWTS. Annual Release Limit values for radionuclides in liquid effluents for WL are based on the DRL [30]. These values were revised in 2016. An error was discovered in Table 88, note “d” in previous years’ reports. The alpha DRL was listed as 1.11×10^1 GBq/month, and should have read 1.11 GBq/month. The annual release limits for alpha were calculated using the correct value for DRL. The % of monthly DRL for alpha was calculated using the wrong DRL value. This made the % of monthly DRL for alpha a factor of 10 lower than the true value.

Observed levels of alpha in WL's LLLW active releases are sufficiently low that even with this correction, levels are well below the DRL. This correction was made for the 2021 values.

Table 88 – Building 100 and Building 300 LLLWTS Radioactive Releases

Radionuclide	Total 2021 Effluent (GBq)	Annual Release Limit[a] (GBq/a)	Total 2021 Effluent as a % of Annual Release Limit	Peak Release	
				Max. Monthly Release (GBq)	% of[b] Monthly DRL
Total (Total-Beta Analysis) [c]	0.01	–	–	0.001	–
Sr-90	1.02×10^{-3}	1.56×10^{2}	0.76×10^{-3}	2.18×10^{-4}	1.87×10^{-3}
Cs-137	3.74×10^{-3}	1.39×10^{2}	2.69×10^{-3}	5.95×10^{-4}	5.12×10^{-3}
Total Alpha (As Pu-239 Equivalent) [d]	0.86×10^{-3}	1.33×10^{1}	6.46×10^{-3}	1.35 x 10-4	1.22×10^{-2}
Historical Data Total Effluent (GBq)					
	2017[e]	2018[e]	2019[e]	2020[e]	2021
Total (Total-Beta Analysis) [c]	0.04	0.02	0.01	0.01	0.01

a The annual release limit is calculated by multiplying the DRL by 12.

b DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The beta particulate emitters are considered to be Cs-137, the most restrictive isotope of those identified or potentially present. The DRL is 1.16×10^{1} GBq/month [30].

c A total beta analysis results in a conservative (higher) estimate of the total amount of activity, which is more accurately determined by measuring the individual radionuclides by radiochemical or gamma spectrometry methods.

d DRLs and most restrictive isotope for the LLLW systems was changed in 2016. The alpha particulate emitters are considered to be Pu-239, the most restrictive isotope of those identified or potentially present. The DRL is 1.11 GBq/month [30].

e Year's 2014 to 2016 effluent was all processed in ALWTC. 2017 effluent was processed in ALWTC and Building 300 LLWTS. From 2018 on, all effluent was processed in Buildings 300 and 100 LLWTS.

E.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from these facilities. Radioactive wastewater generated in Building 300 was pumped to the LLLWTS in Building 300 Room B-33.

Any liquid and/or gaseous releases from the facilities are provided and discussed in Section 9, Environmental Protection.

Appendix F WR-1 Facility

F.1 Operations

Activities in Whiteshell Reactor 1 (WR-1) were conducted under the WL site licence [1] from the CNSC, in accordance with the requirements of *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64]. The status of the WR-1 facility in its shut down, de-fuelled, and partially decommissioned state is described in *The WR-1 Reactor Phase 1 Decommissioning Project Interim End-State Report - Facility Description* [65]. The facility is monitored and maintained as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64].

Routine operations in the WR-1 facility, as defined by *The Monitoring and Surveillance Plan for the WR-1 Deferment Period* [64], were carried out by the five (four and one trainee) Site and Nuclear Operations Technologists assigned to Building 100. Throughout the course of 2021, the number of Building 100 staff dropped to three (two and one trainee) with plans to hire additional staff. Building 100 continued to maintain the minimum staffing requirements outlined in the Facility Authorization [64]. Staffing was maintained at levels to provide the needed operational and safety support.

In 2018, approximately 20 m^3 of low concentration (3.4 E06 Bq/L) tritiated water was found in the thermoshield and bioshield cooling systems. This water is still in the systems, awaiting a decision on how to remove this water as the systems were not designed to be drained. Investigation is also ongoing to determine what the impact would be if this water is left in situ as part of the proposed in situ disposal of WR-1.

No program changes were made for WR-1 in 2021. Procedures are updated as necessary as part of the five-year review cycle for WL Nuclear Facilities Operating Procedures.

F.2 Facility Changes

All facility changes were performed as per the approved Engineering Change Control procedure [13].

F.3 Equipment Performance, Planned Maintenance Testing and Inspections

During 2021, the operations status of WR-1 remained unchanged. There were no changes to the reactor’s equipment.

Issues with missed and archived preventive maintenance activities was identified in 2021 and reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence. All Monthly housekeeping and fire prevention inspections were completed.

F.4 Wastes Generated

Solid Radioactive and/or Hazardous Wastes

See Section 11.1 Waste Management Program for summaries of the volume of any volume of radioactive solid and/or liquid waste generated in WR-1 in 2021.

Solid radioactive waste was generated in the facility as part of routine operations. This consisted of mainly operational supplies such as Tyvek suits.

During 2021, 1.5 m^3 of low-level radioactive compactable waste and no non-compactible waste were generated from Building 100/WR-1 operations and sent to the Waste Handling Area for compaction.

There were no new hazardous solid wastes generated from Building 100/WR 1.

Liquid Radioactive and/or Hazardous Wastes

Liquid radioactive and no hazardous waste was generated in the facility as part of routine operations.

During 2021, 9.9 m^3 of low-level radioactive liquid waste was generated from Building 100/ WR-1 operations, the majority from the WR-1 sumps. Appendix E has more information on the liquid waste processed. There were no hazardous liquid wastes generated from this facility.

F.5 Effluents Released

There were no radioactive and/or hazardous effluents (liquid or gaseous) released into the environment from the facility as part of routine operations.

Any liquid and/or gaseous releases from the facility are provided and discussed in Section 9, Environmental Protection.

Appendix G Non-Nuclear Facilities

G.1 Operations

The WL non-nuclear facilities status and changes for 2021 are as noted in Table 89.

Table 89: Operating Summary of Non-Nuclear Facilities

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
303	Containment Test Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
304	Waste Clearance Facility	Removed in 2020	None	Removed from use	Facilities	Building removed, pad retained, End-State Report to be completed
306	Waste Clearance Facility	Removed in 2016	None	None	Buildings & Lands D&D Project Personnel	Building removed, pad retained, End-State Report to be completed
308	Large Scale Vented Combustion Test Facility	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
309	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
310	Large Scale Vented Combustion Test Facility -Local Services	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
311	Large Scale Vented Combustion Test Facility Hydrogen Storage	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
401	Security, Reception, Firehall and Security Monitoring Room	Operational	None	None	All Site/Visitors	No change
405	Lunchroom/Offices (formerly the Library)	Operational	None	None	All Site/Visitors	No change
408	Stores	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
409	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
412	Offices/Machine Shop	Operational	None	None	All Site/Visitors	No change
413	Quonset: Cold Storage	Shut down	None	None	Security and Common Services	Preparing for demolition

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
414	Controlled Area 2 Entrance	Removed in 2019	None	None	Facilities	Decommissioned, End-State Report to be completed
415	Warm Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
416	Heated Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
418	Active Area Storage	Removed in 2017	None	None	Facilities	Decommissioned, End-State Report to be completed
420	Cold Garage	Shut down	None	None	Transportation, Security and Stores	Preparing for demolition
422	Outfall Monitoring Station	Operational	None	None	Environmental Monitoring and Maintenance	No change
424	WR-1 Organic Monitoring Building	Removed in 2020 l	None	None	Facilities	Building removed,, End-State Report to be completed
426	Quonset: Cold Storage	Shut down	None	None	Utility	Preparing for demolition
427	Cold Mechanical Storage	Removed in 2016	None	None	Facilities	Building removed, pad retained, End-state Report to be completed
428	Cold Storage	Removed in 2016	None	None	Facilities	Decommissioned, End-State Report to be completed
429	Quonset: Cold Storage	Shut down	None	None	Maintenance	Preparing for demolition
505	Fire/Security Training (formerly R&D Lab)	Removed in 2016	None	None	Environmental	The building and pad were previously decommissioned, 3 environmental monitoring wells have been installed
531	Asbestos/PCB Storage	Operational	None	None	Facilities	No change
540	Modular Office Complex	Operational	None	New	Facilities	Modular Trailer office complex installed in parking lot
543	Dosimetry Building	Under Construction	None	New	Facilities	Start of construction 2021 To be completed 2022

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
570	Hazardous Chemical Storage	Operational	None	None	Facilities, Waste Management	Relocated from Building 402 to near Building 300 Shielded Facilities. Placed back in Operation.
597	Portable Boiler Building 1	Out of Operation	None	None	Powerhouse Operators and Maintenance	Taken out of Service due to shutdown of Building 200
598	Portable Boiler Building 2	Operational	None	None	Powerhouse Operators and Maintenance	No change
902	Pump House	Operational	None	None	Powerhouse Operators and Maintenance	No change
903	Water Filtration Plant	Operational	None	None	Powerhouse Operators and Maintenance	No change
904	Fire Protection Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
905	Process Water System	Operational	None	None	Powerhouse Operators and Maintenance	No change
906	Storm Drainage System	Operational	None	None	Maintenance	No change
907	Sewage Lift Station and Lagoons	Operational	None	None	Powerhouse Operators and Maintenance	No change
911	Powerhouse	Operational	None	None	Powerhouse Operators and Maintenance	No change
913	Main Substation (Owned by MB Hydro)	Operational	None	None	Manitoba Hy dro	No change
914	Main Power Distribution	Operational	None	None	Powerhouse Operators and Maintenance	No change
916	Communications System	Operational	None	None	Security and Maintenance	No change
917	Supervisory Control and Alarm	Operational	None	None	Security and Maintenance	No change

Building Number	Building Function	Operating Status	Reportable Events	Operating Status Changes	Authorized Personnel [a]	Comments
918	Clarified Water System	Shut Down Mid-1980s	None	None	Powerhouse Operators and Maintenance	No change
921	Access Tunnel	Operational	None	None	All Site/Visitors	No change

[a] Security personnel perform regular patrols of all site buildings

There were no policy, program or procedural changes for the non-nuclear facilities in 2021. There were no changes in organization in 2021.

In 2021, the Facility continued to maintain the minimum staffing requirements to provide the needed operational and safety support.

G.2 Facility Changes

All facility changes were performed as per the Engineering Change Control procedure [13].

G.3 Equipment Performance, Planned Maintenance Testing and Inspections

Systems and equipment for all the non-nuclear facilities, including any safety-related systems, performed as designed and required during 2021 with the exception of Compressed Air Systems where one of the three compressors was not operational (awaiting parts). In addition, issues with some gas detection systems were part of the missed preventive maintenance activities that was reported to the CNSC (see ImpAct ERM-21-3009 in Table 5). A corrective action plan was developed that will fix the issues and prevent recurrence.

Routine maintenance was carried out, and equipment tests and inspection were completed in 2021 with no significant results.

G.4 Wastes Generated

There were no radioactive and/or hazardous wastes generated in the non-nuclear facilities as part of routine operations.

G.5 Effluents Released

There were no radioactive and/or hazardous effluents (gaseous or liquid) released into the environment from the facilities as part of routine operations.

There was 1.15E+09 L of effluent released from buildings Building 422 (Outfall Monitoring Station) and 0 L of effluent released from Building 907 (Sewage Lift Station and Lagoons) as there was no lagoon release in 2021.

Landfill Dugout Water Monitoring

The WL landfill is surrounded by six dugouts where surface water collects. These dugouts are sampled as part of the ongoing operational control monitoring for the facility. In 2021, the precipitation was low over the year (395 mm) and the dugouts had low water levels during the summer sampling period. The location of the dugouts are shown in Figure 14. Dugout 22 is used as the Control and is about 300 m away from the landfill to the north-northeast, and would not be affected by facility operations.

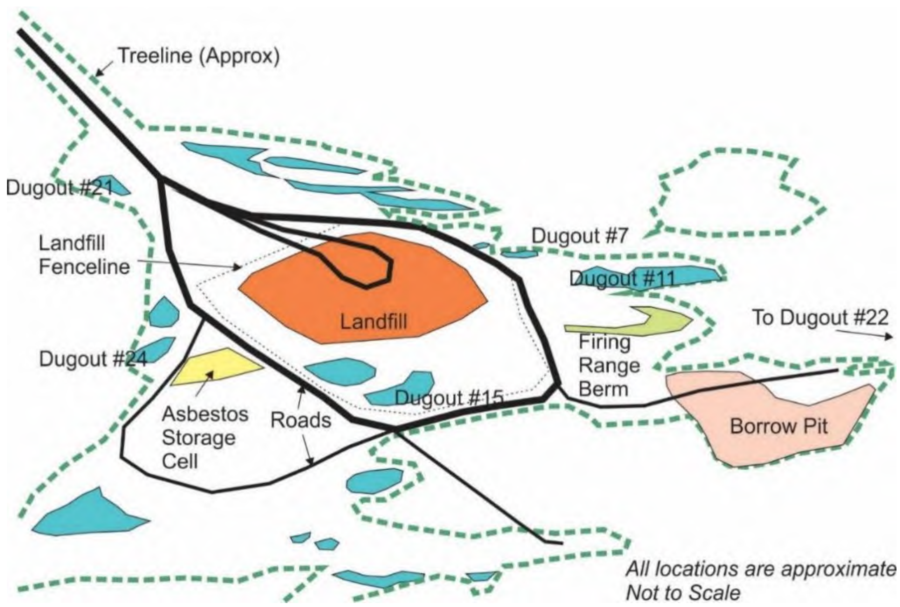

Figure 14: WL Landfill Area Showing Approximate Locations of Monitored Dugouts

The results from the sample analysis for alpha and beta from these dugouts are provided in Table 90 and Table 91 respectively. All alpha results for 2021 were at the detection limits, and are below the drinking water screening level of 0.50 Bq/L. All beta results for 2021 were near the detection limits, and are below the drinking water screening level of 1.0 Bq/L. Both alpha and beta results for 2021 are consistent with previous results obtained from 2016 to 2020.

Table 90: Gross Alpha Results from the Landfill Dugouts

Sample	Gross Alpha (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	< 0.14	< 0.17	< 0.17	0.07	<0.05	<0.05
Dugout #11	< 0.10	< 0.14	< 0.14	< 0.05	<0.05	0.05
Dugout #15	0.16	0.10	0.10	0.28	<0.05	0.05
Dugout #21	0.16	0.07	0.07	Dry	<0.05	<0.05
Dugout #22	< 0.11	< 0.14	< 0.14	0.11	<0.05	<0.05
Dugout #24	< 0.18	< 0.19	< 0.19	0.29	<0.05	<0.05

Table 91: Gross Beta Results from the Landfill Dugouts

Sample	Gross Beta (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	0.19	0.17	0.17	0.11	0.07	0.08
Dugout #11	0.07	0.02	< 0.10	< 0.05	< 0.05	0.01
Dugout #15	0.35	< 0.07	< 0.07	0.12	0.16	0.30
Dugout #21	0.12	< 0.05	< 0.05	Dry	< 0.05	0.13
Dugout #22	< 0.06	< 0.13	0.13	< 0.05	0.05	0.05
Dugout #24	0.26	0.08	< 0.08	0.25	0.06	0.10

Low levels of tritium (9 Bq/L) were detected in one of the landfill wells (water table) starting in 2011. Its appearance in the groundwater resulted in initiation of the surface (dugout) water measurement of tritium. Tritium has been detected in landfill Dugout 15 for the past eight years, and a low value was noted in Dugout 24 in 2011, 2012, 2016, and although a higher amount was noted in 2018 (76 Bq/L), the value returned to background in 2019 and remained there through 2021. The higher tritium level in Dugout 15 was 93 Bq/L, approximately one-half of that measured in 2019 (212 Bq/L). All results are well below drinking water limits of 7,000 Bq/L. The other dugouts do not appear to contain tritium, as levels comparable to blank samples analyzed from 2013 to 2021 that contain < 5 Bq/L of tritium were recorded. Tritium results from the landfill dugouts are shown in Table 92.

Table 92: Results from the Landfill Dugouts

Sample	Tritium (Bq/L)					
Location	2016	2017	2018	2019	2020	2021
Dugout #7	< 4	< 4	< 4	< 3	< 4	< 5
Dugout #11	< 4	< 4	< 4	< 4	18	< 5
Dugout #15	98	82	105	212	54	93
Dugout #21	< 4	NA	< 4	Dry	< 3	< 5
Dugout #22	< 4	< 4	< 4	< 4	< 3	< 5
Dugout #24	5.5	< 4	76	< 4	< 4	< 5

NA sample not available

When initially detected in the dugouts, it was assumed that it was possible that tritium emissions from the WR-1 Building 100 deposited in the ponds surrounding the landfill, and was subsequently drawn in to the water table. After consideration, it was determined that the most likely source of tritium is the landfill. The presence of above background tritium in only a few dugouts cannot be explained by air borne deposition. The highest tritium activities are found in the dugouts and wells in closest proximity to the landfill. Due to its 10 m height, the landfill has

a higher hydraulic head than the local terrain, including the asbestos storage cell, and thus will be more likely to contribute leached contaminants to the shallow ground water system. Due to local groundwater flow directions (toward the south and southwest), Dugouts 15 and 24 are more likely to receive contaminants from the migration of water from the landfill. As the landfill had been in operation for over 50 years, the potential for a historic error in placement is greater for the landfill than the adjacent asbestos storage cell.

The water testing conducted in 2018 included Sr-90 and Tc-99, two potentially mobile radionuclides. In 2018, near detection levels of Sr-90 were noted in Dugout 21 and near detection limit levels of Tc-99 were noted in Dugouts 21 and 24. In 2019, only Sr-90 was tested, and was found to be at the detection limit. In 2020, both Sr-90 and Tc-99 were again measured. Sr-90 was at the detection limit and Tc-99 was not detected. In 2021 (Table 93), no Sr-90 analysis was conducted as per the instructions provided to lab to only analyze if gross Beta exceeded 5 Bq/L. Tc-99 was again below the detection limit. The water from these dugouts and wells is not used for human consumption. All results were below drinking water limits of 5 Bq/L for Sr-90 and 200 Bq/L for Tc-99.

Table 93: Sr-90 and Tc-99 Results from the landfill Dugouts in 2021

Sample Location	(Bq/L)	
	Sr-90	Tc-99
Dugout #7	NA	ND
Dugout #11	NA	ND
Dugout #15	NA	ND
Dugout #21	NA	ND
Dugout #22	NA	ND
Dugout #24	NA	ND

NA – No Analysis Gross Beta below analysis trigger limit.
ND – Non Detect

The water from the dugouts was also tested for a suite of non-radiological parameters including total metals, mercury, nitrate + nitrite, sulphate, chloride, sodium, potassium, calcium, magnesium, sulphur, total ammonia (N), phosphorus, phenols and volatile organics (including benzene, toluene, ethylbenzene and xylene). Elevated levels of boron were detected in Dugout #15, a continuation of results from 2017 onwards (Table 94). The value in 2021 remained under the Drinking Water Guideline for Boron (5,000 µg/L). Dugout #24 showed 431 µg/L in 2021, all other dugouts showed values below detection limits.

Table 94: Boron Results from the Landfill Dugout #15

Sample Location	(µg/L)				
	2017	2018	2019	2020	2021
Dugout #15	1630	5460	8460	2040	3760

Molybdenum remained at detection limits from 2020 through 2021. In 2021, Manganese remained higher than drinking water guidelines of 50 µg/L in Dugout #15 (509 µg/L). No other parameters were detected at concentrations of concern.

Groundwater results will be discussed in the annual Environmental Monitoring report [29]. Sediment sampling of one of the dugouts was conducted as part of the Environmental Assessment Follow-up Program and will be reported in [28].

Landfill Dugout Sediment Monitoring

Sediment sampling of the dugouts was conducted in 2017 as part of the Environmental Assessment Follow-up Program. The analysis of the sediment included a full suite of metals, mercury, lead, PCBs and for radioactivity, including Sr-90. There were elevated levels of molybdenum in the surface sediment of one dugout (Dugout 24) and no other contaminants of potential concern noted. Molybdenum can be found naturally in the environment (minerals containing iron, bismuth, or copper) as well as being a component of man-made items such as filaments, X-ray tubes, screens, grids for radios, spark plugs, contacts, induction heating elements, and/or part of a waste stream from man-made processes (burning of fossil fuels). The source of the molybdenum is being investigated as part of the assessment of the Landfill prior to closure. Monitoring of the sediments in the dugouts around the landfill is planned to continue every 5 years (from 2017) as well as annual monitoring of the water, as such no sediment sampling was conducted in 2021.

Further investigation will be conducted during the eventual closure of the landfill and will also be reported in the Environmental Assessment Follow-up Program [28].

Landfill Radiological Monitoring

Annual radiological monitoring of the landfill surface is performed as a confirmatory measure. The results show readings consistent with background levels at the landfill fence line. Table 95 provides a five year listing of survey results at the top of the landfill. For some years monitoring was performed at the base of the pile, and more recently monitoring was performed around the perimeter of the fenced area of the landfill.

Table 95: Landfill Radiological Monitoring

Sample Location	(µR/h)				
	2017	**2018**	**2019**	**2020**	**2021**
Landfill Top Surface	10-16	8 - 10	6 -12	6 - 12[2]	10
Landfill Base	< 20	NR	5 - 8[1]	5 - 8[1]	10

NR – Not recorded

[1] Taken at the fence line instead of base of landfill

[2] Metal waste collection bins sited at top of landfill

Year | Année	NPRI ID | ID INRP	Company Name | Raison Sociale	Facility Name | Nom de l'installation	City | Ville	CSD | SDR	CA or CMA | AR	Economic Region |	Province |	Latitude | Latitude	Longitude | Longitude	Substance Name (English) | Nom de substance (Anglais)	Substance Name (French) | Nom de substance (Français)	Units | Unités	Stack Emissions |	Direct Discharge |	Footnotes | Notes de bas de page
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	1.27E+12	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.61E+13	8.80E+12	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	6.66E+08	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	0.00E+00	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.01E+06	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.17E+07	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	3.05E+05	3.08E+08	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	2.11E+07	8.76E+09	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	9.40E+09	
2023	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0024	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.10E+10	4.84E+09	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	7.65E+04	2.12E+07	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	1.42E+05	8.32E+07	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.03E+07	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	9.19E+06	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	7.78E+06	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	6.35E+06	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	2.10E+07	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	5.05E+06	
2023	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	5.90E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2023	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	1.56E+05	
2023	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	0.1	
2023	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2023	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	6.59E+05	
2023	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.1	
2023	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2023		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.72E+11	2.44E+10	
2023		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	NRM | NRS	8.02E+06	
2023		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	1.34E+05	8.18E+06	
2023		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0014	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2023		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.30E+11	5.26E+10	
2023		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	3.34E+04	8.37E+07	
2023		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	3.13E+12	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.84E+13	1.07E+13	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	6.92E+08	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	0.00E+00	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.76E+06	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	3.03E+07	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	3.03E+05	2.56E+08	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	2.91E+07	1.82E+10	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	7.37E+09	
2022	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0026	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.79E+10	5.96E+09	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	7.59E+04	2.69E+07	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	1.23E+05	2.27E+08	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	7.27E+07	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	2.49E+07	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	2.34E+07	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	7.16E+06	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	1.03E+07	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	8.36E+06	
2022	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	2.10E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	1.87E+05	
2022	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	0.1	
2022	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.033	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	5.12E+05	
2022	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2022	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.028	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.41E+11	2.40E+10	
2022		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	NRM | NRS	5.70E+06	
2022		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	1.17E+05	8.60E+06	
2022		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0024	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2022		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	9.21E+11	1.75E+10	
2022		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	2.96E+04	2.68E+07	
2022		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	2.08E+12	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.49E+13	1.50E+13	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	0.00E+00	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	0.00E+00	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.76E+06	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.12E+07	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	2.59E+05	2.40E+08	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	1.61E+07	1.79E+10	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	5.89E+09	
2021	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00374	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.76E+10	4.18E+09	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	8.39E+04	3.32E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.33E+05	1.78E+08	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.11E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	2.23E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	2.23E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	1.39E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	2.35E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.31E+07	
2021	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	1.10E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	2.77E+05	
2021	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	0.1	
2021	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.041	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	6.25E+05	
2021	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2021	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.023	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.57E+11	2.30E+10	
2021		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	NRM | NRS	5.55E+06	
2021		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	7.58E+04	2.97E+07	
2021		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0016	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.50E+11	3.08+10	
2021		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	3.85E+04	4.43+07	
2021		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	5.06E+12	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.54E+13	1.08E+13	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	2.61E+10	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	0.00E+00	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.00E+06	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.44E+07	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	2.72E+05	2.40E+08	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	2.04E+07	1.75E+10	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	7.07E+09	
2020	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00722	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.31E+10	4.91E+09	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.98E+04	6.67E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.13E+05	3.62E+08	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.30E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	3.94E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	2.39E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	1.80E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	5.71E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.86E+07	
2020	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	2.90E-06	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	8.45E+05	
2020	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	1.0	
2020	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	7.78E+05	
2020	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2020	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.033	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	4.10E+11	1.74E+10	
2020		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	8.44E+03	8.34E+06	
2020		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	1.38E+05	3.31E+07	
2020		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0018	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.65E+11	6.67E+09	
2020		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	4.43E+04	2.05E+08	
2020		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	5.51E+12	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.01E+14	1.31E+13	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	3.44E+10	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	0.00E+00	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.44E+06	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.67E+07	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	1.06E+05	4.62E+08	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	4.35E+07	2.75E+10	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	2.57E+09	
2019	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00357	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.34E+10	4.51E+09	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.31E+04	5.82E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	3.27E+05	3.43E+08	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.49E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	4.70E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	4.86E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	2.01E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	5.95E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	2.11E+07	
2019	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	8.70E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	2.20E+06	
2019	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	2.7	
2019	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0396	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	7.82E+05	
2019	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2019	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.035	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.41E+11	3.73E+10	
2019		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	4.90E+03	6.75E+06	
2019		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	3.90E+04	4.52E+07	
2019		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0015	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.59E+11	2.52E+10	
2019		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	4.21E+04	4.06E+07	
2019		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	6.86E+12	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.34E+14	1.93E+13	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	2.59E+11	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	6.50E+12	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	9.67E+07	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.05E+08	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	2.64E+15	NRM | NRS	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	2.74E+05	6.88E+08	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	8.01E+07	2.84E+10	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	8.72E+09	
2018	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.036	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.31E+10	NRM | NRS	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.13E+04	3.90E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	1.70E+05	1.94E+08	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.16E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	2.32E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	1.84E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	4.21E+06	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	3.21E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.51E+07	
2018	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	3.60E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	1.00E+06	
2018	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	1.3	
2018	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	7.00E+05	
2018	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.5	
2018	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	5.68E+09	Releases from non-routine operations | Rejets des opérations anormales
2018	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	14.6	Releases from non-routine operations | Rejets des opérations anormales
2018	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0275	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	7.96E+11	2.73E+10	
2018		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	3.07E+03	1.18E+07	
2018		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	4.55E+04	1.97E+07	
2018		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Carbon-14	Carbone-14	Bq	1.51E+09	NRM | NRS	
2018		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0017	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.08E+11	1.80E+09	
2018		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	4.23E+04	5.91E+07	
2018		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	4.64E+12	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.53E+14	3.81E+13	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	4.91E+11	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	6.50E+12	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	5.30E+08	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	3.78E+08	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.16E+16	NRM | NRS	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	3.05E+05	7.66E+08	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	7.20E+07	4.17E+10	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	1.66E+10	
2017	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.087	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	5.03E+10	NRM | NRS	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.34E+04	3.88E+07	

2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.24E+05	2.97E+08	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Uranium-total	Uranium total	Bq	NRM | NRS	1.69E+07	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-239/240	Plutonium-239/240	Bq	NRM | NRS	1.20E+07	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Plutonium-238	Plutonium-238	Bq	NRM | NRS	8.69E+06	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Americium-241	Américium-241	Bq	NRM | NRS	5.10E+06	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	6.67E+07	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.89E+07	
2017	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	4.80E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	1.00E+06	
2017	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	1.4	
2017	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00571	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	8.00E+05	
2017	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.1	
2017	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	1.59E+10	Releases from non-routine operations | Rejets des opérations anormales
2017	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	110.1	Releases from non-routine operations | Rejets des opérations anormales
2017	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0045	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.12E+11	3.57E+10	
2017		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	1.64E+03	1.12E+07	
2017		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	2.29E+04	2.56E+07	
2017		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0021	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.48E+12	3.58E+13	
2017		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	1.84E+05	1.80E+08	
2017		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	2.55E+12	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.45E+14	3.50E+13	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	4.85E+11	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	3.97E+14	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.91E+08	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	5.17E+10	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.07E+16	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	3.12E+15	NRM | NRS	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	3.06E+05	6.60E+08	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	1.53E+08	3.22E+10	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	7.30E+09	
2016	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.078	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.24E+10	NRM | NRS	
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.46E+04	4.59E+07	
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.12E+05	2.83E+08	
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	6.08E+07	
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.28E+07	
2016	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	7.50E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	2.40E+06	
2016	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	15.6	
2016	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00543	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	3.30E+06	
2016	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	19.3	
2016	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.01195	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.59E+11	2.23E+10	
2016		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross alpha	Particules alpha brutes	Bq	1.68E+03	9.00E+06	
2016		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	1.91E+04	1.05E+07	
2016		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0016	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.53E+11	6.57E+10	
2016		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	4.30E+04	3.57E+07	
2016		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	4.77E+12	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.77E+14	3.94E+13	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	3.77E+11	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	1.20E+15	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	3.44E+08	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.03E+11	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.29E+16	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	4.89E+15	NRM | NRS	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	3.51E+05	6.94E+08	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	3.14E+07	3.96E+10	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	6.70E+10	
2015	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.083	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	9.88E+10	NRM | NRS	
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.79E+04	4.08E+07	
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.26E+05	2.28E+08	
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	3.96E+07	
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	1.65E+07	
2015	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.001	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	4.60E+06	
2015	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	29.0	
2015	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0084	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	4.50E+06	
2015	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	20.7	
2015	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.09352	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.33E+10	4.24E+10	
2015		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	NRM | NRS	7.31E+07	
2015		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0029	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.15E+11	6.61E+10	
2015		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	4.81E+04	4.13E+06	
2015		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	1.37E+12	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.60E+14	3.07E+13	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	8.69E+11	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	2.11E+15	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.62E+08	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.06E+11	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	9.37E+15	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	8.68E+15	NRM | NRS	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	4.81E+05	9.07E+08	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	4.82E+07	2.62E+11	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	2.26E+11	
2014	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.06	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.48E+10	NRM | NRS	
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	8.82E+04	4.76E+07	
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	3.97E+05	9.31E+07	
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	6.61E+07	
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	2.66E+07	
2014	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.002	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	5.40E+06	
2014	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	36.7	
2014	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.00383	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	7.70E+06	
2014	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	23.0	
2014	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.02867	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.74E+11	5.19E+10	
2014		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	NRM | NRS	6.37E+07	
2014		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.002	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.63E+11	9.60E+10	
2014		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	5.27E+04	6.08E+06	
2014		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Elemental Tritium (HT)	Tritium élémentaire	Bq	1.59E+12	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Tritium (HTO)	Tritium (Eau tritiée)	Bq	2.46E+14	2.91E+13	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Carbon-14	Carbone-14	Bq	5.74E+11	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Total noble gases	Total des gaz nobles	Bq-MeV	1.32E+15	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.84E+08	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.38E+11	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	8.46E+15	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	5.72E+15	NRM | NRS	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross alpha	Particules alpha brutes	Bq	4.22E+05	5.62E+08	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Particulate gross beta	Particules bêta brutes	Bq	3.84E+07	3.62E+10	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Strontium-90	Strontium-90	Bq	NRM | NRS	1.51E+10	
2013	3147	Canadian Nuclear Laboratories / Lal	Chalk River Laboratories	Chalk River	Deep River	Renfrew	Kingston--Per	ON	46.0554	-77.3628	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.05914	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Tritium (HTO)	Tritium (Eau tritiée)	Bq	3.52E+10	NRM | NRS	
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross alpha	Particules alpha brutes	Bq	9.24E+04	1.14E+08	
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Particulate gross beta	Particules bêta brutes	Bq	2.29E+05	3.86E+08	
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Strontium-90	Strontium-90	Bq	NRM | NRS	6.97E+07	
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Cesium-137	Césium-137	Bq	NRM | NRS	6.40E+07	
2013	7434	Canadian Nuclear Laboratories / Lal	Whiteshell Laboratories	Pinawa	Pinawa	Division No	Southeast / S	MB	50.1789	-96.0604	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.002	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Radium-226	Radium-226	Bq	NRM | NRS	5.00E+06	
2013	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	49.2	
2013	30760	Canadian Nuclear Laboratories / Lal	Port Granby Project	Clarington				ON	43.9106	-78.4511	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.003	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Radium-226	Radium-226	Bq	NRM | NRS	6.20E+06	
2013	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	25.4	
2013	30761	Canadian Nuclear Laboratories / Lal	Port Hope Project	Port Hope				ON	43.9608	-78.3407	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Tritium (HTO)	Tritium (Eau tritiée)	Bq	1.59E+11	8.73E+10	
2013		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Particulate gross beta	Particules bêta brutes	Bq	NRM | NRS	5.31E+07	
2013		Canadian Nuclear Laboratories / Lal	Douglas Point	Tiverton	Kincardine		Stratford--Bru	ON	44.3267	-81.6000	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	0.0013	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Tritium (HTO)	Tritium (Eau tritiée)	Bq	6.86E+10	1.41E+11	
2013		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Particulate gross beta	Particules bêta brutes	Bq	6.63E+04	9.76E+05	
2013		Canadian Nuclear Laboratories / Lal	Nuclear Power Demonstration	Rolphton				ON	46.1868	-77.6578	Estimated public dose (see footnote)	Dose estimée au public (voir note de b	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)

Environment Canada Environnement Canada

Guide for Reporting
to the National Pollutant Release Inventory (NPRI)
2012 and 2013

Canadian Environmental Protection Act, 1999 (CEPA 1999)

Canada

Guide for Reporting

to the National Pollutant Release Inventory (NPRI)

2012 and 2013

Canadian Environmental Protection Act, 1999 (CEPA 1999)

Contact Information

For more information on the National Pollutant Release Inventory (NPRI), including guidance materials, annual summary reports, and access to NPRI data, consult the NPRI website at www.ec.gc.ca/inrp-npri. Questions and requests for assistance can be directed to Environment Canada using the "Contact the NPRI" form on the NPRI website (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=D212BD29-1), or through the following:

National Pollutant Release Inventory
Environment Canada
Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Tel.: 1-877-877-8375
Fax: 819-953-0461
Email: inrp-npri@ec.gc.ca

Disclaimer

Should any inconsistencies be found between this guide and the official *Canada Gazette*, Part I *Notice with respect to substances in the National Pollutant Release Inventory for 2012 and 2013*, published on December 29, 2012, the Notice will prevail.

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Acknowledgements

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1. Introduction

The National Pollutant Release Inventory (NPRI) is Canada's legislated, publicly accessible inventory of pollutant releases, disposals and recycling. Sections 46–53 of the *Canadian Environmental Protection Act*, *1999* (CEPA 1999) contain information-gathering provisions that allow the Minister of the Environment to require reporting of information on substances. The provisions also require the Minister to establish and publish a national inventory of releases and transfers of pollutants. These provisions under CEPA 1999 form the primary legislative basis for the NPRI. The NPRI reporting requirements for the 2012 and 2013 reporting years were published in the *Notice with respect to substances in the National Pollutant Release Inventory for 2012 and 2013* in the *Canada Gazette*, Part I, on December 29, 2012.

NPRI information is a major starting point for identifying and monitoring sources of pollution in Canada, and in developing indicators for the quality of our air, land and water. The NPRI helps determine if regulatory or other action is necessary to ensure reductions, and if so, the form that action should take. The NPRI provides Canadians with annual information on industrial, institutional, commercial and other releases and transfers in their communities.

This guide is designed to assist facility owners and operators in understanding the NPRI reporting requirements, and in determining if they are required to report to the NPRI. It provides a general overview of the reporting requirements for all NPRI substances, and provides information on additional guidance materials that address specific sectors, activities and substances.

2. Reporting Deadline and Changes to Reporting Requirements

2.1 Reporting Deadline

Reporting is mandatory for facilities that meet the requirements of the NPRI Notice published in the *Canada Gazette*, Part I.

The deadline for reporting to the NPRI for the 2012 calendar year is June 1, 2013. Because June 1, 2013, is a Saturday, reports for 2012 will be considered on time if they are submitted by **Monday, June 3, 2013**.

The deadline for reporting to the NPRI for the 2013 calendar year is June 1, 2014. Because June 1, 2014, is a Sunday, reports for 2013 will be considered on time if they are submitted by **Monday, June 2, 2014**.

Facilities that are required to report to other jurisdictions (for example, reporting under the Ontario *Toxics Reduction Act, 2009*) are advised to verify the correct reporting deadlines with those jurisdictions.

2.2 Changes to the Reporting Requirements for 2012 and 2013

2.2.1 No Changes to Reporting Requirements

There are no substantive changes to the reporting requirements for 2012 and 2013.

2.2.2 Gazette Notice Multi-Year Format

NPRI reporting requirements have been published annually in the *Canada Gazette*, Part I since the program was established. In the past, each Notice applied to a single calendar year (with the exception of the *Notice with respect to tailings and waste rock reporting under the National Pollutant Release Inventory for 2006 to 2008*). On December 29, 2012, a single Notice was published in the *Canada Gazette* that contains the reporting requirements for two years: 2012 and 2013. Because the notice applies to two years, the requirements described in this Guide also apply to the 2012 and 2013 calendar years.

Note that each year must be considered individually when determining if thresholds are met and if reporting is required. Quantities of substances that are released, disposed of and recycled should be reported for each separate year, by each reporting deadline indicated above.

3. General Information and Reporting Requirements

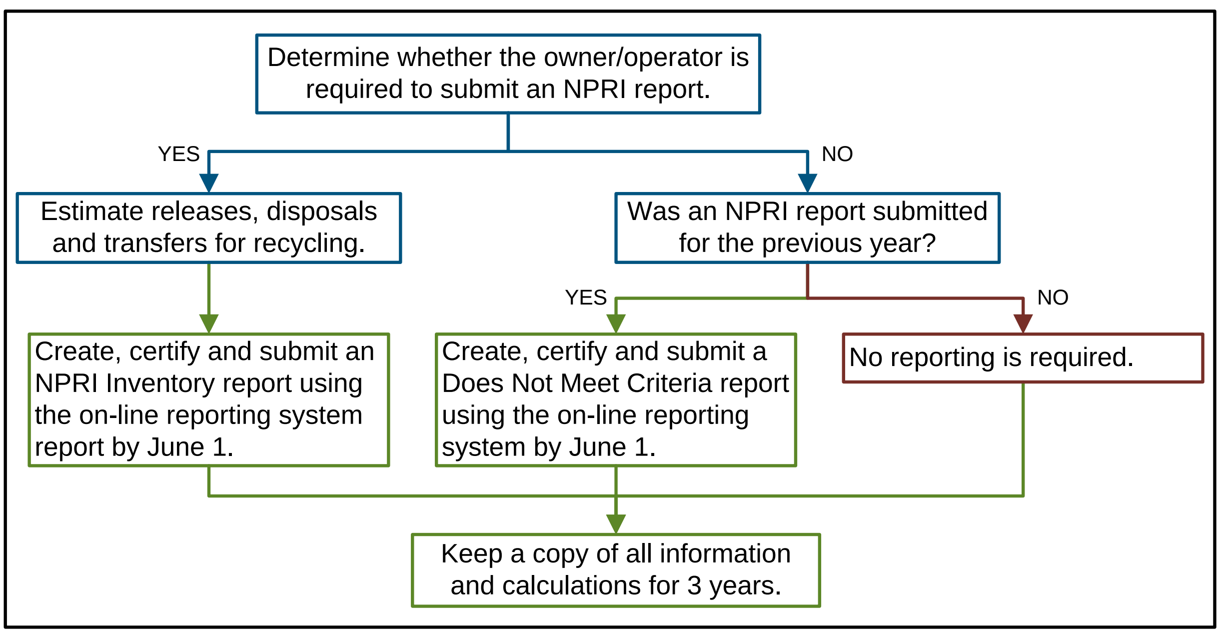
3.1 Introduction

This section summarizes the process for reporting to the NPRI, describes the legal basis for the NPRI, provides an overview of the NPRI reporting requirements, provides definitions of terms that are used throughout the Guide, and describes the information to be reported that applies to more than one group of substances. This section also provides information on additional resources that are available to assist in determining if a report is required for a facility, and on the methods for estimating quantities of releases, disposals and transfers for recycling. Details on reporting requirements and information to be reported that are specific to Parts 1 through 5 substances are presented in sections 4 through 9.

3.2 Process for Reporting to the National Pollutant Release Inventory

The NPRI reporting process is outlined in Figure 1. An NPRI report can be created and submitted to Environment Canada using the on-line reporting system, available through the NPRI website at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=F6300E68-1. Step-by-step instructions on the process of creating and submitting a report are available in the on-line reporting system.

Figure 1. Process for Reporting to the National Pollutant Release Inventory



3.3 The *Canada Gazette* Notice – The Legal Basis for the National Pollutant Release Inventory

The legal basis for the NPRI is the *Notice with respect to substances in the National Pollutant Release Inventory for 2012 and 2013* published in the *Canada Gazette*, Part I (hereafter referred to as "the Notice"). The Notice is published under the authority of subsection 46(1) of CEPA 1999, and specifies that any person who owned or operated a facility during the 2012 or 2013 calendar years, under the conditions prescribed in the Notice, must provide certain information to the Minister of the Environment by the reporting deadline for that calendar year.

The owner or operator of that facility as of December 31st of a given year is required to report to the NPRI, whether or not the ownership of a facility changes during the calendar year. If operations at a facility are terminated during the calendar year, it is the last owner or operator of the facility that is required to report.

Companies that meet reporting requirements but fail to report, fail to report on time, or knowingly submit false or misleading information, face penalties as listed under sections 272 and 273 of CEPA 1999. Facilities that did not meet the reporting criteria or were exempt from reporting in previous years should review their status to determine whether they are required to report for the current reporting year.

The Notice encompasses a wide range of substances and groups of substances, reporting criteria and requirements. It is divided into four schedules with several parts in each, as described in Table 1. For the complete list of NPRI substances, consult the NPRI website at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E2BFC2DB-1.

Table 1. Overview of the National Pollutant Release Inventory *Canada Gazette* Notice

Schedule	Part	Contents
1 – List of Substances	1	Lists 237 substances and groups of substances and is divided into Groups A and B, based on thresholds and information to be reported (referred to as Part 1A and Part 1B substances)
	2	Lists 29 individual polycyclic aromatic hydrocarbons (PAHs)
	3	Lists 7 dioxins, 10 furans and hexachlorobenzene (HCB)
	4	Lists 7 criteria air contaminants (CACs)
	5	Lists 75 selected volatile organic compounds (VOCs) and groups of VOCs with additional reporting requirements (speciated VOCs)
2 – Definitions	n/a	Provides definitions of the terms used in the Notice
3 – Reporting Criteria	General	General reporting criteria, including the reporting deadline, the employee threshold, and exclusions and exemptions
	1	Criteria for substances listed in Schedule 1, Part 1
	2	Criteria for the PAHs listed in Schedule 1, Part 2
	3	Criteria for dioxins, furans and HCB listed in Schedule 1, Part 3
	4	Criteria for CACs listed in Schedule 1, Part 4
	5	Criteria for speciated VOCs listed in Schedule 1, Part 5

Schedule	Part	Contents
4 – Information to be Reported	General	General information required to be reported and manner of reporting
	Facility Information	Information to be reported on the facility, including name, identification codes, contacts and activities
	1	Information to be reported for substances listed in Schedule 1, Part 1
	2	Information to be reported for PAHs listed in Schedule 1, Part 2
	3	Information to be reported for dioxins, furans and HCB listed in Schedule 1, Part 3
	4	Information to be reported for CACs listed in Schedule 1, Part 4
	5	Information to be reported for speciated VOCs listed in Schedule 1, Part 5

3.4 Overview of the National Pollutant Release Inventory Reporting Requirements

This section provides a brief overview of what facilities are required to report and the reporting thresholds, which are described in detail in Sections 4 through 9 of this Guide. In general, an NPRI report is required for any facility:

- where employees work a total of ≥ 20 000 hours (the employee threshold) (see section 3.6.1);
- where specified activities to which the employee threshold does not apply take place (see section 3.6.2);
- where the employee threshold is not met, but the reporting criteria for CACs are met; or
- that is a pipeline installation (defined in section 3.5.1)

and that meets any of the other reporting criteria (e.g., mass, concentration or activity thresholds).

The groups of substances have various thresholds (e.g., mass, concentration, activity, etc.) that are specified in Schedule 3 of the Notice. The thresholds are summarized in Table 2.

Table 2. Overview of National Pollutant Release Inventory Reporting Thresholds

Part	Substances	Mass Threshold	Thresholds
1A	• 230 substances and groups of substances	10 tonnes	**TOTAL** quantity of a substance: • manufactured, processed or otherwise used at a concentration by weight of ≥ 1%, **plus** • incidentally manufactured, processed or otherwise used as a by-product at any concentration, **plus** • contained in tailings disposed of during the calendar year at any concentration, **plus** • contained in waste rock disposed of during the calendar year at a concentration by weight of ≥ 1%
1B	• Mercury	5 kilograms	**TOTAL** quantities of mercury at any concentration: • manufactured, processed or otherwise used, **plus** • incidentally manufactured, processed or otherwise used as a by-product, **plus** • contained in tailings disposed of during the calendar year, **plus** • contained in waste rock disposed of during the calendar year

Part	Substances	Mass Threshold	Thresholds
1B	• Cadmium	5 kilograms	**TOTAL** of the quantity of a substance: • manufactured, processed or otherwise used at a concentration by weight of ≥ 0.1%, **plus** • incidentally manufactured, processed or otherwise used as a by-product at any concentration, **plus** • contained in tailings disposed of during the calendar year at any concentration, **plus** • contained in waste rock disposed of during the calendar year at any concentration
	• Arsenic • Hexavalent chromium • Lead • Tetraethyl lead	50 kilograms	
	• Selenium	100 kg	**TOTAL** of the quantity of selenium: • manufactured, processed or otherwise used at a concentration by weight of ≥ 0.000005%, **plus** • incidentally manufactured, processed or otherwise used as a by-product at any concentration, **plus** • contained in tailings disposed of during the calendar year at any concentration, **plus** • contained in waste rock disposed of during the calendar year at any concentration
2	• 29 polycyclic aromatic hydrocarbons (PAHs)	50 kilograms	**TOTAL** of the quantities of PAHs at any concentration: • incidentally manufactured and released, disposed of or transferred for recycling, **plus** • contained in tailings disposed of during the calendar year
		Any quantity	Where wood preservation using creosote takes place, reporting is mandatory regardless of quantities or concentrations.
3	• 7 dioxins • 10 furans • Hexachlorobenzene (HCB)	Any quantity	Where specified activities take place, reporting is mandatory regardless of quantities or concentrations.
4	• Carbon monoxide • Nitrogen oxides • Sulphur dioxide • Total particulate matter	20 tonnes	Quantity released to air (no concentration threshold applies)
	• Volatile organic compounds (VOCs)	10 tonnes	
	• Particulate matter ≤ 10 micrometres (PM_{10})	0.5 tonnes	
	• Particulate matter ≤ 2.5 micrometres ($PM_{2.5}$)	0.3 tonnes	
5	• 75 speciated VOCs (individual VOCs, isomer groups and other groups and mixtures)	1 tonne	Quantity released to air, provided that ≥ 10 tonnes of total VOCs are released to air (no concentration threshold applies)

3.5 Definitions

A comprehensive glossary of terms and expressions used by the NPRI is available on the NPRI website at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=9264E929-1. The following sections provide definitions for some of the most common terms and expressions.

3.5.1 Facilities

The term "facility" refers to a contiguous facility, a portable facility, a pipeline installation or an offshore installation, as defined below. The reporting requirements for Part 1 substances apply to contiguous facilities and offshore installations. The requirements for Parts 2 and 3 substances apply to contiguous, portable and offshore facilities. Parts 4 and 5 substance requirements apply to all four types of facilities: contiguous, portable, pipeline and offshore.

Contiguous facility

A contiguous facility is defined as all buildings, equipment, structures and stationary items that are located on a single site, or on contiguous sites or adjacent sites, that are owned or operated by the same person and that function as a single integrated site, including wastewater collection systems that release treated or untreated wastewater into surface waters.

Portable facility

A portable facility is defined as portable polychlorinated biphenyl (PCB) destruction equipment, portable asphalt plants and portable concrete batching plants. The definition applies where the facility can be entirely relocated for operation.

Pipeline installation

A pipeline installation is defined as a collection of equipment, situated at a single site, used in the operation of a natural gas transmission or distribution pipeline. This definition includes pipeline compressor and storage stations along pipelines used to transport both raw and processed natural gas. Pipeline installations are subject only to the reporting criteria for CACs (Part 4 substances) and speciated VOCs (Part 5 substances).

Offshore installation

An offshore installation is defined as an offshore drilling unit, production platform or ship, or subsea installation that is related to the exploitation of oil or natural gas and that is attached or anchored to the continental shelf of Canada or within Canada's exclusive economic zone.

3.5.2 Reporting Thresholds

Manufacture

The term "manufacture" means to produce, prepare or compound an NPRI substance. It also includes the incidental production of an NPRI substance as a by-product.

Examples of manufacture

The production of chlorine dioxide by a chemical plant is an example of manufacturing. The production of hydrochloric acid during the manufacture of chlorofluorocarbons is an example of the incidental manufacture of hydrochloric acid.

Process

The term "process" means the preparation of an NPRI substance, after its manufacture, for distribution in commerce. Processing includes the preparation of a substance with or without changes in physical state or chemical form. The term also applies to the processing of a mixture or formulation that contains an NPRI substance as one component, the processing of articles (see below for the definition of article), and the processing of a substance as a by-product.

Examples of process

The use of chlorine to manufacture hypochloric acid (not an NPRI substance) is an example of processing of chlorine. The use of toluene and xylene to blend paint solvent mixtures is an example of processing without changes in chemical form.

Other use or otherwise used

The terms "other use" and "otherwise used" mean any use, disposal or release of an NPRI substance that does not fall under the definitions of manufacture or process. This includes the use of the substance as a chemical processing aid, manufacturing aid or some other ancillary use, and the other use of by-products. Certain uses of substances are excluded. These are listed in Table 4 below.

Example of other use

The use of trichloroethylene in the maintenance of manufacturing and process equipment is considered an other use of that substance.

By-product

Before the by-product requirements were created, large-volume, low-concentration releases and disposals were not being reported to the NPRI because of the concentration thresholds for Part 1 substances. The by-product requirements were created to ensure that these releases and disposals are reported since the overall quantities of by-products can be significant, even though their concentration may be low.

The term "by-product" refers to the quantity of an NPRI Part 1 substance that is ***incidentally*** **manufactured, processed or otherwise used** at the facility **at any concentration**, and **released to the environment or disposed of**. The quantity of a substance that is recycled or that remains in the final product is not considered to be a by-product for the purpose of the NPRI threshold calculation.

In general, if a quantity of a substance is ***intentionally*** **manufactured, processed or otherwise used** at a facility, then that quantity of the substance is **not a by-product**, even if it is unintentionally manufactured, processed or otherwise used at another step in the process.

The quantity of a substance that is a by-product must be included in the calculation of the reporting threshold, regardless of concentration. The by-product requirements only apply to Part 1 substances and are only used for the purpose of determining whether or not the mass threshold for a substance has been met.

Examples of by-products

Hydrogen fluoride is incidentally manufactured and released during aluminum smelting. Therefore, the hydrogen fluoride is a by-product and must be included in the calculation of the reporting threshold, regardless of concentration.

Manganese and nickel are incidentally present in coal and are therefore by-products of the coal combustion process. During combustion, a portion of these metals is concentrated in the ash, which is disposed of, and a portion of the metals is released in stack emissions. The weight of the metal released from the stack and in the ash sent for disposal must be included in the calculation of the reporting threshold, regardless of concentration.

Metal cuttings, sent for disposal, contain alloyed chromium and nickel at a concentration of less than 1%. The chromium and nickel are essential components of the alloy; therefore they are not incidentally processed and are not considered to be by-products. Therefore, the chromium and nickel in the metal cuttings do not need to be included in the calculation of the reporting threshold, because the substances are present at a concentration less than the concentration threshold of 1%.

Article

An "article" is defined as a manufactured item that does not release an NPRI substance when it undergoes processing or other use. When articles are processed or otherwise used, and there are no releases, or the releases are recycled with due care, the NPRI substances in that article do not need to be included in the threshold calculation.

Exercising due care means that the facility generated less than one kilogram of a Part 1A substance as waste during the year. There is no quantitative measure of due care in recycling Part 1B substances, because even minimal releases of these substances can cause significant adverse effects and can reasonably be expected to contribute to exceeding their low thresholds. Therefore, if an article containing a Part 1B substance is processed or otherwise used and there are releases, the Part 1B substance in the article must be included in the threshold calculation.

Examples of articles

In an instance where a metal reclamation facility accepts spent lead-acid batteries for recycling, and the batteries are broken into pieces in a hammer mill and their parts (sulphuric acid, lead and plastic) are subsequently reclaimed, the batteries lose their article status, because they are broken apart during the recycling process. The metal reclamation facility is now required to report any NPRI substances from these batteries if the thresholds are met.

A sealed glass bulb containing mercury used in a leveling switch meets the definition of an article. However, the quantity of mercury in the switch must be included in a facility's calculation of the reporting threshold if the item loses its article status (e.g., the bulb is broken during waste management operations, thus allowing a release of mercury). As long as the bulbs remain intact, they are considered articles and are therefore not included in calculating the reporting threshold.

Tailings

The term "tailings" is defined as the waste material, which may or may not be mixed with water, that remains after processing of ore or mined materials, in order to extract marketable components such as metals, minerals or bitumen. This can include ground rock material, sand, clay, process chemicals or residual metals, minerals or bitumen, petroleum coke (petcoke) and sulphur.

Waste rock

"Waste rock" is rock that is removed in the mining process to provide access to the ore, and is not further processed during the reporting year. Waste rock does not include unconsolidated overburden, which is defined as unconsolidated materials overlying the ore (or bitumen) deposit, including, but not limited to, soil, glacial deposits, sand and sediment.

3.5.3 Releases, Disposals and Transfers

On-site releases

An on-site release is a discharge of a substance to the environment within the physical boundaries of the facility. This includes:

- emissions to air: discharges through a stack, vent or other point of release, losses from storage and handling of materials, fugitive emissions (releases that cannot be captured and releases that are unintentional), spills and accidental releases, other non-point releases, and road dust (particulate matter only);
- releases to surface waters: direct discharges, spills and leaks, but not including discharges to municipal wastewater treatment plants (which are reported under off-site transfers for treatment); and
- releases to land: spills, leaks and other releases.

On-site disposals

On-site disposals include the following:

- total quantities of substances sent for final disposal to landfill, land application or underground injection on the facility site; and
- net quantities of substances that are moved into an on-site area where tailings or waste rock are discarded or stored and further managed to reduce or prevent releases.

Off-site disposals

Off-site disposals include total quantities that are transferred off the facility site to:

- landfill, land application or underground injection;
- storage prior to final disposal;
- treatment prior to final disposal (see below); and
- an area where tailings or waste rock are discarded or stored and further managed to reduce or prevent releases.

Off-site transfers for treatment prior to final disposal

A substance may be transferred to a location off the facility site for treatment prior to final disposal. Treatment processes include:

- physical treatment (e.g., drying, evaporation, encapsulation or vitrification);
- chemical treatment (e.g., precipitation, stabilization or neutralization);
- biological treatment (e.g., bio-oxidation);
- incineration or thermal treatment, where energy is not recovered; and
- treatment at a municipal sewage treatment plant.

Off-site transfers for recycling and energy recovery

A substance may be transferred to a location off the facility site for recycling and energy recovery. Recycling refers to activities that keep a material or a component of the material from becoming a waste destined for final disposal. Ten types of recycling operations are identified:

- energy recovery
- recovery of solvents
- recovery of organic substances (not solvents)
- recovery of metals and metal compounds
- recovery of inorganic materials (not metals)
- recovery of acids or bases
- recovery of catalysts
- recovery of pollution abatement residues
- refining or reuse of used oil
- other recovery, reuse or recycling activities

3.6 Facilities to Which the NPRI Reporting Requirements Apply

The NPRI reporting requirements apply to a facility:

- where the employee threshold is met (see section 3.6.1);
- where activities to which the employee threshold does not apply take place (see section 3.6.2);
- where the employee threshold is not met, but the reporting criteria for Part 4 substances are met; or
- that is a pipeline installation (defined in section 3.5.1)

and that meets any of the other reporting criteria (e.g., mass and concentration thresholds).

3.6.1 Employee Threshold

Facilities where the employees work a total of 20 000 hours or more during the calendar year (the employee threshold) are required to report to the NPRI, if the thresholds for at least one substance are met, or if an activity-based threshold is met. The employee threshold depends on the number of hours worked by all employees at the facility during the calendar year. This includes:

- all hours worked by individuals employed at the facility, including students, part-time and term employees;
- all hours worked by the owner(s) who performed work on-site at the facility;

- all hours worked by a person, such as a contractor, who performed work at the facility that is related to the operations of the facility; and
- all paid vacation and sick leave.

The employee threshold must be met by most facilities before they need to consider reporting for Parts 1 through 3 substances, unless activities to which the employee threshold does not apply (see section 3.6.2) take place at the facility.

3.6.2 Activities to Which the Employee Threshold Does Not Apply

If one or more of the activities listed in Table 3 take place at the facility, the owner/operator of the facility must report to the NPRI, regardless of the number of hours worked by employees (provided that other reporting criteria, such as mass and concentration thresholds [see Table 2], are also met). The employee threshold does not apply to these activities because they release significant quantities of NPRI substances to the environment, while not necessarily meeting the employee threshold. Descriptions of these activities are provided below.

In addition to the activities listed in Table 3, the employee threshold does not apply to facilities where stationary combustion equipment is operated, for the purposes of reporting Part 4 and 5 substances. Facilities that operate stationary combustion equipment must report for Parts 4 and 5 substances regardless of employee hours, provided the release thresholds are met.

Table 3. Activities to Which the Employee Threshold Does Not Apply

Activity
Non-hazardous solid waste incineration of ≥ 26 tonnes of waste, including, but not limited to, conical burners and beehive burners
Biomedical or hospital waste incineration of ≥ 26 tonnes of waste
Hazardous waste incineration
Sewage sludge incineration
Wood preservation (using heat or pressure treatment, or both)
Terminal operations
Discharge of treated or untreated wastewater from a wastewater collection system discharging an average of ≥ 10 000 m^3/day into surface waters
Operations at pits or quarries where production is ≥ 500 000 tonnes

Incineration

A waste incinerator is a device, mechanism or structure constructed primarily to thermally treat (e.g., combust or pyrolyze) waste for the purpose of reducing its volume, or destroying hazardous chemicals or pathogens present in the waste. This includes facilities where waste heat is recovered as a by-product from the exhaust gases of an incinerator (e.g., energy-from-waste incinerators), conical burners and beehive burners. This does not include industrial processes where fuel derived from waste is fired as an energy source, such as industrial boilers. For example, if bark, wood chips or other wood waste is used as fuel to fire a boiler, these activities are not considered energy-from-waste incinerators.

Non-hazardous solid waste incineration

Non-hazardous solid waste is any solid waste, regardless of origin, that, if not incinerated, might normally be disposed of in a non-secure manner (e.g., at a sanitary landfill site). It includes clean wood waste (i.e., waste from woodworking or forest product operations, including bark, where the wood waste has not been treated with preservative chemicals or decorative coatings), and residential and other municipal wastes.

Biomedical or hospital waste incineration

Biomedical or hospital waste is waste that is generated by:

- human or animal health-care facilities;
- medical or veterinary research and testing establishments;
- health-care teaching establishments;
- clinical testing or research laboratories; and
- facilities involved in the production or testing of vaccines.

Biomedical or hospital waste includes human anatomical waste, animal waste, microbiology laboratory waste, human blood and body fluid waste, and waste sharps. It does not include waste that is from animal husbandry, is household in origin, or is controlled in accordance with the *Health of Animals Act*. Household wastes or wastes that are generated in food production, general building maintenance and office administration activities of those facilities to which this definition applies are considered to be non-hazardous waste, not biomedical or hospital waste. For more information, consult www.ccme.ca/assets/pdf/pn_1060_e.pdf.

Hazardous waste incineration

Hazardous waste includes wastes that are potentially hazardous to human health and/or the environment because of their nature and quantity, and that require special handling techniques. They are defined by taking into account the hazard criteria established under the *Transportation of Dangerous Goods Regulations* (www.tc.gc.ca/eng/tdg/clear-tofc-211.htm) as well as wastes and materials specifically listed in the Schedules of the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (www.ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=84). This includes hazardous waste incinerated in a mobile incinerator temporarily located at a facility.

Sewage sludge incineration

Sludge is a semi-liquid mass removed from a liquid flow of wastes. Sewage sludge is sludge from a facility treating wastewater from a sewer system. The drying of sludge to reduce water content is part of the incineration stage.

Wood preservation

Wood preservation is the use of a preservative for the preservation of wood by means of heat or pressure treatment, or both, and includes the manufacture, blending or reformulation of wood preservatives for that purpose. For more information, consult the *Guidance for Wood Preservation Facilities Reporting to the NPRI*, available at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=29B3E589-1.

Terminal operations

Terminal operations are either (i) the use of storage tanks and associated equipment at a site used to store or transfer crude oil, artificial crude or intermediates of fuel products into or out of a pipeline; or (ii) the operating activities of a primary distribution installation, normally equipped with floating roof tanks, that receives gasoline by pipeline, railcar, marine vessel or directly from a refinery. Terminal operations do not include bulk plants or service stations.

Wastewater collection systems

A wastewater facility is a wastewater collection system that discharges treated or untreated wastewater into surface waters. Therefore, a wastewater system includes both the collection components (a system of sewers and/or ditches that convey sanitary or combined sewage for a community) and treatment components (a plant or process location that accepts collection-system flows for the purposes of removing substances from the wastewater). For more information, consult the *NPRI Guidance Manual for the Wastewater Sector*, available at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=86E3D932-1, and *Identification of Wastewater Treatment System Configuration and Process Characteristics*, available at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=57FBBE31-1.

Pits and quarries

A pit is an excavation that is open to the air, and any associated infrastructure, that is operated for the purpose of extracting sand, clay, marl, earth, shale, gravel, unconsolidated rock or other unconsolidated materials, but not bitumen.

A quarry is an excavation that is open to the air, and any associated infrastructure, that is operated for the purpose of working, recovering or extracting limestone, sandstone, dolostone, marble, granite or other consolidated rock.

For more information on reporting for pits and quarries, consult *Pits and Quarries Guidance*, available at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=A9C1EE34-1.

3.7 Exemptions and Exclusions

3.7.1 Facilities Exempt from All NPRI Reporting Requirements

Two types of facilities are exempt from reporting to the NPRI:

- facilities used exclusively for oil and gas exploration or the drilling of oil and gas wells; these are the only types of oil and gas facilities exempt from reporting to the NPRI; and
- pits and quarries where annual production is < 500 000 tonnes.

3.7.2 Exclusions for All Substances

The quantity of a substance contained in any item listed in Table 4 should not be included when calculating and reporting releases, disposals or transfers for recycling. In addition, vehicle emissions (not including unpaved road dust) should not be considered when calculating the thresholds and when reporting releases, disposals or transfers for recycling. A vehicle is any mobile equipment that is capable of self-propulsion, including fleet vehicles and earth-moving equipment (e.g., loaders, dump trucks, forklifts, excavators and bulldozers).

Table 4. Items Not Considered when Reporting to the National Pollutant Release Inventory

Articles that are processed or otherwise used(1)
Materials used as structural components of the facility (buildings and other fixed structures), but not process equipment
Materials used in janitorial or facility grounds maintenance(2)
Materials used for personal use by employees or other persons
Intake water or intake air, such as water used for process cooling or air used either as compressed air or for combustion

(1) See section 3.5.2 for the definition of an article.

(2) This includes NPRI substances contained in fertilizers and pesticides used for grounds maintenance, and cleaning agents used for maintaining facility cleanliness. The maintenance of process equipment (e.g., cleaning manufacturing equipment with a solvent) is not excluded.

3.7.3 Activities Exempt from Reporting for Parts 1-3 Substances

The threshold calculation for a substance must exclude the quantity of a substance that is manufactured, processed or otherwise used in the activities listed in Table 5. In cases where a facility met the reporting criteria for a substance based on sources other than those listed in Table 5, the quantity of that specific substance from any exempt activities should also not be included when reporting releases, disposals or transfers for recycling to the NPRI.

A facility is exempt from reporting Parts 1 through 3 substances if the only source or use of that substance is from one or more of the activities listed in Table 5. Note, however, that these facilities are not exempt from reporting releases of Parts 4 and 5 substances from stationary combustion equipment.

Table 5. Activities Not Considered when Reporting Parts 1, 2 and 3 Substances

Education or training of students (for example, universities, colleges and schools)
Research or testing
Maintenance and repair of vehicles (automobiles, trucks, locomotives, rail cars, ships or aircraft), except painting and stripping of vehicles or their components, or the rebuilding or remanufacturing of vehicle components(1)
Distribution, storage or retail sale of fuels, except as part of terminal operations(2)
Wholesale or retail sale of articles or products that contain the substance
Retail sale of the substance
Growing, harvesting or management of renewable natural resources
The practice of dentistry

(1) Substances used for activities involving routine, scheduled and preventative maintenance of vehicles are exempt (e.g., repair, cleaning, replacement of lubricants/fluids). However, substances used in the painting or stripping of vehicles or vehicle components are subject to reporting. There is no exemption for activities that involve the removal, breakdown and total reconstruction of vehicle components (e.g., engines, landing gear, traction motors) using recovered or new parts, such that the rebuilt component is reinstalled or sold as an as-new replacement.

(2) See section 3.5.2 for the definition of "terminal operations." The exemption for distribution, storage or sale of fuels does not include terminal operations.

3.7.4 Exclusions for Tailings and Waste Rock

Tailings and waste rock are defined in section 3.5.2. The following sections describe the exclusions for stable/inert constituents of tailings, unconsolidated overburden and inert waste rock. These exclusions apply only to substances **contained in** tailings and waste rock. If a substance is **released to air or water from** tailings or waste rock (e.g., in airborne dust or as effluent), the quantity of the substance released must then be included in threshold calculations.

Stable/inert constituents of tailings

Substances contained in certain materials in tailings should be excluded from threshold calculations and reporting (e.g., sand grains from bitumen mines or in-situ production of bitumen). In order to be excluded, these materials must:

- be inert,
- be inorganic, and
- not have been crushed or otherwise physically or chemically altered.

The exclusion applies only to the components of tailings that meet the above three criteria (i.e., if part of the tailings stream met the criteria, only that portion of the tailings would be excluded, and the remainder of the tailings would be included).

Unconsolidated overburden

Substances contained in unconsolidated overburden should be excluded from threshold calculations and reporting. Unconsolidated overburden is unconsolidated materials overlying the ore or bitumen deposit, including, but not limited to, soil, glacial deposits, sand and sediment.

Inert waste rock

Substances contained in inert or clean waste rock should be excluded from threshold calculations and reporting. Inert waste rock is defined as waste rock that:

- is inert or clean according to a federal or provincial operating permit; or
- has a sulphur concentration of $\leq 0.2\%$; or
- has a sulphur concentration of $> 0.2\%$, and the ratio of neutralizing potential to acid-generating potential is $\geq 3:1$.

There is one exception to the exclusion for inert or clean waste rock: even if waste rock is inert or clean as defined above, the quantity of arsenic in waste rock cannot be excluded if the concentration of arsenic is > 12 milligrams per kilogram of waste rock.

3.8 Methods of Estimation

Estimates of the quantity of a substance that is manufactured, processed or otherwise used, and of the quantity that is released, disposed of or transferred for recycling, may be based on one of the following methods:

- Continuous emission monitoring systems
- Predictive emission monitoring

- Source testing
- Mass balance
- Site-specific emission factor
- Published emission factor
- Engineering estimates

A description of these methods is provided in the following sections. Examples using these estimation methods can be found in the *NPRI Toolbox* (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=65A75CDF-1).

Information on releases, disposals and transfers for recycling needs to be reported if the owner/operator possesses the information or may reasonably be expected to have access to the information. The Notice specifies that if emissions are already monitored or measured under provincial or federal legislation or a municipal bylaw, those measurements must be used to report to the NPRI. If emissions are not monitored or measured under provincial or federal legislation or a municipal bylaw, reasonable efforts must still be undertaken to gather information on releases, disposals and transfers of a substance. What is "reasonable" depends on individual circumstances, but may include additional monitoring for NPRI substances.

In deciding whether additional efforts should be undertaken to generate new information for the purposes of NPRI reporting, the following factors, among others, should be considered:

- the health and environmental risks posed by a substance, including whether the substance has been declared toxic under CEPA 1999;
- the relative contribution of the industrial sector to releases, disposals and transfers for recycling of a substance in Canada;
- the relative contribution of the facility to releases, disposals and transfers for recycling of a substance in Canada; and
- the cost of additional monitoring.

Environment Canada is developing more detailed guidance that will outline suggested estimation methods, and will be recommending their use as they become available. For more information, consult the *NPRI Toolbox*.

3.8.1 Continuous Emission Monitoring Systems

Continuous emission monitoring systems (CEMS) record emissions over an extended and uninterrupted period. Once the concentration of a substance and the flow rate have been determined, emission rates can be calculated by multiplying the concentration by the discharge flow rate or volumetric stack gas flow rate. Annual emissions of the substance can then be estimated by multiplying the concentration by the annual flow rate of the discharged effluent or the gases in the stack or duct.

3.8.2 Predictive Emission Monitoring

Predictive emission monitoring (PEM) is based on developing a correlation between substance emission rates and process parameters (e.g., fuel usage, steam production, furnace temperature). PEM may be considered a hybrid of continuous monitoring, emission factors and stack tests. A correlation test must first be performed to determine the relationship between emission rates and process parameters. Emissions can then be calculated or predicted using process parameters to predict emission rates based on the results of the initial source test.

3.8.3 Source Testing

Source testing involves collecting a sample of the emission or effluent, then determining the concentration of one or more substances in the sample. The concentration of the substance(s) of interest is then multiplied by the volumetric flow rate to determine the quantity of the substance(s) emitted over time. Source testing of air emissions generally involves inserting a sampling probe into the stack or duct to collect a volume of exhaust effluent isokinetically. The substances collected in or on various media are subsequently analyzed. For liquid effluents, grab samples or 24-hour composite samples are extracted from the effluent stream.

3.8.4 Mass Balance

Mass balance involves applying the law of conservation of mass to a facility, process or piece of equipment. If there is no accumulation, all the materials that go into the system must come out. Releases are determined from the differences in input, output, accumulation and depletion of a substance. The general equation for a mass balance is:

$M_{in} = M_{out} + M_{accumulated/depleted}$

Where:

M_{in} = Mass of compound in the raw material feed

M_{out} = Mass of compound in the finished product and released to air, land and water

($M_{out} = M_{product} + M_{emitted}$)

$M_{accumulated/depleted}$ = Mass of compound accumulated or depleted in the system

The reliability of release estimates based on mass balances is dependent on the source type considered. Mass balance methods may be preferred for some releases, such as solvent use and loss. However, this method may not be suitable for many other sources, such as cases where chemical transformation of input streams occurs.

3.8.5 Site-Specific and Published Emission Factors

Generally, emission factors relate the quantity of substances emitted from a source to a common activity associated with those emissions. Emission factors may be published or developed by facilities using emission testing data and source-activity information. For a particular piece of equipment, specific emission factors may be available from the manufacturer or sales centre. The basic equations for determining emissions from emission factors are as follows:

$E_x = BQ \times CEF_x$ or

$$E_x = BQ \times EF_x \times \frac{100 - CE_x}{100}$$

Where:

E_x = Emission of substance x (kg or other unit of mass)

BQ = Activity rate or base quantity (base quantity unit)

CEF_x = Controlled emission factors of substance x (kg/BQ [dependent on any control devices installed])
EF_x = Uncontrolled emission factors of substance x (kg/BQ)
CE_x = Overall emission control efficiency of substance x (%)

3.8.6 Engineering Estimates

In many cases, sound engineering assessment is the most appropriate approach to determining process factors and base quantity values. Releases can be estimated from engineering principles and judgement by using knowledge of the chemical and physical processes involved, the design features of the source, and an understanding of the applicable physical and chemical laws. The reliability of these estimates depends on the complexity of the process and the level of understanding of its physical and chemical properties. To apply an engineering assessment method, follow these four basic principles:

1. Review all data pertaining to the specific source and to the industrial sector in general.
2. Use this data to provide gross approximations—and refine the approximations using sound engineering principles as data become available, in order to provide more accurate estimations.
3. Whenever possible, use alternate methods of calculation to cross-check each level of approximation.
4. Employ good record keeping.

3.8.7 Method Detection Limit

In NPRI reporting, there are several situations in which the issue of measurements below the method detection limit (MDL) arises. The MDL is the smallest concentration of the substance under analysis (i.e., the analyte) that produces an instrumental response and that meets all analyte detection and identification criteria of a specified test method. An indication that a reportable substance is below the MDL is not equivalent to stating that the substance is not present. If it is known that the substance is present, a concentration equivalent to half of the MDL should be used.

In a year where multiple measurements of the concentration of a substance in a given process stream are all below the MDL, and there is no other reason to believe that the substance is present, it can be assumed that the concentration of the substance in that process stream is zero.

In a year where multiple measurements are taken, and some measurements indicate that the concentration is above the MDL and some indicate that it is below the MDL, there is reason to assume that the substance is present. Therefore, a value of half the MDL should be used for those measurements where the concentration is below the MDL.

3.9 Sources of Information

Information required to perform threshold calculations and to estimate releases, disposals and transfers for recycling of NPRI substances is available from a variety of sources, including Environment Canada, the U.S. Environmental Protection Agency (EPA) and industry associations. These resources are described in the following sections. Useful information can also be found in Material Safety Data Sheets, and in permits and certificates of approval.

3.9.1 Environment Canada Guidance Documents and Tools

NPRI Toolbox

The *NPRI Toolbox* (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=65A75CDF-1) provides a number of tools:

- General Guidance
- General Information on Emission Factors and Emission Estimation Techniques
- Useful Equations and Conversion Factors
- Example Calculations
- Software
- Information on Fuel Combustion and Fugitive Emission Sources
- Sector-Specific Information
- Miscellaneous Resources and Other Relevant Links

The sections on fuel combustion and fugitive emission sources and the sector-specific pages of the *NPRI Toolbox* include links to calculation spreadsheets developed for specific activities and sectors. When information (such as production quantities or fuel used) is entered, these spreadsheets will automatically calculate releases of NPRI substances.

Guidance documents

In addition to this guide, Environment Canada has developed several substance-, activity- and sector-specific guidance documents to assist in reporting to the NPRI. Table 6 lists these documents and their Internet addresses.

Table 6. Environment Canada Guidance Documents

Type of Guidance	Title	Internet Address
Substances	*Criteria Air Contaminants (CACs) Technical Source Guide for Reporting to the National Pollutant Release Inventory*	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=3B695DF5-1
	Phosphorus Guidance	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=46C694F1-1
	Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory	www.ec.gc.ca/Publications/default.asp?lang=En&xml=4A2D4BB8-BFA0-4129-A5A3-DBA372BD3B32
	Determining the Reporting Threshold for Total Reduced Sulphur Using Equivalence Factors	www.ec.gc.ca/inrp-npri/default.asp?lang=en&n=AAECF4F6-1
Activities	*Guidance for the Reporting of Tailings and Waste Rock to the National Pollutant Release Inventory*	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=C115DEB3-1
	Guidance for the Reporting of Welding Activities	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=0FAE8C2F-1
	Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=5DF2CF83-1
	Wet Cooling Tower Guidance	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=2ED8CFA7-1

Type of Guidance	Title	Internet Address
Sectors	*Guidance for Wood Preservation Facilities Reporting to the NPRI*	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=29B3E589-1
	NPRI Guidance Manual for the Wastewater Sector	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=86E3D932-1
	Identification of Wastewater Treatment System Configuration and Process Characteristics	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=57FBBE31-1
	Pits and Quarries Guidance	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=A9C1EE34-1
	National Pollutant Release Inventory Reporting Guidance on Biosolids	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=FC674F4F-1
	Reporting Requirements for the Oil & Gas Sector	www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=5B72775D-1

3.9.2 U.S. Environmental Protection Agency Guidance Documents and Tools

The U.S. EPA has published numerous documents and software programs that can be used to assist facilities; these are described in Table 7.

Table 7. U.S. Environmental Protection Agency Guidance Documents and Tools

Guidance Document/Tool	Description	Internet Address
AP 42, Fifth Edition – *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*	Primary compilation of the U.S. EPA's emission factor information, containing emission factors and process information for more than 200 air pollution source categories	www.epa.gov/ttn/chief/ap42/index.html
Guidance Documents for reporting to the Toxics Release Inventory	Industry/process-specific and substance-specific guidance manuals to help estimate releases for reporting to the Toxics Release Inventory, which provide useful information for NPRI reporters	www.epa.gov/tri/guide_docs/index.htm
Locating and Estimating Documents	Compilations of available information on substances and sources of emissions	www.epa.gov/ttn/chief/le/index.html
Landfill Gas Emissions Model	Tool that can be used to estimate emission rates for non-methane organic compounds and individual air pollutants from municipal solid waste landfills	www.epa.gov/ttn/catc/products.html#software
PM Calculator	Contains information that allows the estimation of particulate matter fractions from total particulate matter	www.epa.gov/ttn/chief/tools/pm_calculator_condensibles.zip
SPECIATE	Repository of total organic compound and particulate matter speciation profiles for air pollution sources	www.epa.gov/ttn/chief/software/speciate/index.html
TANKS	Program that estimates volatile organic compound and hazardous air pollutant emissions from fixed- and floating-roof storage tanks	www.epa.gov/ttn/chief/software/tanks/index.html
WATER9	Program for estimating air emissions of individual waste constituents in wastewater collection, storage, treatment and disposal facilities	www.epa.gov/ttn/chief/software/water/water9_3/index.html
WebFIRE	The online Factor Information Retrieval (FIRE) database, which contains information on air emissions factors	http://cfpub.epa.gov/webfire/

3.9.3 Industry Association Guidance

Table 8 lists the industry association guidance available through the *NPRI Toolbox*.

Table 8. Industry Association Guidance Documents

Sector(s)	Association	Guidance
Mining; base metal smelting; iron ore pellets; potash mining	Mining Association of Canada	• *Reporting to the National Pollutant Release Inventory, An Interpretation Guide*
Chemicals manufacturing	Canadian Chemical Producers Association	• *NERM Reporting Guide* • *Guideline for Quantifying Emissions from Chemical Facilities* • *Source Characterization Guidelines – Primary Particulate Matter and Particulate Precursor Emission Estimation Methodologies for Chemical Production Facilities*
Upstream oil and gas; oil sands; natural gas transmission, distribution and storage	Canadian Association of Petroleum Producers	• *NPRI Guide – A Recommended Approach to Completing the National Pollutant Release Inventory for the Upstream Oil and Gas Industry* • *National Pollutant Release Inventory VOC Speciation Calculator* • *NPRI Guide – CAPP VOC Speciation Calculator*
Petroleum refining; petroleum product terminals	Canadian Petroleum Products Institute	• *Code of Practice for Developing an Emission Inventory for Refineries and Terminals, Revision 12*
Wastewater	Canadian Water and Wastewater Association	• *National Pollutant Release Inventory and Municipal Wastewater Services – Reporting Guidance For Small To Medium Wastewater Facilities*

3.10 General Information to Be Reported

3.10.1 Contact Information

For each of the following, the name, position, mailing address, telephone number and email address must be provided:

- *Technical contact*: the person who prepared the report and who will be able to answer any questions pertaining to its contents. All correspondence from Environment Canada regarding the NPRI will be sent to the technical contact if no coordinator (see below) is identified.
- *Public contact* (if any): the person responsible for answering any questions from the public concerning the report. This name will appear on the NPRI website as the contact for the facility. If a public contact is not identified, the name of the coordinator, or technical contact if no coordinator is identified, will appear instead.
- *Coordinator* (if any): the person who is responsible for preparing and submitting NPRI reports for more than one facility for the same company. The coordinator is responsible for answering any questions concerning all of the NPRI reports he/she filed. All NPRI correspondence from Environment Canada will be sent to the coordinator, if one is identified.
- *Certifying official*: the person who is legally responsible for the contents of the NPRI report. The certifying official is usually the owner or operator, or a company official authorized to act on his/her behalf.

- *Independent contractor* (if any): if an independent contractor prepared the report, contact information must be provided, including the name of the contracting company.

It is important that contact and ownership information be kept up-to-date using the online reporting system or by contacting Environment Canada, if:

- there is a change in the name, address, telephone number or email address of the contacts identified for the facility; or
- there is a change in the owner or operator of a facility.

3.10.2 Facility Information

Table 9 summarizes the general information that must be provided for all facilities that report to the NPRI. Other facility information may also be required, depending on the type of facility and the substances reported.

Table 9. Facility Information Required to Be Reported to the National Pollutant Release Inventory

Type of Information	Information to Be Reported
Facility name and location	• name of the facility • address of the physical location of the facility (e.g., a civic address, a legal land description, or just a description if no other type of physical address is applicable [e.g., for an offshore installation]) • latitude and longitude coordinates of the facility if the facility is reporting for the first time or if the facility is portable
Employees	• number of full-time employees
Organization (company)	• legal and trade name of the facility's company • mailing address • Dun & Bradstreet (D-U-N-S) Number(1) • federal business number(2)
Parent companies (if any)	• legal names of any Canadian parent companies • civic addresses of the parent companies • D-U-N-S Numbers(1) of the parent companies • federal business numbers(2) of the parent companies
NPRI identification number	• unique identifier provided by Environment Canada and used for reporting to the NPRI
North American Industry Classification System (NAICS) Code(3)	• 6-digit NAICS Canada code of the facility
Pollution prevention plan	• whether and why a pollution prevention plan was prepared • whether an existing pollution prevention plan was updated • whether the plan addressed substances, energy conservation or water conservation

(1) A Dun & Bradstreet (D-U-N-S) number is a unique nine-digit identification number for a single business entity.

(2) A federal business number is a nine-digit registration number issued by the Canada Revenue Agency (CRA) to Canadian businesses that register for one or more of the following: corporate income tax; importer/exporter account number; payroll deductions; or goods and services tax. This number can be found on all forms issued to a business by the CRA. The first nine digits that appear on these forms is the federal business number.

(3) NAICS is an industry classification system developed by the statistical agencies of Canada, Mexico and the United States. For more information, see the Statistics Canada website: www.statcan.gc.ca/concepts/industry-industrie-eng.htm.

3.11 Other Requirements

3.11.1 Statement of Certification

A Statement of Certification (SOC) must be electronically signed and submitted with the NPRI report using the on-line reporting system. The certifying official should verify that the information submitted is true, complete and accurate, and acknowledge that the data will be made public. The certifying official is legally responsible for the contents of the NPRI report.

3.11.2 Record Keeping

Pursuant to subsection 46(8) of CEPA 1999, the owner/operator of a facility is required to retain copies of all information on which their report is based, including any calculations, measurements and other related data, for a period of three years. This information must be kept at the facility or at the principal place of business in Canada of the owner/operator of the facility to which the information relates, for a period of three years.

4. Reporting for Part 1A Substances – Core Substances

Part 1A lists 230 substances and groups of substances of concern, most of which have been listed on the NPRI since its inception. These substances are commonly referred to as the "core substances," and comprise the majority of the NPRI substance list. For the complete list of NPRI substances, consult the NPRI website at www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E2BFC2DB-1.

4.1 Reporting Criteria for Part 1A Substances

In general, any person who owns or operates a contiguous facility or offshore installation must submit an NPRI report for a Part 1A substance if both of the following criteria are met:

1. employees work a total of ≥ 20 000 hours, or activities to which the employee threshold does not apply (see Table 3) take place at the facility, and
2. the **total quantity** of the Part 1A substance
    - o manufactured, processed or otherwise used at a concentration (by weight) of 1% or more, **plus**
    - o incidentally manufactured, processed or otherwise used as a by-product at any concentration, **plus**
    - o contained in tailings disposed of during the calendar year at any concentration, **plus**
    - o contained in waste rock disposed of during the calendar year that is not clean or inert (see section 3.7.4) at a concentration (by weight) of 1% or more

   is ≥ 10 tonnes.

Figure 2 illustrates the steps for determining if a report is required for Part 1A substances.

4.1.1 Part 1A Substance Qualifiers

Some Part 1A substances and groups of substances are qualified in terms of their specific physical or chemical form, state or particle size. The qualifiers, described in Table 10, determine whether a report will be required for a given substance.

Figure 2. Reporting for Part 1A Substances

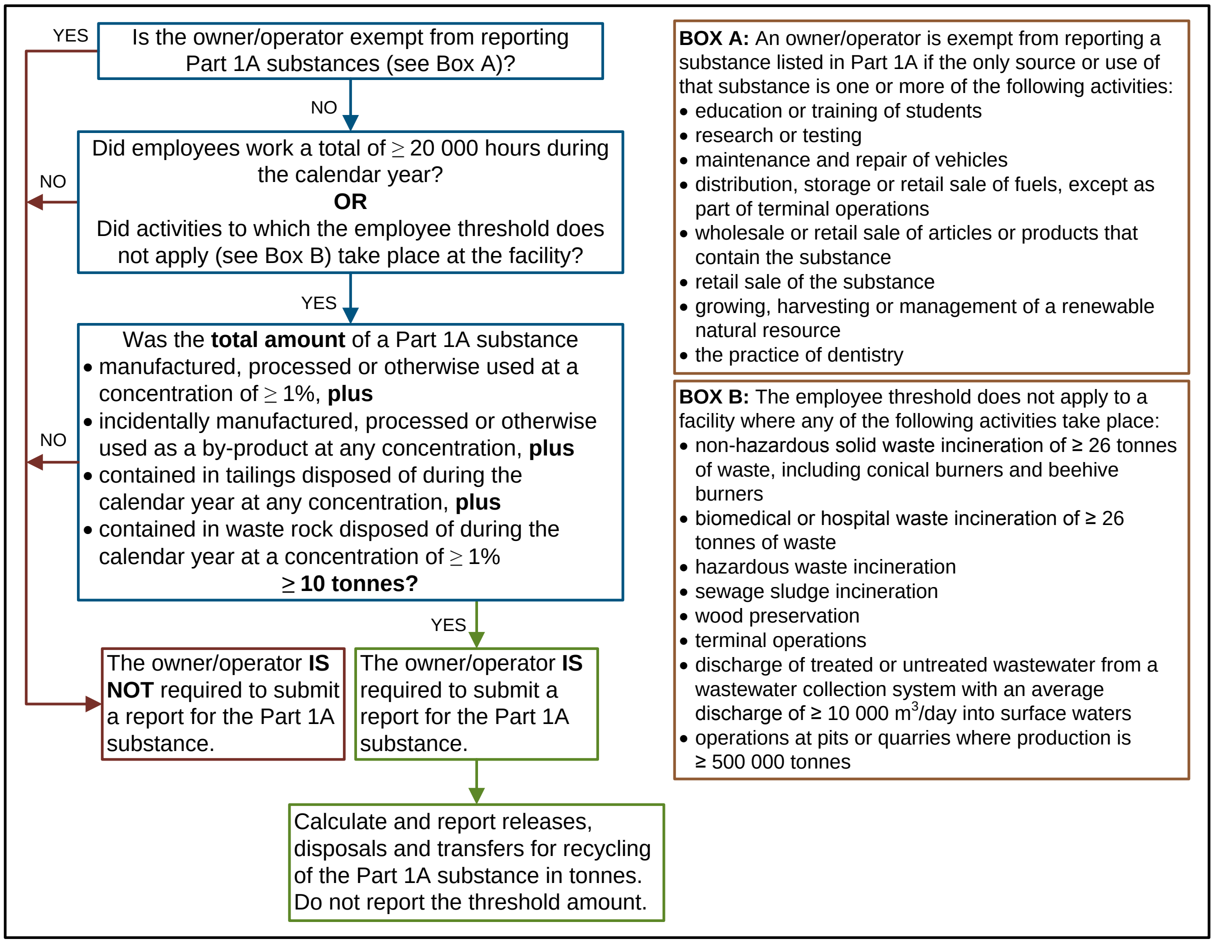


Table 10. Qualifiers for Part 1A Substances

Substance Qualifier	Substance(s) to Which the Qualifier Applies	Description
all isomers	cresol (CAS RN 1319-77-3), HCFC-122 (41834-16-6), HCFC-123 (34077-87-7), HCFC-124 (63938-10-3), and xylene (1330-20-7)	Total of all isomers reported as an aggregate of the individual isomers
and its compounds	antimony, cobalt, copper, manganese, nickel and zinc	The pure metal and the equivalent weight of the metal in any compound, alloy or mixture must be reported as the equivalent weight of the metal itself.
	chromium	Pure chromium and chromium contained in any compound, alloy or mixture must be reported as the equivalent weight of chromium, excluding hexavalent chromium and its compounds.
	vanadium (7440-62-2)	Pure vanadium and vanadium in any compound or mixture must be reported as the equivalent weight of vanadium. Do not include vanadium contained in an alloy.
and its salts	acrylic acid (79-10-7), aniline (62-53-3), chloroacetic acid (79-11-8), cresol (1319-77-3), 2,4-diaminotoluene (95-80-7), 2,4-dichlorophenol (120-83-2), diethanolamine (111-42-2), N,N-dimethylaniline (121-69-7), 4,6-dinitro-*o*-cresol (534-52-1), hydrazine (302-01-2), hydroquinone (123-31-9), Michler's ketone (90-94-8), nitrilotriacetic acid (139-13-9), *p*-nitrophenol (100-02-7), peracetic acid (79-21-0), phenol (108-95-2), *p*-phenylenediamine (106-50-3), *o*-phenylphenol (90-43-7), pyridine (110-86-1), and quinoline (91-22-5)	Weak acids and bases are listed with this qualifier. Although the CAS RN that appears on the NPRI list is specific to the acid or base, all salts of these substances must be reported as an equivalent weight of the acid or base.
expressed as hydrogen sulphide	total reduced sulphur (TRS)	Total of hydrogen sulphide (7783-06-4), carbon disulphide (75-15-0), carbonyl sulphide (463-58-1), dimethyl sulphide (75-18-3), methyl mercaptan (74-93-1), and dimethyl disulphide (624-92-0), expressed as hydrogen sulphide
fibrous forms only	aluminum oxide (1344-28-1)	Fibrous refers to a synthetic form of aluminum oxide that is processed to produce strands or filaments. This includes the form of aluminum oxide found in brake linings, but excludes the more common granular, powdered or fumed forms of alumina.
friable form only	asbestos (1332-21-4)	Only asbestos that is brittle and readily crumbled (i.e., friable) should be reported.
fume or dust only	aluminum (7429-90-5)	Include dry forms of aluminum only, with particle diameters of 0.001-1 micrometre for fumes and 1-100 micrometres for dust.
in solution at a pH of 6.0 or more	nitrate ion	This distinguishes nitrate ion in neutral or basic solution from nitric acid (pH of less than 6.0). If nitric acid is neutralized to a pH of 6.0 or greater, report for both nitric acid (7697-37-2) and nitrate ion in solution.
ionic	cyanides	Includes the salts of hydrogen cyanide, but excludes organocyanides, nitriles and organometallic cyanide compounds.
mixed isomers	dinitrotoluene (25321-14-6) and toluenediisocyanate (26471-62-5)	Total of all isomers occurring in mixtures.
total	ammonia	Total of ammonia (NH_3) (7664-41-7) and the ammonium ion (NH_4^+) (14798-03-9) in solution, expressed as ammonia
	phosphorus	Total of all phosphorus, not including yellow or white phosphorus (7723-14-0)
yellow or white only	phosphorus	Total of the yellow and white allotropes of elemental phosphorus only

4.2 Calculating the Reporting Threshold for Part 1A Substances

When calculating the 10-tonne reporting threshold, include the quantity of a Part 1A substance that is:

- manufactured, processed or otherwise used at a concentration equal to or greater than 1% by weight;
- a by-product, at any concentration, released on-site to the environment or disposed of on- or off-site;
- contained in tailings disposed of during the calendar year, at any concentration; and
- contained in waste rock that is not inert and that is disposed of during the calendar year at a concentration equal to or greater than 1% by weight.

Do not include quantities of a Part 1A substance contained in any of the sources that should not be considered, as listed in Table 4.

Since a substance may undergo many processes in a facility, care should be taken not to double-count process streams when calculating the reporting threshold.

A quantity of a substance that is transferred off-site for recycling and returned to the facility should be treated as the equivalent of newly purchased material. A quantity of a substance that is recycled on-site and re-introduced to a process stream (e.g., substances in ore processing water that are recycled back into the process from tailings) should be included in the threshold calculation only once.

The total quantity of a Part 1A substance manufactured, processed or otherwise used at concentrations greater than or equal to 1%, at any time or in any part of the facility, must be included when calculating the 10-tonne reporting threshold. For example, the quantity of a substance received by a facility at 30% concentration and then diluted to less than 1% for use, is included in the threshold calculation. A substance received at the facility at less than 1% and subsequently concentrated to 5% would also be included in the threshold calculation.

Facilities that repackage or transfer Part 1A substances between containers need only consider the quantity of the substance repackaged or transferred.

If only a range of concentrations is available for a substance present in a mixture, contact the supplier of the substance for more detailed information. If no additional information is available, use the average of the range for threshold determinations.

4.2.1 Example of Calculating the Reporting Threshold for Part 1A Substances

Table 11 illustrates the calculation of the reporting threshold. In the example, a facility has several processes in which a Part 1A substance is manufactured, processed or otherwise used. The substance is also released as a by-product and is contained in tailings and waste rock.

This example assumes that the employee threshold is met, or an activity to which the employee threshold does not apply takes place at the facility. In this case, a report is required for this substance, because the total quantity of the Part 1A substance manufactured, processed, otherwise used, and contained in tailings and waste rock at the facility exceeded 10 tonnes, as explained below.

Table 11. Example of a Threshold Calculation for Part 1A Substances

Material/Process Containing the Substance	Total Weight of Material Containing the Substance (Tonnes)	Concentration/Equivalent Weight of the Substance in Material/Process (Percent)	Net Weight of the Substance to Include in Threshold Calculation (Tonnes)
1. Compound material in process stream A	150	5	7.5
2. Raw material in process B	2	100	2.0
3. Raw material in process C	45	0.20	n/a
4. By-product released from process D	10 000	0.01	1.0
5. Tailings	24 000 000	0.00001	2.4
6. Waste rock	20 000 000	0.00002	n/a
7. **TOTAL**			**12.9**

1. In process A, the Part 1A substance is present at 5% concentration (or equivalent weight for metallic compounds) and is included in the threshold calculation.
2. In process B, the raw material added to the process is a pure substance. It is included in the threshold calculation, regardless of any subsequent dilution in the process.
3. The weight of the substance in the raw material used in process C is not included in the threshold calculation because the concentration is less than 1%. Note that, as a report is required in this example, the releases, disposals and transfers for recycling from all processes, including process C, are required to be reported, regardless of concentration and regardless of whether or not the quantity is used the threshold calculation.
4. The weight of the substance produced and released from process D is included in the calculation because it is a by-product, and the concentration threshold does not apply.
5. The weight of the substance contained in tailings is included in the threshold calculation because there is no concentration threshold for tailings.
6. The weight of the substance contained in waste rock is not included in the threshold calculation, because the concentration of the substance in the waste rock is less than 1%. The weight of the substance in the waste rock would also not be included when calculating disposals of the substance, because the concentration is less than 1%.
7. The total is the value that must be compared to the 10-tonne reporting threshold. This value is only used to determine that a report is required for the Part 1A substance. A subsequent calculation must be done to obtain the actual value of releases, disposals, and transfers for recycling that must be reported.

4.3 Calculating Releases, Disposals and Transfers for Recycling of Part 1A Substances

If the reporting threshold for a Part 1A substance is met (as discussed in section 4.2), a subsequent calculation is required to determine the quantities of that substance that are released, disposed of and transferred for recycling. If the reporting threshold is met, **all releases, disposals and transfers for recycling of that substance must be reported, regardless of their concentration or quantity and regardless of whether or not the quantity is used in the threshold calculation**. The only exception to this is for disposals of Part 1A substances in waste rock where the substance is at a concentration of less than 1%. In the case of waste rock, the 1% concentration threshold for Part 1A substances applies to both the threshold calculation and disposal calculation.

4.4 Reporting Releases, Disposals and Transfers for Recycling of Part 1A Substances

All releases, disposals and transfers for recycling of Part 1A substances must be reported in tonnes.

Note that even if on-site releases, disposals or off-site transfers for recycling are zero, a report must be submitted for a Part 1A substance, once the 10-tonne reporting threshold has been met.

5. Reporting for Part 1B Substances – Alternate Threshold Substances

Part 1B substances may have significant environmental and human health impacts at relatively low levels. Because minimal releases of Part 1B substances may result in significant adverse effects, the reporting thresholds for Part 1B substances are lower than those for Part 1A substances. As such, these substances are commonly referred to as the "alternate threshold substances."

5.1 Reporting Criteria for Part 1B Substances

In general, any person who owns or operates a contiguous facility or an offshore installation must submit a report for a Part 1B substance if both of the following criteria are met:

1. employees work a total of ≥ 20 000 hours, or activities to which the employee threshold does not apply (see Table 3) take place at the facility, and
2. the **total quantity** of the Part 1B substance
    - manufactured, processed or otherwise used at or above the concentration specified in Table 12, **plus**
    - incidentally manufactured, processed or otherwise used as a by-product at any concentration, **plus**
    - contained in tailings at any concentration, **plus**
    - contained in waste rock that is not inert and that is disposed of, at any concentration (see section 3.7.4)

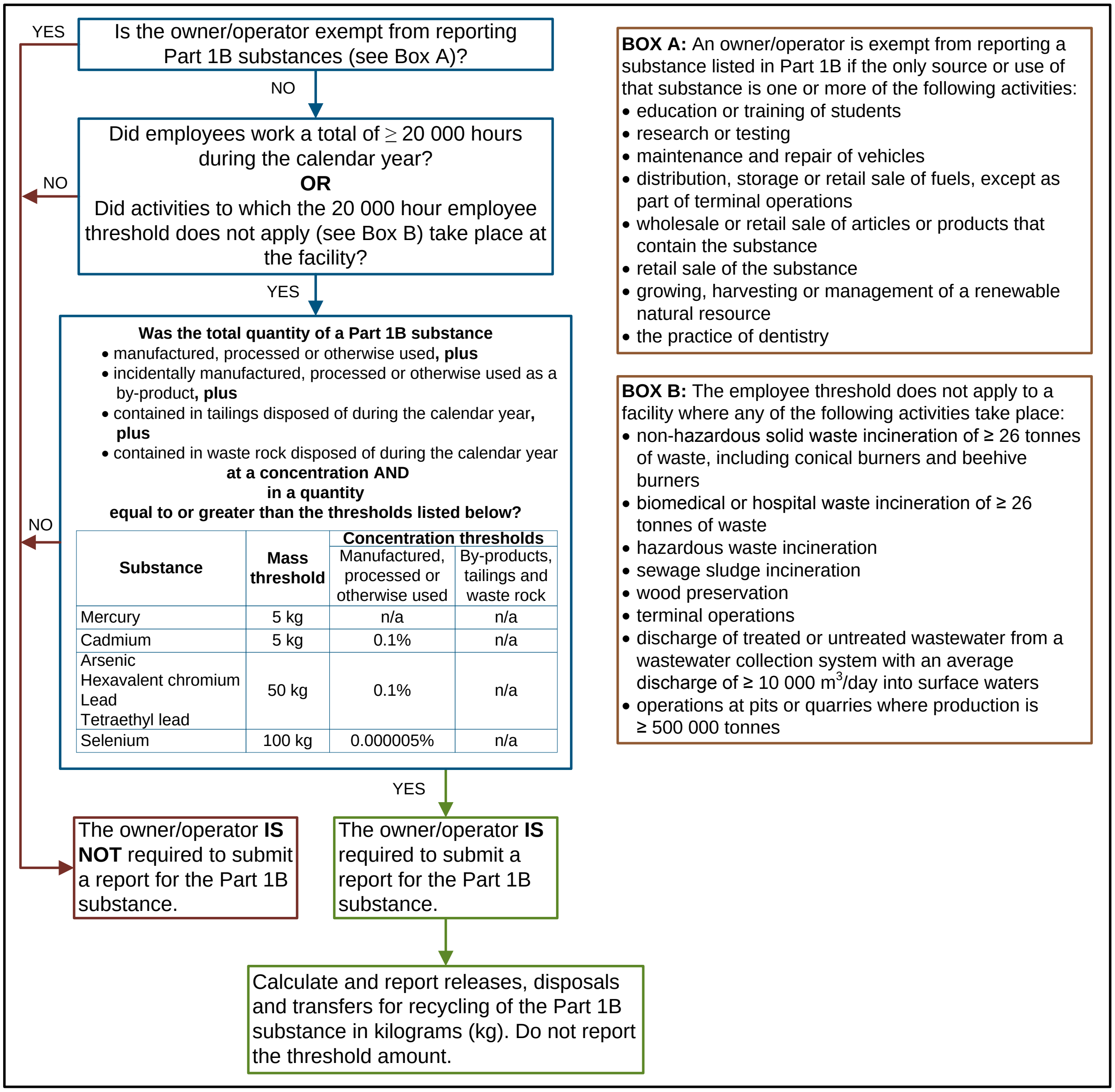
    is greater than or equal to the mass threshold specified in Table 12.

Figure 3 illustrates the steps for determining if a report for Part 1B substances is required.

Table 12. Concentration and Mass Thresholds for Part 1B Substances

Substance	Occurrence of the Substance	Concentration Threshold (by Weight)	Mass Threshold (kg)
Mercury	manufactured, processed or otherwise used	any concentration	5
	incidentally manufactured, processed or otherwise used		
	contained in tailings disposed of during the calendar year		
	contained in waste rock disposed of during the calendar year		
Cadmium	manufactured, processed or otherwise used	0.1% or more	5
	incidentally manufactured, processed or otherwise used	any concentration	
	contained in tailings disposed of during the calendar year		
	contained in waste rock disposed of during the calendar year		
Arsenic Hexavalent chromium Lead Tetraethyl lead	manufactured, processed or otherwise used	0.1% or more	50
	incidentally manufactured, processed or otherwise used	any concentration	
	contained in tailings disposed of during the calendar year		
	contained in waste rock disposed of during the calendar year		
Selenium	manufactured, processed or otherwise used	0.000005% or more	100
	incidentally manufactured, processed or otherwise used	any concentration	
	contained in tailings disposed of during the calendar year		
	contained in waste rock disposed of during the calendar year		

Figure 3. Reporting for Part 1B Substances



5.1.1 Part 1B Substance Qualifiers

Mercury, cadmium, arsenic, hexavalent chromium, lead and selenium are listed with the qualifier "and its compounds." The pure element and any compound, alloy or mixture of any Part 1B substance must be reported as the equivalent weight of the metal itself. For example, if potassium dichromate ($K_2Cr_2O_7$, molecular weight = 294 grams per mole [g/mol]) is used, only the mass contribution of hexavalent chromium (2 × 52 g/mol) in $K_2Cr_2O_7$ should be included in the threshold calculation for hexavalent chromium.

Note that lead has an additional qualifier: the lead contribution from tetraethyl lead, stainless steel, brass and bronze alloys should be excluded from threshold calculations for lead. Tetraethyl lead should be treated as a separate substance. If the criteria are met, separate reports should be submitted for lead (and its compounds) and tetraethyl lead, with the reporting criteria applied to each substance separately.

5.2 Calculating the Reporting Threshold for Part 1B Substances

When calculating the reporting threshold, include the quantity of a Part 1B substance that is:

- manufactured, processed or otherwise used at a concentration equal to or greater than the concentration threshold (if any) specified in Table 12;
- a by-product, at any concentration, released on-site to the environment or disposed of on- or off-site;
- contained in tailings disposed of during the calendar year, at any concentration; and
- contained in waste rock that is not inert and that is disposed of during the calendar year, at any concentration.

Do not include quantities of a Part 1B substance contained in any of the sources that should not be considered, as listed in Table 4.

As noted previously, quantities of substances disposed of in inert or clean waste rock do not need to be included in threshold calculations. However, the quantity of arsenic contained in inert or clean waste rock can be excluded only if the concentration of arsenic is < 12 mg/kg of waste rock.

5.3 Calculating Releases, Disposals and Transfers for Recycling of Part 1B Substances

If the reporting threshold for a Part 1B substance is met (as discussed in section 5.2), a subsequent calculation is required to determine the quantities of that substance that are released, disposed of and transferred for recycling. If the reporting threshold is met, **all releases, disposals and transfers for recycling of that substance must be reported, regardless of their concentration or quantity and regardless of whether or not the quantity is used in the threshold calculation**.

5.4 Reporting Releases, Disposals and Transfers for Recycling of Part 1B Substances

All releases, disposals and transfers for recycling of Part 1B substances must be reported in kilograms (kg).

Note that even if on-site releases, disposals or off-site transfers for recycling are zero, a report must be submitted for a Part 1B substance once the mass reporting threshold has been met.

6. Reporting for Part 2 Substances – Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) may be used as commercial chemicals, incidentally manufactured in certain industrial processes, or contained in tailings. There are 29 PAHs listed in Part 2 of the NPRI substance list. For a list of these PAHs, consult the NPRI website: www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E2BFC2DB-1.

6.1 Reporting Criteria for Part 2 Substances

With the exception of facilities where wood preservation using creosote takes place (see below), reporting for PAHs is based on the quantities of PAHs that are released, disposed of or transferred for recycling as a result of incidental manufacture or from the generation of tailings. A person who owns or operates a contiguous facility, a portable facility, or an offshore installation must submit reports for PAHs if both of the following criteria are met:

1. employees work a total of ≥ 20 000 hours, or activities to which the employee threshold does not apply (listed in Table 3) take place at the facility; and
2. the sum of all PAHs released, disposed of or transferred off-site for recycling as a result of incidental manufacture and/or as a result of the generation of tailings is ≥ 50 kg.

Wood preservation facilities using creosote must report for Part 2 substances, regardless of quantities and regardless of the number of hours worked by employees. See section 3.6.2 and the *Guidance for Wood Preservation Facilities Reporting to the NPRI* (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=29B3E589-1) for more information.

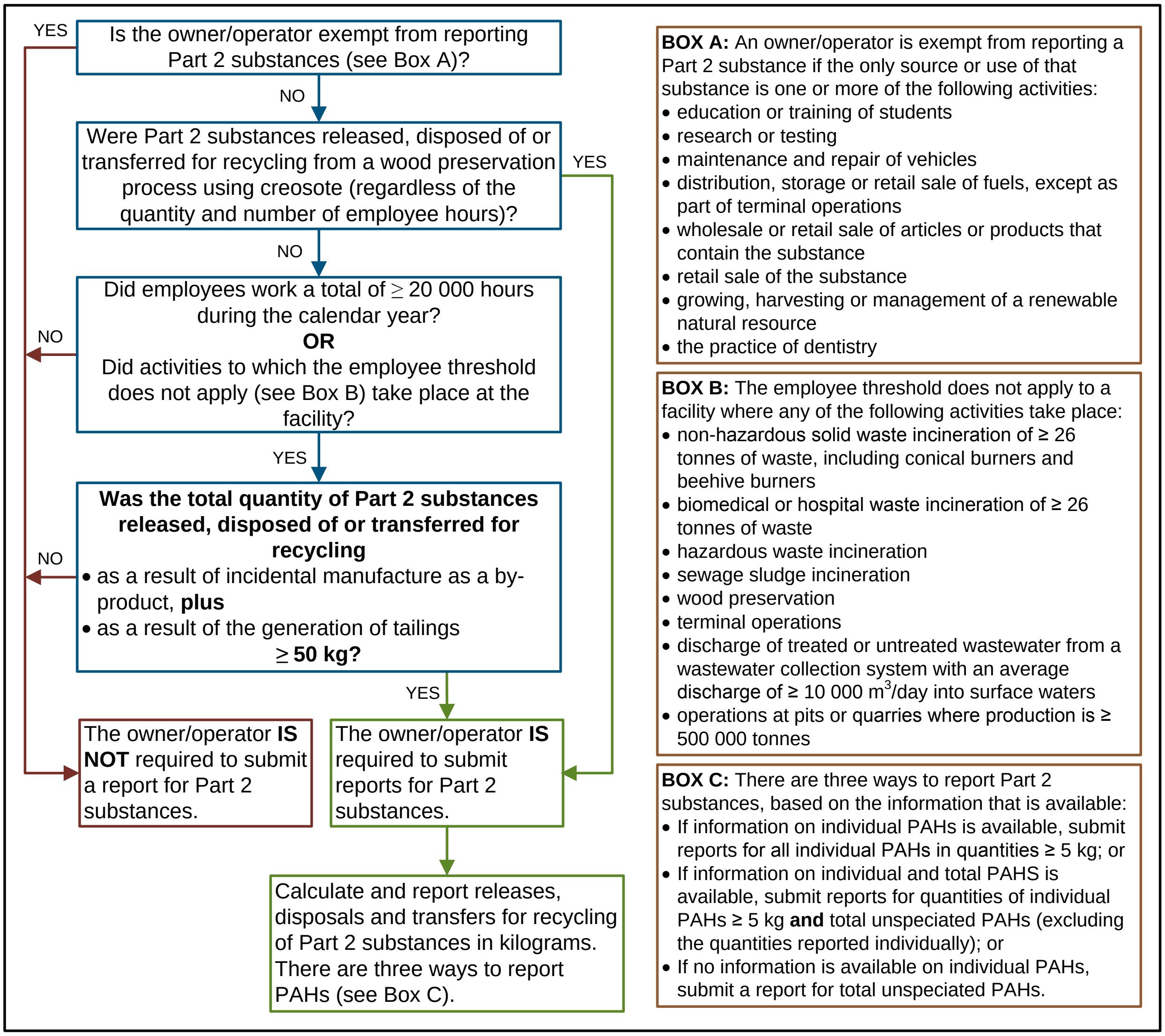
Figure 4 illustrates the steps for determining if reports for Part 2 substances are required, and, if so, what information must be reported.

6.2 Calculating the Reporting Threshold for Part 2 Substances

The sum of the quantities of individual PAHs incidentally manufactured and/or contained in tailings disposed of during the calendar year should be compared to the 50 kg threshold. In some cases, only information on unspeciated PAHs may be available, or a combination of information on individual and unspeciated PAHs may be available. Add the quantities of each individual PAH and the quantity of unspeciated PAHs to determine if the 50 kg reporting threshold is met.

Do not include anthracene (CAS RN 120-12-7) and naphthalene (CAS RN 91-20-3) when determining the reporting threshold for PAHs. Although anthracene and naphthalene are PAHs, they are NPRI Part 1A substances. Therefore, they are subject to Part 1A reporting requirements.

Figure 4. Reporting for Part 2 Substances



6.3 Reporting Releases, Disposals and Transfers for Recycling of Part 2 Substances

All releases, disposals and transfers for recycling of Part 2 substances must be reported in kilograms.

Releases, disposals and transfers for recycling must be reported for the individual PAHs, even though the 50 kg threshold applies to the aggregate total of all 29 PAHs. Depending on the information that is available, there are three ways to report PAHs (illustrated in Figure 4 and summarized in Table 13). If the 50 kg threshold is met, or if wood preservation using creosote takes place at the facility, and information on releases, disposals and transfers for recycling for individual PAHs is available, those PAHs that are incidentally manufactured and released, disposed of or transferred for recycling in quantities ≥ 5 kg must be reported individually.

If only a combination of information on individual and total PAHs is available, quantities of individual PAHs in quantities ≥ 5 kg and quantities of "total unspeciated PAHs" should both be reported. If the only available information is for total PAHs, total unspeciated PAHs should be reported.

Note that total unspeciated PAHs does not mean the sum of the 29 individual PAHs. In order to avoid double-counting when reporting both individual and total unspeciated PAHs, the quantities of individual PAHs that are reported separately should not be included in the quantity reported for total unspeciated PAHs. In addition, do not include release, disposal and transfer for recycling quantities of the two PAHs listed in Part 1A (anthracene and naphthalene) when reporting for total PAHs.

Facilities using creosote for wood preservation must report for PAHs regardless of the quantity of PAHs released, disposed of or transferred for recycling or the number of hours worked by employees. Depending on the information available to the facility, reports can be submitted for: individual PAHs released, disposed of or transferred for recycling in quantities ≥ 5 kg; a combination of individual PAHs in quantities ≥ 5 kg and total PAHs; or total PAHs.

Table 13. How to Report Polycyclic Aromatic Hydrocarbons

Type of information available	Comparison to thresholds	What to report
Quantities of individual PAHs	• Add quantities of individual PAHs • If the total is ≥ 50 kg, reporting is required	• Report quantities of individual PAHs that are incidentally manufactured and released, disposed of or transferred for recycling in quantities ≥ 5 kg • Quantities of individual PAHs that are < 5 kg are not required to be reported
Combination of quantities of individual PAHs and quantity of total PAHs	• Add quantities of total unspeciated PAHs and any individual PAHs that are not already included in the total unspeciated PAHs • If the total is ≥ 50 kg, reporting is required	• Report quantities of individual PAHs that are ≥ 5 kg, **and** • Report total unspeciated PAHs (not including quantities of individually reported PAHs) • Quantities of individual PAHs that are < 5 kg are not required to be reported
Quantity of total PAHs	• If total PAHs are ≥ 50 kg, reporting is required	• Report total unspeciated PAHs

7. Reporting for Part 3 Substances – Dioxins, Furans and Hexachlorobenzene

Polychlorinated dibenzo-p-dioxins (PCDDs or dioxins), polychlorinated dibenzofurans (PCDFs or furans) and hexachlorobenzene (HCB) are released primarily as by-products of industrial and combustion processes; they are also found as contaminants in certain pesticides or chlorinated solvents. HCB may also be found as a contaminant in the wood preservative pentachlorophenol (PCP). These substances are toxic under CEPA 1999, and are slated for virtual elimination.

HCB and 17 dioxin and furan congeners are listed in Part 3. For a list of these congeners, consult the NPRI website: www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E2BFC2DB-1.

7.1 Reporting Criteria for Part 3 Substances

Reporting for dioxins, furans and HCB is mandatory for a contiguous facility, a portable facility or an offshore installation where the activities specified in Table 14 take place, regardless of quantity or concentration. These activities are described in sections 3.6.2, 7.1.1 and 7.1.2. The employee threshold applies to some of these activities, but does not apply to others, as indicated in Table 14. For those activities to which the employee threshold applies, both criteria must be met (i.e., the activity must take place, and the employee threshold must be met). For activities to which the employee threshold does not apply, reporting for dioxins, furans and HCB is mandatory, regardless of the number of hours worked by employees.

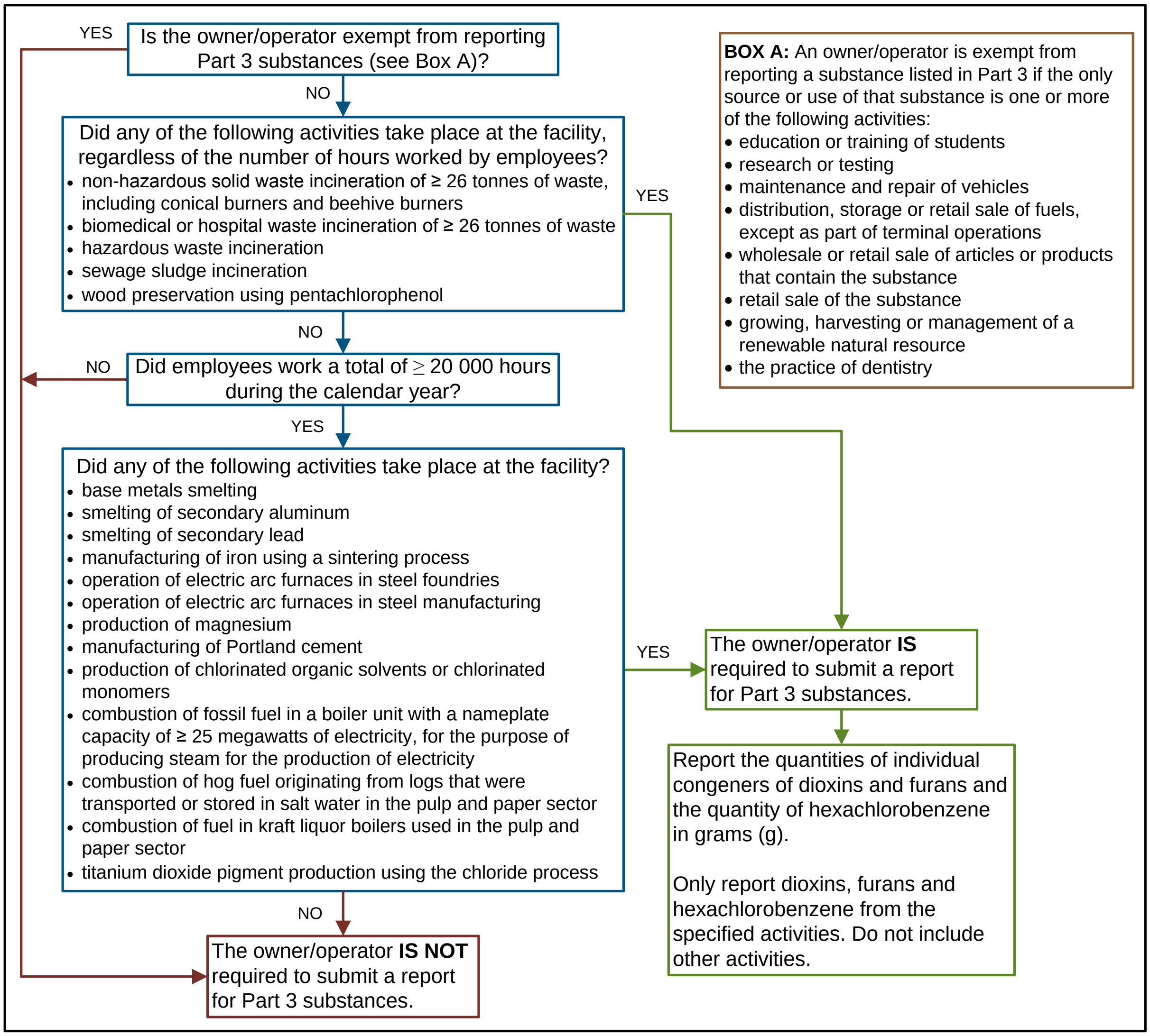
Table 14. Activities for Which Reports on Dioxins, Furans and Hexachlorobenzene Are Required

Employee Threshold	Activity
Employee threshold does not apply	non-hazardous solid waste incineration of ≥ 26 tonnes of waste, including conical burners and beehive burners
	biomedical or hospital waste incineration of ≥ 26 tonnes of waste
	hazardous waste incineration
	sewage sludge incineration
	wood preservation using pentachlorophenol
Employee threshold applies	base metals smelting (copper, lead, nickel or zinc only)
	smelting of secondary aluminum
	smelting of secondary lead
	manufacturing of iron using a sintering process
	operation of electric arc furnaces in steel foundries
	operation of electric arc furnaces in steel manufacturing
	production of magnesium
	manufacturing of Portland cement
	production of chlorinated organic solvents or chlorinated monomers
	combustion of fossil fuel in a boiler unit, with a nameplate capacity of ≥ 25 megawatts of electricity, for the purpose of producing steam for the production of electricity
	combustion of hog fuel originating from logs that were transported or stored in salt water in the pulp and paper sector
	combustion of fuel in kraft liquor boilers used in the pulp and paper sector
	titanium dioxide pigment production using the chloride process

Only those quantities of dioxins, furans and HCB that result from the activities listed in Table 14 need to be reported. Quantities of Part 3 substances that result from other activities do not need to be reported.

Figure 5 illustrates the steps for determining if a report for Part 3 substances is required, and, if so, what information must be reported.

Figure 5. Reporting for Part 3 Substances



7.1.1 Activities for Which Part 3 Substances Must Be Reported, Regardless of Employee Hours

The activities to which the employee threshold does not apply (see Table 14) are described in section 3.6.2. Wood preservation activities are also described in section 3.6.2. However, only wood preservation using PCP triggers mandatory reporting of Part 3 substances. PCP, by its chemical structure, is a close surrogate to HCB. PCP is derived from HCB by substituting one of HCB's six chloro-substituents with a hydroxyl group. Given its chemical similarity to HCB and that its manufacturing ingredients contain the precursors for dioxin and furan production (i.e., chlorinated aromatics), the manufacture of PCP often results in the incidental manufacture of HCB, dioxins and furans.

7.1.2 Activities for Which Part 3 Substances Must Be Reported if the Employee Threshold Is Met

The following sections describe the activities listed in Table 14 to which the employee threshold applies.

Smelting

Smelting is the melting of raw or scrap materials to produce metal for further processing into metal products. The smelting process is typically accompanied by a chemical change in which impurities are removed.

Base metals smelting

"Base metals" refer to copper, lead, nickel or zinc. Base metals smelting does not include smelting of aluminum, secondary lead or any other metals.

Smelting of secondary aluminum

"Secondary aluminum" refers to aluminum-bearing scrap or materials. Secondary aluminum smelting involves pre-cleaning and smelting, both of which may produce emissions of dioxins and furans.

Smelting of secondary lead

"Secondary lead" refers to lead-bearing scrap or materials, other than lead-bearing concentrates derived from a mining operation. Facilities engaged in smelting of lead-bearing concentrates derived from a mining operation are considered to be base metal smelters.

Manufacturing of iron using a sintering process

"Sintering" means to cause something to become a coherent mass by heating without melting, or the growth of contact area between two or more initially distinct particles at temperatures below the melting point but above one half of the melting point (in Kelvin). In sintering operations, dioxins and furans may be formed as by-products during high-temperature decomposition or combustion of raw materials containing chlorine and organic compounds.

Operation of electric arc furnaces in steel foundries and in steel manufacturing

In an electric arc furnace, material is heated by an electric arc. Dioxins, furans and HCB may be formed as by-products during high-temperature decomposition or combustion of raw materials containing chlorine and organic compounds.

Production of magnesium

Production of magnesium from magnesium chloride by electrolysis may result in the generation of dioxins, furans and HCB.

Manufacturing of Portland cement

Portland cement is a fine greyish powder consisting of four basic materials: lime, silica, alumina and iron compounds. Cement production involves heating the raw materials to a very high temperature in a rotating kiln to induce chemical reactions that produce a fused material called clinker. The cement clinker is further ground into a fine powder, and then mixed with gypsum to form Portland cement.

Production of chlorinated organic solvents or chlorinated monomers

This activity is limited to the intentional manufacturing of chlorinated organic solvents or chlorinated monomers, and does not include coincidental production.

Combustion of fossil fuel in a boiler unit, with a nameplate capacity of ≥ 25 megawatts of electricity, for the purpose of producing steam for the production of electricity

This activity includes fossil fuel combustion at electric power generation utilities and large industrial facilities co-generating electric power using waste heat from industrial processes. Fossil fuel is fuel that is in a solid or liquid state at standard temperature and pressure, such as coal, petroleum or any liquid or solid fuel derivatives. It does not include natural gas or other fuels that are gases at ambient pressure and temperature. Fuel combustion in diesel generators is not included in this activity.

Combustion of hog fuel originating from logs that were transported or stored in salt water in the pulp and paper sector

Pulp and paper boilers burning salt-laden wood are unique to British Columbia. Dioxins and furans are emitted from the burning of salt-contaminated hog fuel. Chlorine is absorbed by the bark of logs transported and stored in salt water. The bark stripped from logs is ground up with other waste wood to produce hog fuel, which is used as boiler fuel to produce heat and electrical energy.

Combustion of fuel in kraft liquor boilers used in the pulp and paper sector

A kraft liquor boiler burns black liquor, composed mostly of lignin, which is the residue from the digester in a kraft (sulphate) pulping process. The boiler recovers chemical products from the combusted black liquor, which are later recycled. It also produces steam, which is used in mill process operations.

Titanium dioxide pigment production using the chloride process

This activity is limited to titanium dioxide pigment manufactured by the chloride process, not the sulphate process.

7.2 Reporting Releases, Disposals and Transfers for Recycling of Part 3 Substances

The information that needs to be reported for Part 3 substances depends on the method used to determine the quantities released, disposed of and transferred for recycling. There are three possible scenarios:

- quantities are determined using CEMS, PEM or source testing;
- quantities are estimated using other methods; or
- no information is available.

To determine if a report is required, the quantities determined using CEMS, PEM or source testing must be compared to the level of quantification (LoQ). LoQ is defined in CEPA 1999 as "the lowest concentration that can be accurately measured using sensitive but routine sampling and analytical methods." Table 15 lists estimated LoQs for dioxins, furans and HCB, determined by Environment Canada for gases, liquids and solids.

Table 15. Estimated Level of Quantification for Dioxins, Furans and Hexachlorobenzene

Material State	Estimated Level of Quantification	
	Dioxins and furans(1)	Hexachlorobenzene
Gaseous(2)	32 picograms (pg) toxic equivalents (TEQ)/m^3	6 nanograms (ng)/m^3
Liquid(3)	20 pg TEQ/L	70 ng/L
Solid(4)	9 pg TEQ/g	2 ng/g

(1) See section 7.2.1 for an explanation of toxic equivalents (TEQ).

(2) Environment Canada, 1999. Use these values to determine whether concentrations in releases to air from stacks and other sources are above, equal to or below the LoQ.

(3) The LoQ for concentrations of dioxins and furans in liquids was extrapolated from the effective LoQ for 2,3,7,8-TCDD in the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations*. Use 70 ng/L as the estimated LoQ for concentrations of HCB in liquids (Environment Canada, 1997).

(4) Environment Canada, 2000. Use these values to determine whether concentrations of dioxins and furans or HCB in solid materials are above, equal to or below the LoQ. Incinerator bottom ash, pollution-abatement residues and sludge are examples of solid materials containing dioxins and furans or HCB.

Measured concentrations must be compared to the appropriate LoQ indicated in Table 15 for each type of release, disposal and site transfer for recycling. If measured quantities are greater than or equal to the LoQ, the quantities must be reported. If measured quantities are less than the LoQ, reporting the quantities is optional.

If quantities of dioxins, furans and HCB are estimated using mass balance, emission factors or engineering estimates, the quantities that are released, disposed of or transferred for recycling do not need to be compared to an LoQ, and must be reported.

Table 16 summarizes the information that should be reported for Part 3 substances, depending on the method of estimation and the comparison to the LoQ. Figure 6 illustrates the steps for determining the information that should be reported for Part 3 substances.

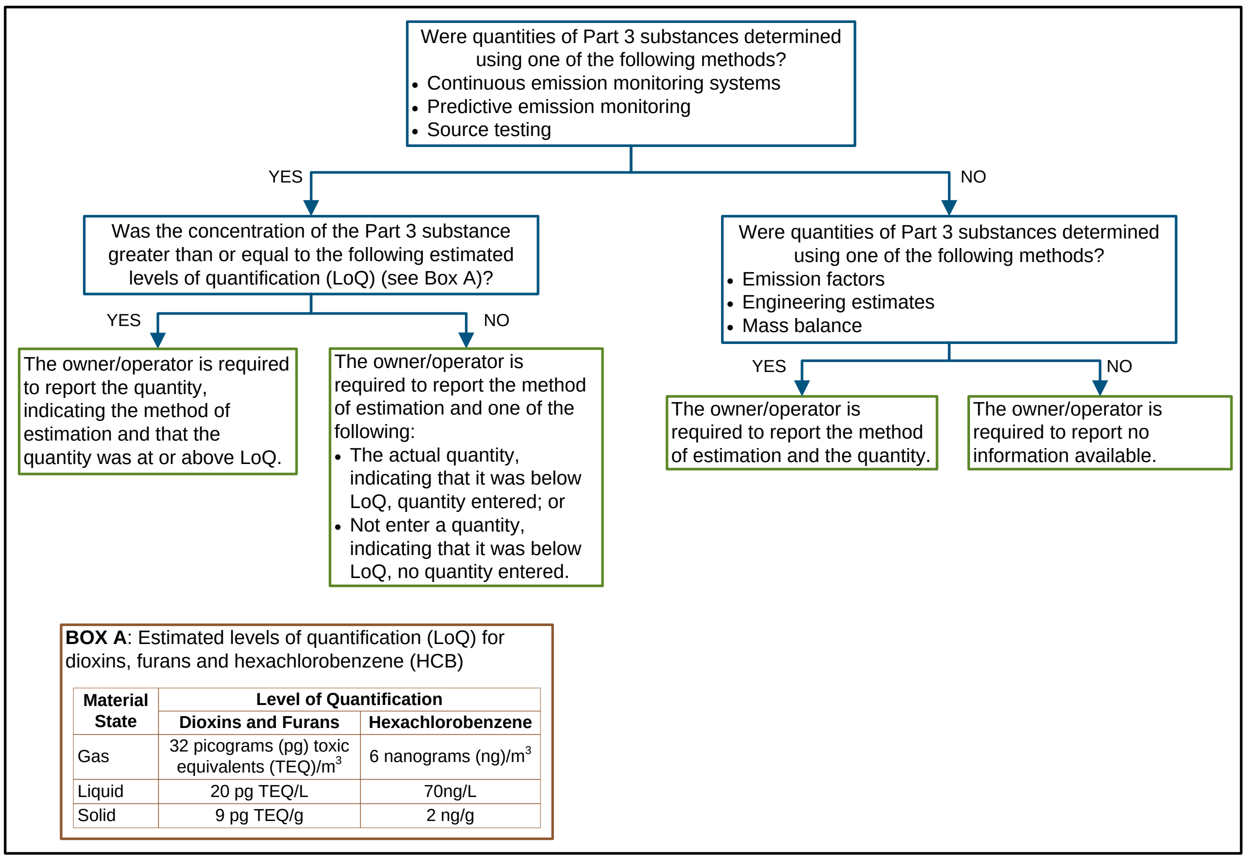
Table 16. How to Report Dioxins, Furans and Hexachlorobenzene

Method of Estimation	Comparison to Level of Quantification (LoQ)	What Must be Reported
CEMS, PEM or source testing	at or above LoQ	Report the quantity, and report that the quantity is at or above the LoQ.(1)
CEMS, PEM or source testing	below LoQ	Report that the quantity is below the LoQ. The quantity can also be reported, but this is optional when it is below the LoQ.(1)
Mass balance	n/a	Report the quantity.
Site-specific emission factor or published emission factor	n/a	Report the quantity.
Engineering estimate	n/a	Report the quantity.
No information available	n/a	Report that no information is available.(2)

(1) Use the "Help" link in the on-line reporting system to determine what detail codes are used to indicate whether the quantity is at, above or below the LoQ.

(2) "No information available" is an option under "Basis of Estimate" in the on-line reporting system, which can be selected for Part 3 substances only.

Figure 6. How to Report Dioxins, Furans and Hexachlorobenzene



Material State	Level of Quantification	
	Dioxins and Furans	Hexachlorobenzene
Gas	32 picograms (pg) toxic equivalents (TEQ)/m^3	6 nanograms (ng)/m^3
Liquid	20 pg TEQ/L	70ng/L
Solid	9 pg TEQ/g	2 ng/g

7.2.1 Reporting for Individual or Total Dioxins and Furans

Information on individual congeners of dioxins and furans must be reported if it is available. If the only information available is for total dioxins and furans, the total must be reported as toxic equivalents (TEQ).

Dioxins and furans are often found in complex mixtures, typically at extremely low concentrations, making it difficult to determine the cumulative toxicity of the mixture. Accordingly, toxic equivalency factors (TEFs) have been assigned to each dioxin and furan congener as weighting factors. These TEFs are assigned relative to the toxicity of 2,3,7,8-TCDD, the most toxic congener.

The TEFs listed in Table 17 should be used. To calculate TEQ, multiply the concentration (or quantity) of an individual congener by its respective TEF. For example, 1,2,3,4,7,8-HxCDF has a TEF of 0.1, and a sample concentration of 30 ng/kg 1,2,3,4,7,8-HxCDF is therefore equal to 3 ng TEQ/kg.

Table 17. Toxic Equivalency Factors for Dioxins and Furans

Congener	Abbreviation	CAS RN	Toxic Equivalency Factor
2,3,7,8-Tetrachlorodibenzo-p-dioxin	2,3,7,8-TCDD	1746-01-6	1
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1,2,3,7,8-PeCDD	40321-76-4	0.5
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	1,2,3,4,7,8-HxCDD	39227-28-6	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	1,2,3,6,7,8-HxCDD	57653-85-7	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1,2,3,7,8,9-HxCDD	19408-74-3	0.1
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	1,2,3,4,6,7,8-HpCDD	35822-46-9	0.01
Octachlorodibenzo-p-dioxin	OCDD	3268-87-9	0.001
2,3,7,8-Tetrachlorodibenzofuran	2,3,7,8-TCDF	51207-31-9	0.1
2,3,4,7,8-Pentachlorodibenzofuran	2,3,4,7,8-PeCDF	57117-31-4	0.5
1,2,3,7,8-Pentachlorodibenzofuran	1,2,3,7,8-PeCDF	57117-41-6	0.05
1,2,3,4,7,8-Hexachlorodibenzofuran	1,2,3,4,7,8-HxCDF	70648-26-9	0.1
1,2,3,7,8,9-Hexachlorodibenzofuran	1,2,3,7,8,9-HxCDF	72918-21-9	0.1
1,2,3,6,7,8-Hexachlorodibenzofuran	1,2,3,6,7,8-HxCDF	57117-44-9	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	2,3,4,6,7,8-HxCDF	60851-34-5	0.1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1,2,3,4,6,7,8-HpCDF	67562-39-4	0.01
1,2,3,4,7,8,9-Heptachlorodibenzofuran	1,2,3,4,7,8,9-HpCDF	55673-89-7	0.01
Octachlorodibenzofuran	OCDF	39001-02-0	0.001

Source: North Atlantic Treaty Organization, 1988a and 1988b.

8. Reporting for Part 4 Substances – Criteria Air Contaminants

Air issues such as smog and acid rain result from the presence of, and interactions between, a group of pollutants known as criteria air contaminants (CACs) and related pollutants. There are seven CACs listed in Part 4 (see Table 18).

8.1 Reporting Criteria for Part 4 Substances

In contrast to the majority of NPRI substances, the thresholds for CAC emissions are based on the quantity released to air, rather than the quantity manufactured, processed and otherwise used. In general, any person who owns or operates a facility must submit a report to the NPRI for a Part 4 substance if the following criteria are met:

- employees work a total of ≥ 20 000 hours, or
- activities to which the employee threshold does not apply (see Table 3) take place at the facility, or
- employees work a total of < 20 000 hours, and stationary combustion equipment is operated at the facility, or
- the facility is a pipeline installation where stationary combustion equipment is operated (see section 3.5 for the definition of a pipeline installation)

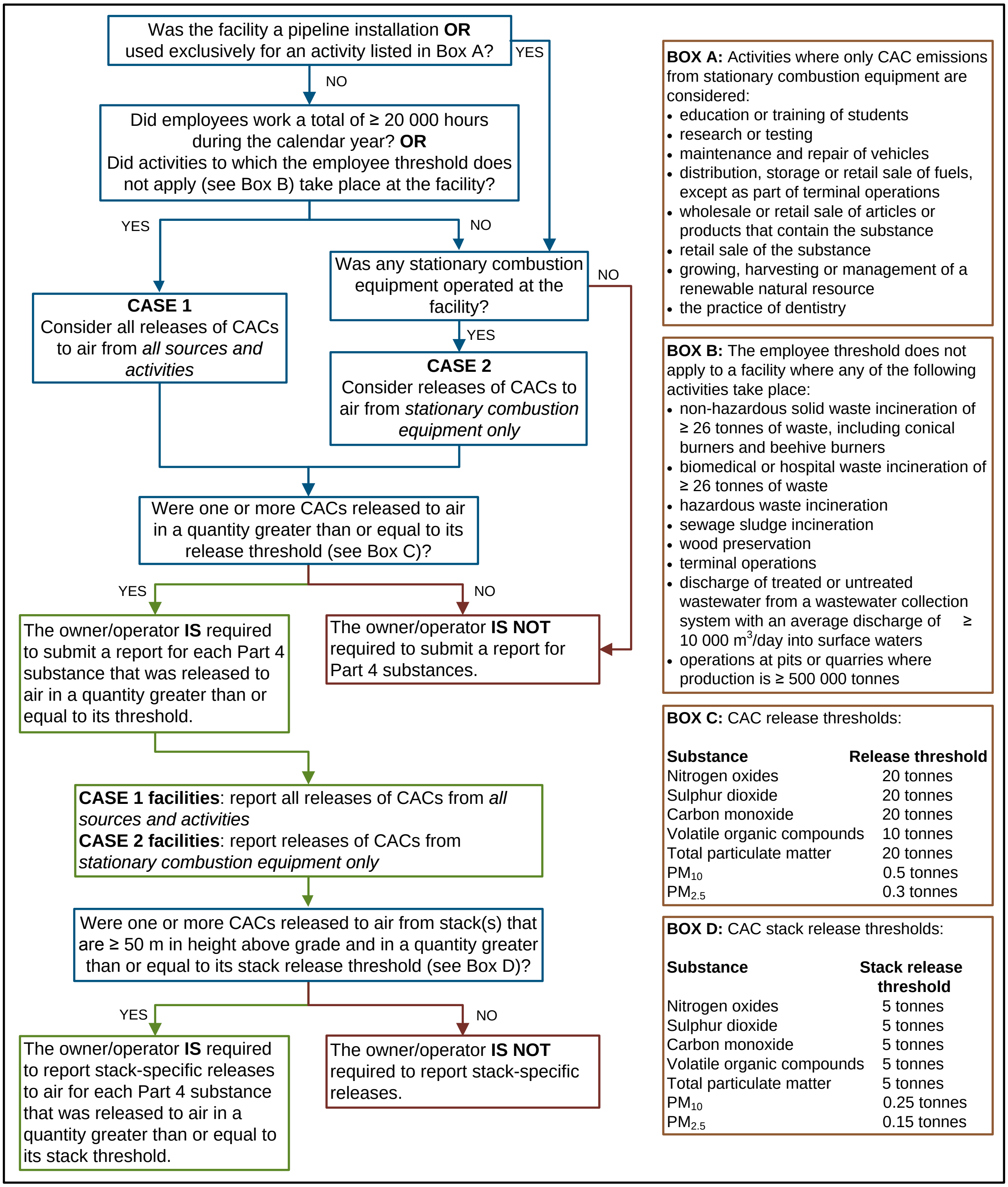
and the total quantity of the Part 4 substance released to air is greater than or equal to the release threshold specified in Table 18.

Table 18. Release Thresholds for Criteria Air Contaminants

Criteria Air Contaminant	Release Threshold (tonnes)
Nitrogen oxides (expressed as nitrogen dioxide)	20
Sulphur dioxide	
Carbon monoxide	
Total particulate matter	
Volatile organic compounds	10
Particulate matter with a diameter less than or equal to 10 micrometres (PM_{10})	0.5
Particulate matter with a diameter less than or equal to 2.5 micrometres ($PM_{2.5}$)	0.3

Figure 7 illustrates the steps for determining if a report for Part 4 substances is required, and, if so, what information must be reported. For further information on CACs and their reporting criteria, refer to the *Criteria Air Contaminants (CACs) Technical Source Guide for Reporting to the National Pollutant Release Inventory* (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=3B695DF5-1) and the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory* (www.ec.gc.ca/Publications/default.asp?lang=En&xml=4A2D4BB8-BFA0-4129-A5A3-DBA372BD3B32).

Figure 7. Reporting for Part 4 Substances



8.1.1 Part 4 Substance Qualifiers

The following sections provide information on what should be included and excluded when reporting releases of CACs.

Nitrogen oxides

Nitrogen oxides (NO_x) include nitric oxide (NO) and nitrogen dioxide (NO_2). Since NO_x is a mixture, both NO and NO_2 must be expressed on an NO_2-equivalent basis before the individual quantities are combined for the total NO_x release. Do not include nitrous oxide (N_2O) when calculating NO_x releases.

Sulphur dioxide

Sulphur dioxide (SO_2) is part of the sulphur oxide (SO_x) family of gases. However, reporting to the NPRI is only required for SO_2, not SO_x. Therefore, the quantity of the other gases in the SO_x family, (i.e., sulphite, sulphur trioxide [SO_3] and sulphate [SO_4]) released should not be considered when calculating SO_2 releases.

Particulate matter

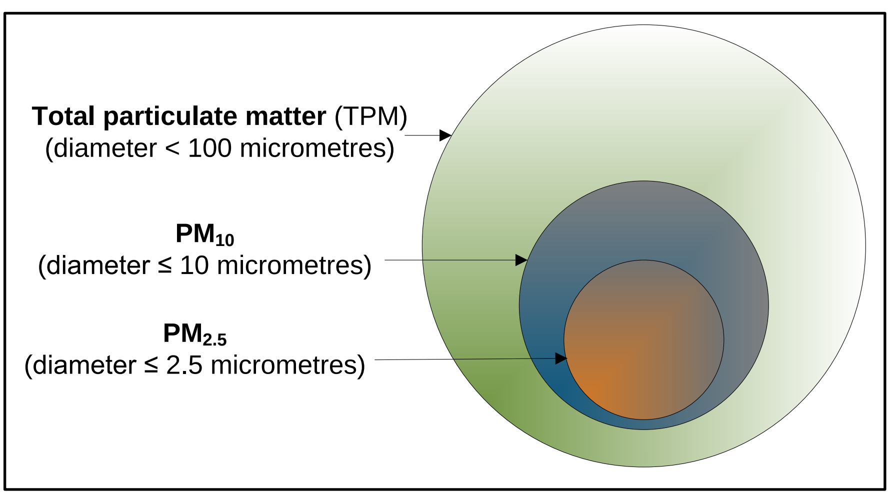
Three size fractions of particulate matter (PM) are required to be reported to the NPRI:

- total PM with a diameter less than 100 micrometres (TPM)
- PM with a diameter less than or equal to 10 micrometres (PM_{10})
- PM with a diameter less than or equal to 2.5 micrometres ($PM_{2.5}$)

As shown in Figure 8, the TPM fraction includes PM_{10} and $PM_{2.5}$, while PM_{10} includes $PM_{2.5}$. It is therefore impossible for $PM_{2.5}$ or PM_{10} releases to exceed TPM releases. It is also impossible for $PM_{2.5}$ releases to exceed PM_{10} releases.

TPM, PM_{10} and $PM_{2.5}$ emissions must be reported on a dry basis. Only filterable PM is reportable to the NPRI; condensable PM should not be included in release calculations.

Figure 8. Particulate Matter Size Fractions



Volatile organic compounds

Volatile organic compounds (VOCs) are an aggregate grouping of more than 1000 organic substances that readily volatilize and undergo photochemical reactions in the atmosphere.

VOCs should be reported as the total quantity of VOCs that participate in atmospheric photochemical reactions. Do not include any of the substances that are specified as exclusions in section 65 of Schedule 1 of the *Toxic Substances List* established under CEPA 1999 (for the list of excluded substances, see www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=0DA2924D-1&wsdoc=4ABEFFC8-5BEC-B57A-F4BF-11069545E434).

In addition, it is important to note the following:

- Approximately 100 VOCs are listed individually in Part 1A. Individual reports must be submitted for each of these VOCs that meet the Part 1A criteria (based on quantities manufactured, processed or otherwise used). Regardless of whether the Part 1A criteria are met, any releases to air of these substances must also be included in threshold calculations for Part 4 VOCs, along with all other VOCs emitted.
- When calculating Part 4 total VOCs, include any substance that meets the CEPA 1999 definition of VOC, even if it is not listed separately in Part 1 or Part 5.
- Base the VOC emissions on the total mass of all VOC substances emitted annually.
- In addition to total VOCs, facilities may be required to report additional information on speciated VOCs listed in Part 5 (see section 9 for more information).
- Total organic compounds (TOCs) and VOCs do not have the same definition. All VOCs can be considered TOCs; however, not all TOCs are considered VOCs.

8.2 Calculating Releases of Part 4 Substances

Table 19 lists some of the most common sources of CAC emissions, with a brief description of each. For more information on these sources of CACs, consult the CAC guidance documents in the *NPRI Toolbox* (www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=65A75CDF-1).

There are two possible scenarios that must be considered to determine which sources of CAC emissions must be included in threshold calculations. In Case 1, all CAC emission sources at the facility must be included in calculations. In Case 2, only the releases from the stationary combustion equipment at the facility should be included. Each case is described below.

Case 1: Facilities that must consider CAC emissions from all sources

All sources of CAC emissions must be considered when calculating releases (excluding the sources listed in Table 4), if:

- the facility is a contiguous facility, portable facility or offshore installation at which employees work $\geq$ 20 000 hours; or
- any of the activities to which the employee threshold does not apply (see Table 3) take place at the facility, regardless of the hours worked by employees.

Case 2: Facilities that must consider CAC emissions from stationary combustion equipment only

When calculating releases of Part 4 substances, facilities must consider only emissions from stationary combustion equipment if:

- employees work < 20 000 hours; or
- the only activities that take place at the facility are those listed in Table 5; or
- the facility is a pipeline installation.

A facility that is exempt from reporting Parts 1-3 substances (see section 3.7.3) may still be required to report releases of CACs from stationary combustion equipment.

Table 19. Common Sources of Criteria Air Contaminant Emissions

Source	Description
Abrasive blasting	Abrasive blasting is the process of cleaning or texturing materials with an abrasive material, such as sand, coal and smelter slag, as well as mineral, metallic or synthetic abrasives. The blasting process itself is a source of PM emissions, especially PM_{10} and $PM_{2.5}$.
Equipment leaks	Equipment connections, joints and interfaces can be the source of gaseous and liquid releases. If the equipment is handling a gaseous stream containing a CAC, the gaseous leak would result in a fugitive CAC release. Depending on the properties of a liquid (such as vapour pressure, temperature and pressure), a liquid release may also result in a fugitive CAC release.
External combustion equipment	This comprises any equipment with a combustion process that occurs at atmospheric pressure and with excess air, including heaters, furnaces, incinerators, boilers, flares, combustion chambers, external combustion engines such as steam engines and Stirling engines, steam/electric generating plants, and other commercial units.
Fermenting	The process of fermentation involves the use of yeast, bacteria, enzymes, etc., to break down complex organic compounds. Many industries use fermentation, including the production of bread, spirits, pharmaceuticals, fuel, beer and wine, as well as environmental bioremediation processes.
Internal combustion equipment	This comprises any equipment with a combustion process that occurs in a confined space and above atmospheric pressure, including gas turbines, natural-gas-fired reciprocating engines, gasoline and diesel industrial engines, and large, stationary diesel and dual-fuel engines.
Loading and unloading	Fugitive CAC emissions can result from the loading and unloading of vehicles or containers. If the material being transferred is a liquid, the resulting emissions would likely be in the form of VOCs. If the material is a solid, the resulting emissions would likely be in the form of PM.
Painting	VOCs are released from paint during its application and drying. This category includes, but is not limited to, the painting of vehicles, furniture, storage tanks and any other painted product. $PM_{2.5}$ may also be emitted if paint is applied by pulverization.
Printing	VOCs are released from fixers, developers and solvents used during printing processes.
Road dust	TPM, PM_{10} and $PM_{2.5}$ releases from road dust caused by vehicular traffic on unpaved roads within facility boundaries are required to be included in release calculations, when travel on these roads is ≥ 10 000 vehicle kilometres travelled per year.
Solvent use	Solvent use includes, but is not limited to, solvent degreasing, waste solvent reclamation, product formulation and commercial solvent use. Many solvents contain VOCs that are released during storage, through evaporation.
Stationary combustion equipment	This comprises any combustion equipment that needs to be stationary to function or operate properly, or is not capable of self-propulsion, including both internal and external combustion equipment.
Storage piles	Handling storage piles generates PM emissions. Pile moisture content, wind speed and proportion of aggregate fines all influence total emissions from a storage pile.
Storage tanks	These comprise any storage tanks containing fuels, solvents, hydrocarbons, paints and other solutions that contain VOCs. This includes fixed roof, external floating roof, domed external floating roof, internal floating roof, variable vapour space and pressure storage tanks.

Possible exclusion for Case 2 facilities

A facility that meets the Case 2 criteria is **not** required to submit reports for CACs, if all the following criteria are met:

- CACs are released to air only from stationary external combustion equipment; and
- the cumulative nameplate capacity of all stationary external combustion equipment is less than 10 million BTUs/hour (10.55 million kJ/hour); and
- the only type of fuel combusted in that equipment is commercial-grade natural gas, liquefied petroleum gas, Number 1 or 2 fuel oil, or any combination thereof.

This exclusion does not apply if any other fuels are burned in the stationary external combustion equipment.

8.3 Reporting Releases of Part 4 Substances

If the reporting criteria are met for a Part 4 substance, the releases to air of that substance must be reported in tonnes. Case 1 facilities must report all releases from all sources. Case 2 facilities should only report releases from stationary combustion equipment.

Stack-specific releases to air may also need to be reported for each stack ≥ 50 metres (m) above grade, if the stack-specific release threshold specified in Table 20 is met. The following information about each stack must also be reported: height above grade, equivalent diameter, average exit velocity and average exit temperature.

Table 20. Stack-Specific Release Thresholds for Criteria Air Contaminants

Criteria Air Contaminant	Stack Release Threshold (Tonnes)
Nitrogen oxides (expressed as nitrogen dioxide)	5
Sulphur dioxide	
Carbon monoxide	
Volatile organic compounds	
Total particulate matter	
Particulate matter with a diameter less than or equal to 10 micrometres (PM_{10})	0.25
Particulate matter with a diameter less than or equal to 2.5 micrometres ($PM_{2.5}$)	0.15

Example of stack-specific CAC reporting

A facility releases 25 tonnes of NO_x to air from the whole facility. The facility has a stack that is 55 m above grade and that emitted 7 tonnes of NO_x. The following must be reported:

- 25 tonnes of NO_x must be first reported for total NO_x releases (NO_x has a total release threshold of 20 tonnes); and
- 7 tonnes of NO_x must be reported under the stacks requirement (NO_x has a stack release threshold of 5 tonnes).

9. Reporting for Part 5 Substances – Speciated Volatile Organic Compounds

Part 5 lists 75 VOCs in three groups (individual substances, isomer groups, and other groups and mixtures), which are subject to additional reporting requirements. These VOCs are collectively referred to as "speciated VOCs." For a list of the speciated VOCs listed in Part 5, consult the NPRI website: www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=E2BFC2DB-1.

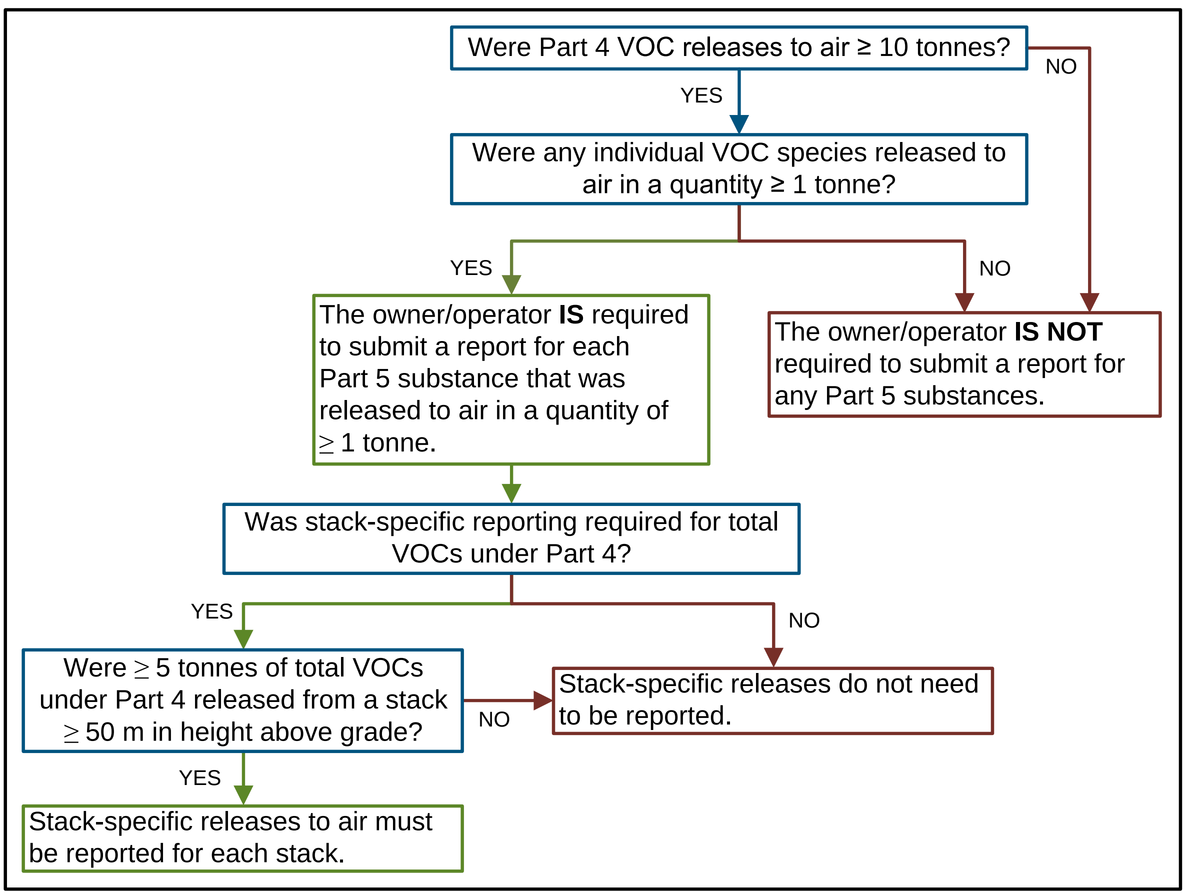
9.1 Reporting Criteria for Part 5 Substances

Like Part 4 substances, speciated VOCs must be reported based on quantities released to air. In general, any person who owns or operates a facility must submit a report to the NPRI for a Part 5 substance if both of the following criteria are met:

- Part 4 total VOCs released to air are ≥ 10 tonnes, and
- the total quantity of the Part 5 substance released to air is ≥ 1 tonne.

Figure 9 illustrates the steps for determining if a report for Part 5 substances is required, and, if so, what information must be reported.

Figure 9. Reporting for Part 5 Substances



9.1.1 Part 5 Substance Qualifiers

Some Part 5 substances and groups of substances are qualified in terms of what needs to be included when calculating releases. The qualifiers, described in Table 21, determine whether a report will be required for a given substance.

Table 21. Part 5 Substance Qualifiers

Substance Qualifier	Substance(s) to Which the Qualifier Applies	Description
and its salts	aniline (CAS RN 62-53-3)	Aniline and all salts of aniline must be reported as an equivalent weight of the acid or base.
all isomers	anthraquinone, butane, butene (25167-67-3), cycloheptane, cyclohexene, cyclooctane, decane, dihydronaphthalene, dodecane, heptane, hexene (25264-93-1), methylindan (27133-93-3), nonane, octane, pentane, pentene, terpenes (68956-56-9) and xylene (1330-20-7)	Total of all isomers reported as an aggregate of the individual isomers
	hexane	Total of all isomers reported as an aggregate of the individual isomers, excluding n-hexane (110-54-3)
	trimethylbenzene (25551-13-7)	Total of 1,2,3-trimethylbenzene (526-73-8) and 1,3,5-trimethylbenzene (108-67-8) Excludes 1,2,4-trimethylbenzene (95-63-6)

9.2 Calculating Releases of Part 5 Substances

There are two scenarios that must be considered to determine what sources of VOC emissions must be included in threshold calculations for Part 5 substances.

Case 1: Facilities that must consider all sources of VOC emissions

All sources of VOC emissions must be considered when calculating releases (excluding the sources listed in Table 4), if:

- the facility is a contiguous facility, portable facility or offshore installation at which employees work ≥ 20 000 hours; or
- any of the activities to which the employee threshold does not apply (see Table 3) take place at the facility, regardless of the hours worked by employees.

Case 2: Facilities that must consider VOC emissions from stationary combustion equipment only

Only VOC emissions from stationary combustion equipment must be considered when calculating releases if:

- employees work <20 000 hours; or
- the only activities that take place at the facility are those listed in Table 5; or
- the facility is a pipeline installation.

9.3 Reporting Releases of Part 5 Substances

If the reporting criteria are met for a Part 5 substance, the releases to air of that substance must be reported. Part 5 substances must be reported in tonnes. Stack-specific releases to air may also need to be reported for each stack ≥ 50 m above grade if both of the following criteria are met:

- stack-specific reporting is required for total VOCs under Part 4; and
- 5 tonnes or more of total VOCs under Part 4 are released to air from the stack.

Example of stack-specific speciated VOC reporting

A facility emits 28 tonnes of VOCs to air, 7 tonnes of which are emitted from a stack 65 m above grade. The remaining 21 tonnes are from storage/handling, fugitive releases, spills and other non-point sources. Three tonnes of styrene are released to air, 0.4 tonnes of which are from the 65 m stack. The following must be reported:

Part 4 (total VOCs)

- 28 tonnes of total VOCs must be reported under Part 4 (total VOCs have a release threshold of 20 tonnes)
- 7 tonnes of total VOCs must be reported for the facility's stack under Part 4 (total VOCs have a stack-specific release threshold of 5 tonnes)

Part 5 (speciated VOCs)

- 3 tonnes of styrene must be reported under Part 5 (speciated VOCs have a release threshold of 1 tonne)
- 0.4 tonnes of styrene must be reported for the facility's stack (speciated VOCs must be attributed to stack if the speciated VOC meets the facility-wide 1 tonne threshold, and the Part 4 VOC stack release threshold of 5 tonnes is met)
- the remaining 2.6 tonnes of styrene must be reported as being released from "other sources"

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www.ec.gc.ca

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TTY: 819-994-0736
Email: enviroinfo@ec.gc.ca

Year | Année	NPRI ID | ID INRP	Company Name | Raison Sociale	Facility Name | Nom de l'installation	City | Ville	CSD | SDR	CA or CMA | AR ou RMR	Economic Region | Région économique	Province | Province	Latitude | Latitude	Longitude | Longitude	Substance Name (English) | Nom de substance (Anglais)	Substance Name (French) | Nom de substance (Français)	Units | Unités	Stack Emissions | Émissions de cheminées	Direct Discharge | Évacuations directes	Footnotes | Notes de bas de page
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	2.08E+12	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.49E+13	1.50E+13	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	0.00E+00	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	0.00E+00	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.76E+06	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.12E+07	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	2.59E+05	2.40E+08	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	1.61E+07	1.79E+10	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	5.89E+09	
2021	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.0015	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	2.76E+10	NRM | NRS	
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules	Bq	8.39E+04	4.81E+07	
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules	Bq	2.33E+05	2.88E+08	
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	5.18E+07	
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.80E+07	
2021	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	1.09E-05	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	2.77E+05	
2021	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	0.1	
2021	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.041	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	6.25E+05	
2021	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2021	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	2.57E+11	2.30E+10	
2021		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Particulate	Particules	Bq	0.00E+00	5.55E+06	
2021		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Particulate	Particules	Bq	7.58E+04	2.97E+07	
2021		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0016	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2021		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	1.50E+11	3.08+10	
2021		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules	Bq	3.85E+04	4.43+07	
2021		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	5.06E+12	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.54E+13	1.08E+13	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	2.61E+10	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	0.00E+00	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.00E+06	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.44E+07	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	2.72E+05	2.40E+08	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	2.04E+07	1.75E+10	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	7.07E+09	
2020	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.0074	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	1.31E+10	4.91E+09	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules	Bq	9.98E+04	6.67E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules	Bq	2.13E+05	3.62E+08	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Uranium-to	Uranium to	Bq	NRM | NRS	1.30E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	3.94E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	2.39E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Americium	Américium	Bq	NRM | NRS	1.80E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	5.71E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.86E+07	
2020	7434	Canadian	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	3.00E-06	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	8.45E+05	
2020	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS	1	
2020	30760	Canadian	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.02	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	7.78E+05	
2020	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS	0.2	
2020	30761	Canadian	Port Hope	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.033	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	4.10E+11	1.74E+10	
2020		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Particulate	Particules	Bq	8.44E+03	8.34E+06	
2020		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Particulate	Particules	Bq	1.38E+05	3.31E+07	
2020		Canadian	Douglas Po	Tiverton	Kincardine		Stratford--	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0018	NRM | NRS	Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2020		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	3.65E+11	6.67E+09	
2020		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules	Bq	4.43E+04	2.05E+08	
2020		Canadian	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS	Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	5.51E+12	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.01E+14	1.31E+13	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	3.44E+10	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	0.00E+00	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.44E+06	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.67E+07	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	0.00E+00	NRM | NRS	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	1.06E+05	4.62E+08	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Particulate	Particules	Bq	4.35E+07	2.75E+10	
2019	3147	Canadian	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	2.57E+09	

2019	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.0039	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	3.34E+10	4.51E+09		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.31E+04	5.82E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules l	Bq	3.27E+05	3.43E+08		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Uranium-to	Uranium to	Bq	NRM | NRS	1.49E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	4.70E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	4.86E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Americium	Américium	Bq	NRM | NRS	2.01E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	5.95E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	2.11E+07		
2019	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	8.70E-05	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	2.20E+06		
2019	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		2.7	
2019	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.0396	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	7.82E+05		
2019	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		0.2	
2019	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.035	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	2.41E+11	3.73E+10		
2019		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules a	Bq	4.90E+03	6.75E+06		
2019		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules l	Bq	3.90E+04	4.52E+07		
2019		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0015	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2019		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	1.59E+11	2.52E+10		
2019		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules l	Bq	4.21E+04	4.06E+07		
2019		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	6.86E+12	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.34E+14	1.93E+13		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	2.59E+11	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	6.50E+12	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	9.67E+07	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.05E+08	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	2.64E+15	NRM | NRS		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules a	Bq	2.74E+05	6.88E+08		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules l	Bq	8.01E+07	2.84E+10		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	8.72E+09		
2018	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.036	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	1.31E+10	NRM | NRS		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.13E+04	3.90E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules l	Bq	1.70E+05	1.94E+08		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Uranium-to	Uranium to	Bq	NRM | NRS	1.16E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	2.32E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	1.84E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Americium	Américium	Bq	NRM | NRS	4.21E+06		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	3.21E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.51E+07		
2018	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	3.60E-05	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	1.00E+06		
2018	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		1.3	
2018	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.02	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	7.00E+05		
2018	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		0.5	
2018	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	5.68E+09		Releases from non-routine operations | Rejets des opérations anormales
2018	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		14.6	Releases from non-routine operations | Rejets des opérations anormales
2018	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.0275	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	7.96E+11	2.73E+10		
2018		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules a	Bq	3.07E+03	1.18E+07		
2018		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules l	Bq	4.55E+04	1.97E+07		
2018		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Carbon-14	Carbone-1	Bq	1.51E+09	NRM | NRS		
2018		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0017	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2018		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	3.08E+11	1.80E+09		
2018		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules l	Bq	4.23E+04	5.91E+07		
2018		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	4.64E+12	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.53E+14	3.81E+13		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	4.91E+11	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	6.50E+12	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	5.30E+08	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	3.78E+08	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.16E+16	NRM | NRS		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules a	Bq	3.05E+05	7.66E+08		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules l	Bq	7.20E+07	4.17E+10		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	1.66E+10		
2017	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.087	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	5.03E+10	NRM | NRS		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.34E+04	3.88E+07		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Particulate	Particules l	Bq	2.24E+05	2.97E+08		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Uranium-to	Uranium to	Bq	NRM | NRS	1.69E+07		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	1.20E+07		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Plutonium-	Plutonium-	Bq	NRM | NRS	8.69E+06		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Americium	Américium	Bq	NRM | NRS	5.10E+06		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division Nc	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	6.67E+07		

2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.89E+07		
2017	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	4.80E-05	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	1.00E+06		
2017	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		1.4	
2017	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.00571	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	8.00E+05		
2017	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		0.1	
2017	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	1.59E+10		Releases from non-routine operations | Rejets des opérations anormales
2017	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		110.1	Releases from non-routine operations | Rejets des opérations anormales
2017	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.0045	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	1.12E+11	3.57E+10		
2017		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Particulate	Particules a	Bq	1.64E+03	1.12E+07		
2017		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Particulate	Particules b	Bq	2.29E+04	2.56E+07		
2017		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0021	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2017		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	1.48E+12	3.58E+13		
2017		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules b	Bq	1.84E+05	1.80E+08		
2017		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	2.55E+12	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.45E+14	3.50E+13		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	4.85E+11	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	3.97E+14	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.91E+08	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	5.17E+10	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.07E+16	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	3.12E+15	NRM | NRS		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Particulate	Particules a	Bq	3.06E+05	6.60E+08		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Particulate	Particules b	Bq	1.53E+08	3.22E+10		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	7.30E+09		
2016	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.078	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	3.24E+10	NRM | NRS		
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.46E+04	4.59E+07		
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules b	Bq	2.12E+05	2.83E+08		
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	6.08E+07		
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.28E+07		
2016	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	7.50E-05	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	2.40E+06		
2016	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		15.6	
2016	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.00543	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	3.30E+06		
2016	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		19.3	
2016	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.01195	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	1.59E+11	2.23E+10		
2016		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Particulate	Particules a	Bq	1.68E+03	9.00E+06		
2016		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Particulate	Particules b	Bq	1.91E+04	1.05E+07		
2016		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Estimated	Dose estim	mSv/a	0.0016	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2016		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	2.53E+11	6.57E+10		
2016		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules b	Bq	4.30E+04	3.57E+07		
2016		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated	Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Elemental	Tritium élé	Bq	4.77E+12	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.77E+14	3.94E+13		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	3.77E+11	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	1.20E+15	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	3.44E+08	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.03E+11	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	1.29E+16	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	4.89E+15	NRM | NRS		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Particulate	Particules a	Bq	3.51E+05	6.94E+08		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Particulate	Particules b	Bq	3.14E+07	3.96E+10		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	6.70E+10		
2015	3147	Canadian N	Chalk Rive	Chalk Rive	Deep River	Renfrew	Kingston--P	ON	46.0554	-77.3628	Estimated	Dose estim	mSv/a	0.083	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	9.88E+10	NRM | NRS		
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.79E+04	4.08E+07		
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules b	Bq	2.26E+05	2.28E+08		
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	3.96E+07		
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	1.65E+07		
2015	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated	Dose estim	mSv/a	0.001	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	4.60E+06		
2015	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		29	
2015	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated	Dose estim	mSv/a	0.0084	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	4.50E+06		
2015	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		20.7	
2015	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated	Dose estim	mSv/a	0.09352	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	1.33E+10	4.24E+10		
2015		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--B	ON	44.3267	-81.6	Particulate	Particules b	Bq	NRM | NRS	7.31E+07		

2015		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Estimated		Dose estim	mSv/a	0.0029	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2015		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	2.15E+11	6.61E+10		
2015		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules l	Bq	4.81E+04	4.13E+06		
2015		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated		Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Elemental '	Tritium élé	Bq	1.37E+12	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.60E+14	3.07E+13		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	8.69E+11	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	2.11E+15	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	1.62E+08	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	2.06E+11	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	9.37E+15	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	8.68E+15	NRM | NRS		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules a	Bq	4.81E+05	9.07E+08		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules l	Bq	4.82E+07	2.62E+11		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	2.26E+11		
2014	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Estimated		Dose estim	mSv/a	0.06	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	3.48E+10	NRM | NRS		
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	8.82E+04	4.76E+07		
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules l	Bq	3.97E+05	9.31E+07		
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	6.61E+07		
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	2.66E+07		
2014	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Estimated		Dose estim	mSv/a	0.002	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	5.40E+06		
2014	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		36.7	
2014	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Estimated		Dose estim	mSv/a	0.00383	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	7.70E+06		
2014	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		23	
2014	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Estimated		Dose estim	mSv/a	0.02867	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	2.74E+11	5.19E+10		
2014		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules l	Bq	NRM | NRS	6.37E+07		
2014		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Estimated		Dose estim	mSv/a	0.002	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2014		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	2.63E+11	9.60E+10		
2014		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules l	Bq	5.27E+04	6.08E+06		
2014		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Estimated		Dose estim	mSv/a	<0.01	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Elemental '	Tritium élé	Bq	1.59E+12	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Tritium (HT	Tritium (Ea	Bq	2.46E+14	2.91E+13		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Carbon-14	Carbone-1	Bq	5.74E+11	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Total noble	Total des g	Bq-MeV	1.32E+15	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-125	Iode-125	Bq	2.84E+08	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Iodine-131	Iode-131	Bq	1.38E+11	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Argon-41	Argon-41	Bq	8.46E+15	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Xenon-133	Xenon-133	Bq	5.72E+15	NRM | NRS		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules a	Bq	4.22E+05	5.62E+08		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Particulate	Particules l	Bq	3.84E+07	3.62E+10		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Strontium-	Strontium-	Bq	NRM | NRS	1.51E+10		
2013	3147	Canadian N	Chalk River	Chalk River	Deep River	Renfrew	Kingston--F	ON	46.0554	-77.3628	Estimated		Dose estim	mSv/a	0.05914	NRM | NRS		Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Tritium (HT	Tritium (Ea	Bq	3.52E+10	NRM | NRS		
2013	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules a	Bq	9.24E+04	1.14E+08		
2013	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Particulate	Particules l	Bq	2.29E+05	3.86E+08		
2013	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Strontium-	Strontium-	Bq	NRM | NRS	6.97E+07		
2013	7434	Canadian N	Whiteshell	Pinawa	Pinawa	Division No	Southeast	MB	50.1789	-96.0604	Cesium-13	Césium-13	Bq	NRM | NRS	6.40E+07		
2013	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Radium-22	Radium-22	Bq	NRM | NRS	5.00E+06		
2013	30760	Canadian N	Port Granb	Clarington				ON	43.9106	-78.4511	Uranium	Uranium	kg	NRM | NRS		49.2	
2013	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Radium-22	Radium-22	Bq	NRM | NRS	6.20E+06		
2013	30761	Canadian N	Port Hope I	Port Hope				ON	43.9608	-78.3407	Uranium	Uranium	kg	NRM | NRS		25.4	
2013		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Tritium (HT	Tritium (Ea	Bq	1.59E+11	8.73E+10		
2013		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Particulate	Particules l	Bq	NRM | NRS	5.31E+07		
2013		Canadian N	Douglas Po	Tiverton	Kincardine		Stratford--I	ON	44.3267	-81.6	Estimated		Dose estim	mSv/a	0.0013	NRM | NRS		Includes the entire Bruce site. Estimated public dose is calculated incorporating all major release pathways (emissions and discharges) | Comprend tout le site de Bruce. La dose estimée au public est calculée en utilisant toutes les principales voies de pénétration de rejet (émissions et rejets)
2013		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Tritium (HT	Tritium (Ea	Bq	6.86E+10	1.41E+11		
2013		Canadian N	Nuclear Po	Rolphton				ON	46.1868	-77.6578	Particulate	Particules l	Bq	6.63E+04	9.76E+05		

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Whiteshell Laboratories Site Emergency Response Plan REV 0

WL-508730-PLA-001591

Information Use

Approved by	Title	Date
Adrian Bilton	Director, Corporate Fire & Eme	2023/03/23

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
0	2023/05/31	Issued as "Approved for Use".	J. O'Connor	A. Nash	A. Bilton
0D1	2023/03/06	Issued for "Review and Comment". Issued for review and comment. Update to Officer-In-Charge program details, re-worked content to reflect current site and staff realities. Other minor revisions throughout. Supersedes document WL-508730-ERP-001.	J. O'Connor	A. Nash G. Rollins R. Swartz	

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1. Purpose

The Whiteshell Laboratories (WL) Emergency Response Plan was created to support operations at the WL site to prepare for, respond to, and recover from emergency situations that are beyond the day-to-day operations of on-site emergency response services. This plan adheres to the industry standard of a four-pillared approach to emergency management. These pillars are:

- Prevention and Mitigation;
- Preparedness;
- Response; and
- Recovery.

This plan is designed to be an All-Hazards plan. This means that while specific high-risk events may receive additional planning rigor, the approaches and methodologies used are designed to build procedures and processes that can be applied to any emergency. The ultimate objectives of this plan, and the WL Emergency Preparedness (EmP) program, are to:

- Protect the public from the nuclear legacy of the site during the decommissioning process;
- Protect CNL employees and contractors;
- Protect the environment; and
- Protect the reputations and interests of both CNL and AECL through timely responses and quick recovery times.

2. Scope

This plan conforms to the requirements of the Company Wide Emergency Preparedness Program Requirements Document [1]. This plan is not restricted to radiological emergencies. Response to incidents that can be handled without invoking this site wide emergency plan are covered in the Fire Protection Program Description Document [2], the ESO Standard Operating Guidelines [3] and the Radiation Protection (RP) Program Requirements Document [4].

The Site-Wide Emergency Procedure [5] and corresponding quick reference tools were created to provide employees on site with instructions to follow during specific emergencies that support this plan, and those listed above.

This plan is designed to guide responses to any emergency at the WL site, which includes the controlled and supervised areas of the main campus, the Waste Management Area (WMA), and the Concrete Canister Storage Facility (CCSF). The plan includes a description of the site, a general description of the resources available to manage an emergency of either radiological or non-radiological nature, and a summary of the responsibilities and actions of various groups or individual employees.

This plan also provides an overview of the interactions between WL's EmP staff and supporting provincial and municipal emergency organisations and their plans.

3. Abbreviations

CCSF	Concrete Canister Storage Facility
CMT	Crisis Management Team
CNSC	Canadian Nuclear Safety Commission
EOC	Emergency Operations Centre
ESO	Emergency Services Operations
IC	Incident Commander
ICP	Incident Command Post
LGD	Local Government District
MB EMO	Manitoba Emergency Measures Organisations
OIC	Officer in Charge
PSC	Public Safety Canada
RP	Radiation Protection
SRC	Safety Review Committee
WL	Whiteshell Laboratories
WMA	Waste Management Area

4. Site Description

4.1 Location

WL is located in the Local Government District of Pinawa, along the Winnipeg River between Lac du Bonnet and Seven Sisters Falls (see Figure 1). The site is about 85 km east northeast of Winnipeg, and is accessible by all-weather highways. WL is served by Provincial Trunk Highway 211 which connects to Provincial Highway 11, on the west side of the Winnipeg River, with the community of Pinawa, 13 km east of the site.

This region is located in the Canadian Shield which is heavily forested, and near the northeastern boundary of the plains area of eastern Manitoba which is dominated by agricultural land. The site is located alongside the Winnipeg River but is well above present flood levels.

The seismology, meteorology, and population of WL and the surrounding areas are described in Appendix A.

4.2 WL Facilities

The main WL facilities from which radioactive material could be released to the environment following an accident or emergency event are:

1. The Shielded Facilities - a shielded research facility designed for remote examination of radioactive materials (primarily mixed fission products (Cs 137, Sr 90, Am 241) and activation products (Co 60, Nb 94). This facility has 12 hot-cells, six are operational and 6 are partially decommissioned.
2. The Waste Management Area - used for storing radioactive materials and some chemical wastes. This location will become very active over the life of the decommissioning project as waste is recovered, packaged, and shipped from site.
3. The Concrete Canister Storage Facility which consists of 16 canisters containing primarily mixed fission products and activation products - Th, U, and Pu.
4. The WR 1 Research Reactor - shutdown since 1985, defueled and partially dismantled 60 MW(t) organic cooled, heavy water moderated reactor (primarily activated reactor components, mixed fission products, activation products, and tritium).

For each of the facilities listed above, the current Source Term document [6] provides information on: the amount of radioactivity contained in a given facility; the most extreme accident scenario; and the amount of radioactivity that could be released as a consequence of the most extreme accident scenario. None of these have a potential for off-site impacts at this time.

There are many buildings and facilities on the WL site in which hazardous chemicals are handled under controlled conditions. The inventories involved are typically small enough that the consequences of an accidental release would be localized to the affected building or area.

A few facilities have inventories (e.g. quantities of liquid chlorine or petroleum products) large enough that a major release or involvement in a fire could impact a large portion of the site or have possible minor off site consequences.

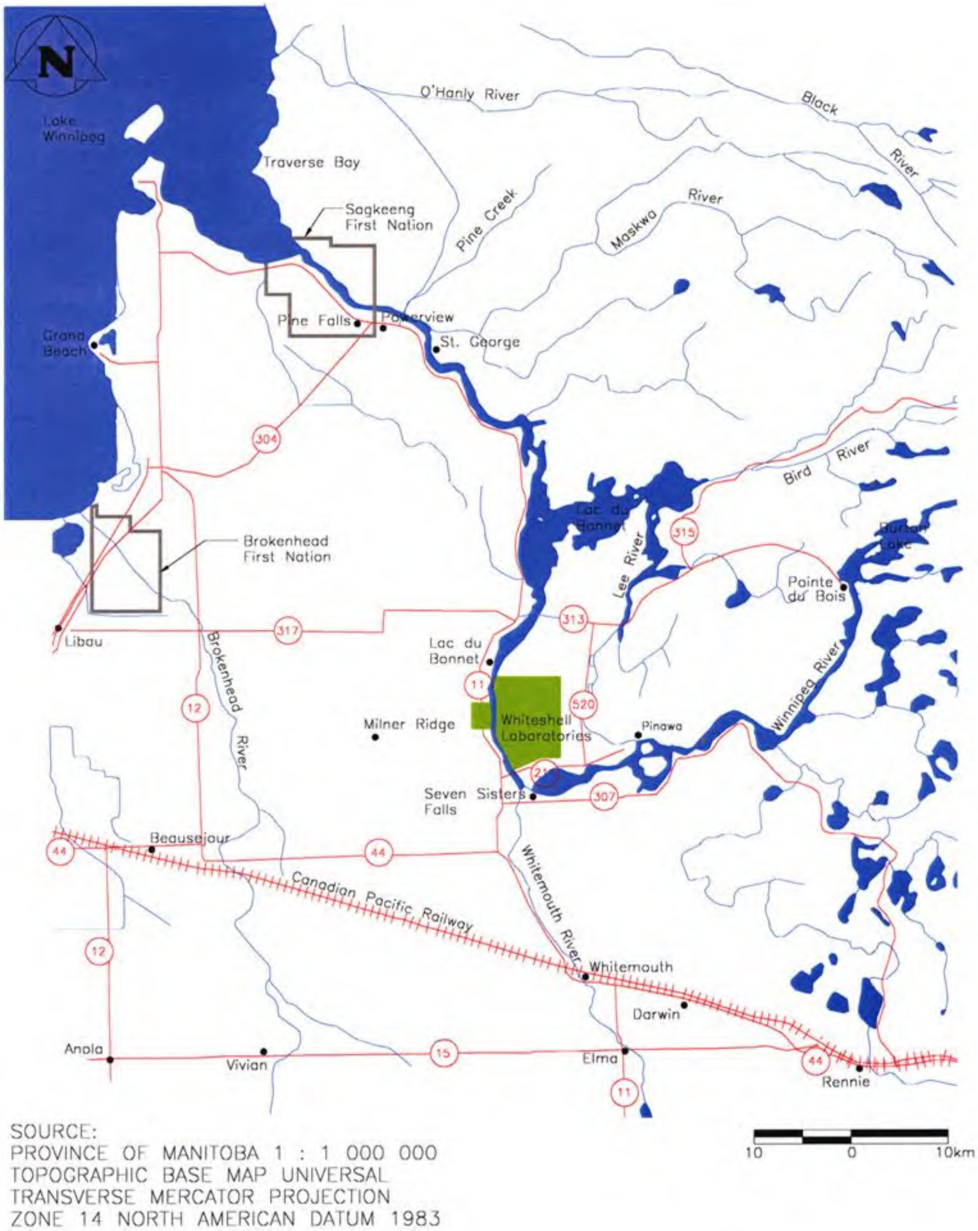

Figure 1: Map Showing Whiteshell Laboratories and Surrounding Area

5. Hazard/Vulnerability Analysis

5.1 Radiological Source Terms

5.1.1 Radiological Airborne Source Term

The Whiteshell Laboratories Source Term [6] documents the current radiological source terms for relevant nuclear buildings and locations of interest in WL, and the calculation of on-site and off-site radiation doses to individuals from postulated accidental airborne radiological releases, for both rare and extremely rare accident scenarios. The nuclear facilities at WL which are of radiological concern for accidental airborne contamination releases are the Shielded Facilities (Hot Cells and the Waste Handling Area), Waste Management Area, and WR-1 reactor. Bounding accidents (maximum worst case scenarios) are a fire involving radioactive material in the Shielded Facilities and WMA and a deflagration event occurring during remediation of an irradiated fuel bearing standpipe in the WMA.

For all exposure situations, the majority of the dose occurs within the first hour of the release due to inhalation as the radioactive plume passes the receptor location and is due primarily to inhalation of released actinide radionuclides. Fission products contribute to longer term exposure through ground shine of deposited contamination on the ground.

The most significant potential accidental radiological release is a deflagration event occurring in an irradiated fuel bearing standpipe [6][1]. The maximum calculated adult dose at the WMA site ranges from 0.81 mSv for a rare accident, to 81 mSv for an extremely rare accident. The rare accident dose is below the rare event dose risk criteria of 5 mSv that would warrant the provision of a stay-in. The extremely rare accident dose exceeds the stay-in dose risk criteria for extremely rare events of 50 mSv. The maximum adult dose at the boundary of the site ranges from 0.03 mSv (rare accident) and 3 mSv (extremely rare accident) both below the stay-in dose risk criteria. The maximum off-site adult dose8 for local residences in the vicinity of CNL property ranges from 3.2 x 10-2 mSv (rare accident) to 0.76 mSv (extremely rare accident) and the calculated maximum dose to local towns ranges from 2.1 x 10-3 mSv (rare accident) to 0.21 mSv (extremely rare accident). These off-site doses are below the stay-in dose risk criteria.

The event capable of causing the maximum calculated dose for an adult on the WL main site campus is a fire in the Shielded Facilities. The maximum dose ranges from 2.8 x 10-3 mSv (rare accident) to 0.95 mSv (extremely rare accident). Maximum off-site adult dose ranges from 9.0 x 10-5 mSv (rare accident) to 3.0 x 10-2 mSv (extremely rare) for local residences and from 2.8 x 10-5 mSv (rare accident) to 9.4 x 10-3 mSv (extremely rare) for local towns. All these doses are below the stay-in dose risk criteria. The calculated doses from an accidental release of tritium from WR-1 are about 100 times lower for on-site doses and 36 to 50 times lower for off-site doses compared to the dose from a Shielded Facility fire rare accident.

[1] See Table 20 of Reference [6] for dose acceptance criteria for accidents, including definitions of “rare” and “extremely rare” accidents.

5.1.2 Off-Hours Nuclear Emergencies

A Hazard and Operability study was carried out at WL [7] to ensure that the removal of trained nuclear operators from off shift operation would still result in an adequate response to emergency situations. The study was conducted to identify the potential emergency situations requiring specific nuclear operator off shift response and additional response required by other expert groups. Facilities were selected on the basis of highest inventory of radionuclides and/or hazardous chemicals or conventional hazards such as high temperature/pressure processes.

5.2 Analysis of Potential Emergencies at WL

A Hazard Impact and Risk Assessment (HIRA) [8] was created for WL in 2017 (last updated in 2022) and forms the basis for EmP planning activities. The HIRA rates the risk of potential emergency situations at WL based on a probability x impact matrix (Table 5-1). This sorted the hazards into four hazard categories; Low, Moderate, High, and Severe. The WL results of this process can be seen in Table 5-2.

Table 1: Hazard Impact and Risk Assessment Matrix

Impact	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Probability				

Table 2: Summary of 2022 WL HIRA

Hazard	Score	Classification
Wildland Fire	9	Moderate
Physical Security Intrusion	8	Moderate
On-site Dangerous Goods Incident (Non-RAM)	8	Moderate
Pandemic	8	Moderate
Severe Weather (Snow)	6	Moderate
Severe Weather (Thunderstorm)	6	Moderate
Severe Weather (Tornado)	5	Moderate
Off-site RAM Transportation Accident	4	Moderate
Bulk Propane Systems	4	Moderate
Standpipes – Localised Fire	4	Moderate
Dam Failure (Flooding)	4	Moderate
Concrete Canister Storage Facility – Canister Breach	4	Moderate
Potential Bunker Leak/Spill During Pumping	4	Low
Emissions to River from D&D Activities	4	Low
Cask Loading Facility – Localised Fire	4	Low
Bldg. 300 Shielded Facilities – Ventilation Failure	4	Low
WMA – Localised Fire	3	Low
Bldg. 300 Shielded Facilities – Hot Cell Fire	3	Low
Bldg. 100 WR-1 Facility – Localized Fire	3	Low
Lagoon Breach	3	Low
Flooding	3	Low
Bldg. 902/903 – Chlorine Gas Release	3	Low
Earthquake	3	Low
On-site RAM Transportation Accident	2	Low

6. Supporting Plans and Policies

6.1 CNL Company-Wide Policies

The company-wide Emergency Preparedness Program Requirements Document [1] describes the EmP program for CNL. It defines specific responsibilities and objectives for the program. The company-wide Emergency Preparedness Program Description Document [9] provides direction to related program documentation and provides an overview of the program. The company-wide Crisis Management Field Instruction Document [10] would also be activated in the event of a crisis that actively threatens, or has significant potential to threaten, the corporation as a whole and whose resolution extends beyond the control of routine management policies and procedures. The Crisis Management documents focus on CNL senior management activities and communications during a crisis. EmP also deals with the health, safety and protection of employees, the public, and the environment as described in the Health & Safety Policy [11] and the Environment Policy [12].

6.2 Whiteshell Procedures/Plans

WL EmP maintains multiple procedures and plans that support the safety of staff and the Whiteshell mandate. All WL staff have been issued a Site-Wide Emergency Procedure Flipbook that describes the required action of all personnel in the event of specific emergencies. All project work at WL is performed under a project specific emergency procedure, called a Green Bordered Placard, which is reviewed by project staff weekly and posted at key location in the project area. The Emergency Operations Centre (EOC) staff operate under a procedure which provides direction on notification, activation, operation, and deactivation of the EOC [13]. General site staff, EOC staff, and other staff or groups with emergency responsibilities are tested and evaluated according to the WL 5 Year Exercise Plan [14] which is a five year guideline from which the annual exercise schedule is created.

6.3 Other Related Plans

The Federal Nuclear Emergency Plan [15] outlines the procedures to be followed by the Government of Canada in dealing with nuclear emergencies that may affect the health and safety of Canadians and that may have radiological safety implications outside Canada. The Federal Nuclear Emergency Plan is issued under the authority of Health Canada.

The Manitoba Emergency Plan [16] provides a mechanism for ensuring a prompt and coordinated response by the Government of Manitoba to any emergency or disaster within provincial jurisdiction, or in support of a municipality that has requested provincial assistance.

The Local Government District (LGD) of Pinawa Emergency Plan [17] provides a description of the response of the LGD of Pinawa to emergency events and the responsibilities of the LGD staff.

7. General Organisation

7.1 Internal Organisations

During emergency events an augmented organisational structure will be implemented to both support the emergency response and coordinate between normal day-to-day and emergency operations. This augmented structure is based on the Incident Command System (ICS) so that it can be seamlessly integrated with other local and provincial response groups. The WL emergency structure is shown in Figure 7-1.

The EOC operates with a minimum complement of six positions, but can expand to 13 unique functions to meet the dynamic needs of the emergency. As a result the EOC maintains two teams of 13 staff members that can be called upon during emergencies, with an additional staff member identified for each position as an alternate. A detailed description of the emergency response organization and training requirements is given in the Whiteshell Emergency Operations Centre Operating Procedure WL-508730-PRO-559 [13].

The normal WL reporting structure will stay the same for most employees during an emergency. The EOC will set up a parallel structure to the normal organisational structure and draw upon resources as required to respond to an emergency at WL. When there is an emergency at the WL site, employees are expected to obey all emergency signals and/or directions provided (e.g., site wide signals, PA and radio announcements). In the absence of any signals or announcements employees are expected to continue with their planned activities for the day.

7.1.1 Emergency Authority

The WL EOC Commanders are authorised by the CEO to operate with full executive authority over all WL Site resources during an emergency event. WL employees need to respond quickly to any request for information, supplies, or resources that come from the EOC. The EOC Commander, or their designate, have the authority to directly enter into service agreements and purchase goods that are urgently required to resolve the emergency situation.

When the EOC is supporting mutual aid agreements or other external emergencies AND when the level of CNL support provided will impact WL operations THEN the EOC Commander will obtain a final decision from the CNL Crisis Management Team on the extent of the CNL support to be provided. No support will be provided that impacts WL’s ability to maintain a safe site. Placing the site in a safe state and suspending site operations to better support an offsite emergency is a consideration that the Crisis Management Team may consider.

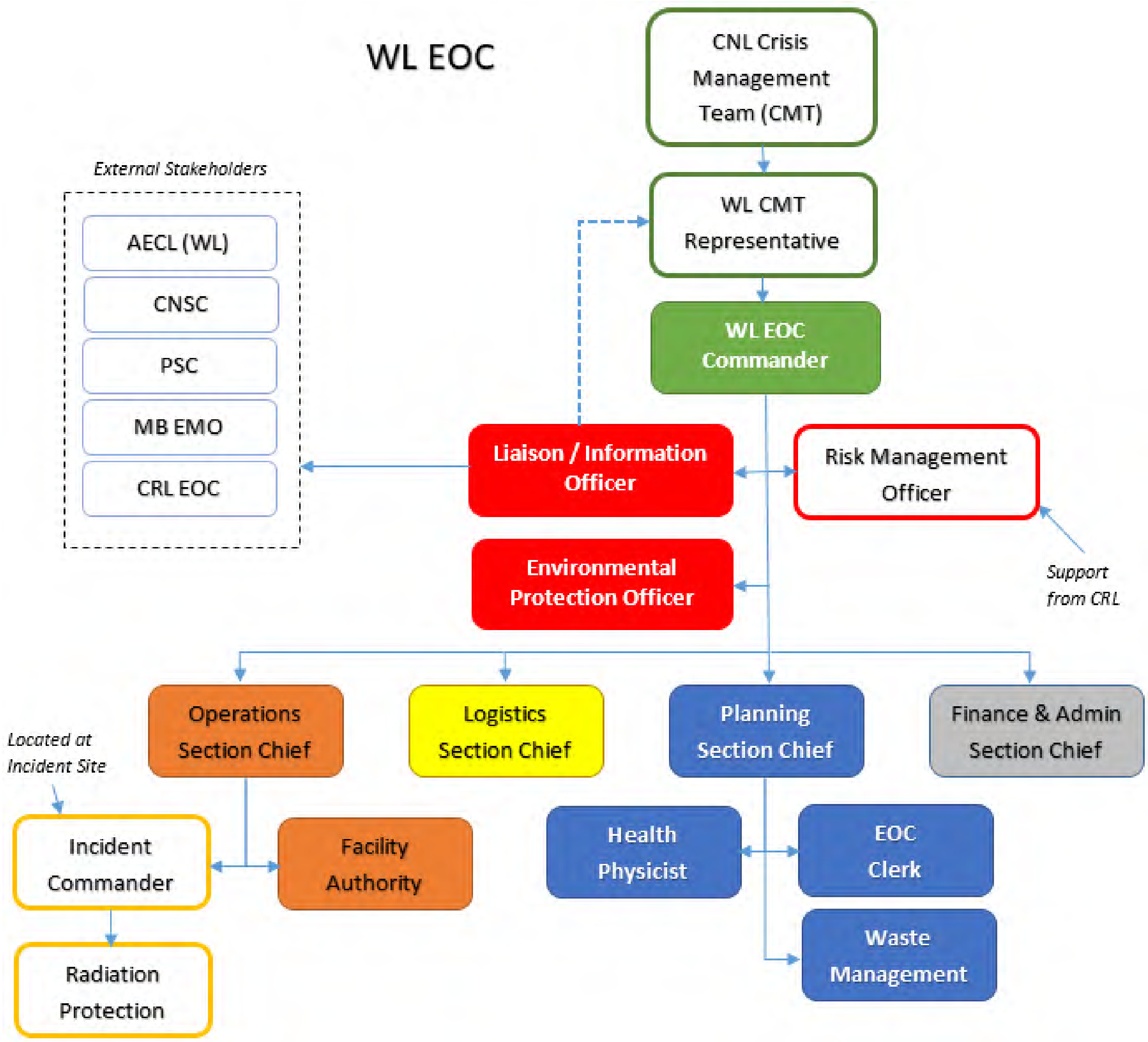

Figure 2: Internal Organisation

7.2 External Organisation

There are several external organizations that would potentially need to be engaged or informed of an emergency at WL. Interactions with these groups is the main responsibility of the Liaison Officer in the WL EOC. Depending on the nature of the emergency, some, or all, of the following federal, provincial, and local groups could need notification.

7.2.1 Federal

Canadian Nuclear Safety Commission (CNSC) - The CNSC is the regulatory body that issues the licence for CNL to operate or decommission the nuclear facilities at WL. The EOC must inform the CNSC of any event causing an emergency and it must keep the CNSC informed of the status of the emergency, as defined in this plan. In the event of being informed of an emergency condition at WL, the CNSC would initiate the current CNSC Emergency Response Plan.

Public Safety Canada (PSC) - PSC is the federal organization responsible for the coordination of federal assistance to Manitoba Emergency Measures Organization (MB EMO) and to federal departments (including CNL) in the event of an emergency. The procedures are documented in the Federal Emergency Response Plan [18]. Once PSC receives a call from AECL/CNL informing them that WL is in a state of emergency, they will inform all federal agencies to be prepared in case assistance is required. PSC utilizes a duty officer that can be contacted 24 hours a day.

Health Canada – Health Canada is the federal organization responsible for the Federal Nuclear Emergency Response Plan. They may be called in by MB EMO, PSC or CNL directly.

7.2.2 Provincial

Manitoba Emergency Measures Organization (MB EMO) – MB EMO is the provincial organization responsible for emergency preparedness and response in Manitoba. It is responsible for putting into effect all actions necessary to manage the off-site situation associated with an emergency. MB EMO may request assistance from the Federal Government as outlined in the Federal Nuclear Emergency Plan [15]. Once MB EMO receives a call from CNL informing them that WL is in a state of emergency, they will inform relevant provincial agencies and local municipalities of the emergency condition. MB EMO utilizes a duty officer that can be contacted 24 hours a day.

During events that originate on-site at WL, but could affect off-site locations, CNL will make the initial evaluation of the emergency condition. Once CNL has evaluated the situation sufficiently to understand the implications to public safety, the EOC will report the event along with public safety recommendations to MB EMO. MB EMO will inform and alert provincial departments, agencies, and municipal authorities, and take appropriate action to coordinate the provincial and municipal government emergency responses.

The EOC will maintain regular contact with MB EMO in an effort to keep the province and the local communities up to speed on the emergency situation and resulting hazard conditions. The CNSC will be included in off-site updates to ensure consistency of information until the emergency is resolved. CNL's Crisis Management Team (CMT) is responsible for providing public information, representing CNL to the Media, and coordinating messaging with external stakeholders.

Manitoba Sustainable Development – Sustainable Development is the lead agency for radiological emergencies that occur off-site, in the province of Manitoba [19]. In the event of a radiological emergency that originates off-site and does not involve CNL material, WL may be called upon to provide support and assistance. MB EMO has the authority to activate the WL Emergency Response Plan if they declare a provincial State of Local Emergency. WL Staff would provide support with CNL management consensus and approval.

7.2.3 Local

At the local level, the following response groups may need to be kept informed of emergency situations as they evolve. At this local level, many of these groups will also be invited to participate in emergency exercises for the mutual benefit of WL and the local community or response group.

LGD of Pinawa, the RM and Town of Lac Du Bonnet, and the RM of Whitemouth – Each of these communities shares a border with the WL site, or is very close to the WL site. Each has an assigned Emergency Coordinator who is responsible for the community level emergency preparedness and response activities for their communities. These communities are responsible for managing any off site situations associated with a non-radiological emergency. The LGD may request assistance from the MB EMO, as per the Manitoba Emergency Management Act.

Local Volunteer Fire Departments – The local volunteer fire departments are expected to automatically respond to all emergencies within their jurisdiction. For the LGD of Pinawa's fire department this does not include emergencies occurring on WL land. The LGD of Pinawa Fire Department does have a mutual assistance response agreement with CNL for the WL site which means the fire department will respond to emergencies on WL land if requested to do so by WL ESO. Joint exercises are conducted between Pinawa Fire Department and the WL Fire Fighters to practice integration of personnel, communications and equipment.

Local RCMP Detachment – The local RCMP detachment is based out of Lac Du Bonnet, although they maintain a part-time presence in the LGD of Pinawa. The RCMP will initially be notified of an emergency at WL by ESO. The RCMP is the primary response force for armed active threats and suspicious packages at WL and they will deploy resources to support incidents on-site. Should the emergency situation escalate to have an impact off site, the RCMP will take their directions from the LGD or provincial authorities as described in their own emergency plans.

Regional Emergency Medical Services (EMS) – The regional EMS, Interlake Eastman Regional Health Authority, serves the area around the WL site, and the site itself. ESO responders will handle immediate care while EMS is on-route to site. Once on-site, the patient is either transported to EMS or EMS is escorted to the patient, depending on injuries.

7.3 CNL

CNL Sites – Intra-site communication and coordination of emergency events is the primary responsibility of the Crisis Management Team (CMT). WL representation on the CMT is handled by the Site Head, Deputy Site Head, and Director of ESH&Q. Through the CMT, other CNL sites will be informed of any emergencies at WL. These sites are available to offer assistance as required. The requests for assistance shall be made by the EOC, through the CMT.

The WL CMT members will coordinate with the CRL Corporate Communications team to manage media and public relations issues during any crisis or event. In the absence of dedicated communications staff at WL, the Liaison Officer in the EOC will provide support to the CMT members and corporate communications.

7.4 General Staff and Resources

All WL employees participate in a site orientation on their first day on-site. This orientation includes an introduction to WL emergency signals and the corresponding expected actions, the use and location of the emergency procedures, and the location of muster points (assembly points). During this orientation, new employees are issued a copy of the Site-Wide Emergency Procedure Flipbook. After the site orientation, the first day on-site also includes a Radiation Protection (RP) component, where staff are informed of the signals and responses associated with various radiological emergencies. They are instructed on basic radiation theory which provides them with a basic understanding of the radiation safety techniques and practices followed at WL.

Employees are instructed to inform their managers if they have, or develop, any special assistance requirements associated with building or site-level evacuations. The manager is then responsible to inform WL ESO of any special needs and also to assign a 'buddy' style system of accountability within their branch to support the staff member in an emergency.

While all WL employees receive a minimum orientation to radiological safety (group 4 training), some employees specialise in radiation hazard control and/or environmental hazard control. These staff are tremendous resources during emergency events. When equipped with the correct instrumentation these staff can provide information on any release of radioactive material extending beyond controlled areas, and determine whether radioactive material exposure has occurred. Details of this instrumentation and dosimetry process can be found in the Radiation Protection program documentation.

Procedures to minimize and control radiological and non-radiological exposure to personnel are documented in the Radiation Protection Program Requirements Document [4] which governs dose protection and measurement under normal and emergency situations. Facilities are available on-site to analyze radiological material samples. The main analytical equipment on-site is kept at or beyond 100 metres distance from the main source of radioactivity on-site. Sufficient portable equipment also exists for backup of radiological measurements, if required.

Training requirements (including training program development) for emergency and non-emergency personnel are identified in the Emergency Preparedness Requirements Document [1].

WL ESO personnel are on-site and available 24/7/365 to provide emergency response or support services.

The Pinawa hospital is equipped to provide medical backup in the event of an emergency. Physicians, nurses, and analytical services are available. WL relies on provincial Emergency Medical Services for advanced in-field medical care and transportation of injured personnel.

CNL maintains personnel and equipment to respond to on and off site transportation accidents involving hazardous materials including, but not limited to radioactive materials, that belong to CNL or their mutual aid partners. Details for off-site responses are specified in the Transportation Accidents Involving Hazardous/Dangerous Goods [20].

8. Roles and Responsibilities

8.1 Emergency Operations Centre Commander

The EOC Commander is responsible for the overall management of an incident, including the incident site, the EOC staff and facility, the unaffected portion of the WL site, and all assigned resources. The EOC Commander guides strategic-level emergency management functions, and provides necessary resources to the Incident Commander through the various EOC functions. The EOC Commander does not direct tactical-level response operations, but instead provides high-level strategic guidance to operations personnel.

8.2 Incident Commander

The Incident Commander (IC) is the person in charge of the Incident Command Post and the emergency scene. The IC is responsible for tactical management of the incident and takes command of all resources assigned to the site to effect rescue, to control the incident, and to deal with the immediate situation at the location of the emergency. At WL, the senior ESO Lieutenant on shift will be the IC by default until the EOC declares the event over or assigns a new IC. When the EOC is activated, the IC reports to the Operations Section Chief in the EOC. If the EOC is not activated, the IC reports to their normal Line Manager.

8.3 WL Emergency Preparedness Program Manager

The EmP Program Manager at WL, in consultation with applicable response groups and facility personnel, ensures that the emergency plan and the related EmP documents are reviewed, updated, and tested as required. The Program Manager is responsible for overseeing the following activities at WL:

- Development of WL emergency plans for the site;
- Development of WL emergency procedures;
- Liaising with the Canadian Nuclear Safety Commission on WL Emergency Preparedness issues at the direction of the Functional Support Manager;
- Liaising with emergency planning and response partners at the local, provincial, and federal levels;
- Ensuring all EOC equipment is inspected and maintained in a state of readiness;
- Development and delivery of emergency exercises to evaluate the effectiveness of WL emergency procedures and evaluate the emergency response capability at WL; and
- Assessing the effectiveness of exercises and drills in preparing WL employees for emergencies.

8.4 Building Superintendents/Facility Managers

The Building Superintendent/Facility Manager, as defined in the Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories document [21], is the person responsible for a specific building or area, and the development and maintenance of any building system-specific emergency procedures. The Building Superintendent/Facility Manager is also responsible for informing WL EmP when there are changes to the facility's use or overall hazard profile.

8.5 Officer in Charge

The Officer in Charge (OIC) is a role that is only filled in the event of an emergency occurrence. All WL employees receive adequate training in the site's emergency response procedures to be able to assume the role of the event OIC in an emergency. The first employee, or the most senior employee if in a group, to reach the muster point shall assume the role of the event OIC. There will only be one OIC at each muster point.

Using the provided OIC checklists (located at the muster points) the event OIC is responsible for collecting situation specific details from the other building occupants and providing that information to the Incident Commander. The OIC then coordinates the building occupant's movements while they are evacuated from the facility. Details on this role can be found in the Whiteshell Site-Wide Emergency Procedure [5].

8.6 Line Managers

All Line Managers are responsible for ensuring that employees under their supervision receive adequate training in their responsibilities under the EmP Program, and for making sure that any emergency equipment their branch is responsible for is kept in a state of readiness.

8.7 Response Groups

8.7.1 The Crisis Management Team

The Crisis Management Team (CMT) enables organisational resiliency, through effective management of CNL's communications and interactions with its employees, the public, media, regulators, shareholders, and other stakeholders, to maintain its credibility, reputation, and ability to carry on/recover business and routine operations, in the face of a crisis.

During an emergency event resulting in the activation of a CNL EOC, the CMT has an oversight and support function that does not implement emergency actions during the emergency response. The CMT is intended to compliment the EOC by focusing on the business impacts resulting from the event, the required business communications for the event, and planning for the recovery and resumption of affected business units.

The CMT is also accountable for assessing any crisis that could result in disruption to CNL critical business functions, and, as required, implementing business continuity plans and strategies [10].

8.7.2 The Emergency Operations Centre

During an emergency, the EOC coordinates organisational emergency management functions by providing guidance, support, and resources to the Incident Commander and the unaffected portion of the site. The EOC is responsible for strategic-level decision-making, and does not directly control field assets; instead the EOC determines operational objectives and leaves tactical decision-making to the Incident Commander. The EOC also coordinates with external agencies, and with CNL's Crisis Management Team. Another function of the EOC is to begin recovery operations, ultimately facilitating the transition from emergency operations back to day-to-day operations.

All EOC staff are required to maintain position logs which track directions given, requests received, decisions made, and actions taken. The maintenance of position logs creates continuity for the EOC functions during shift changes and supports the master events log that is displayed in the EOC, keeping all EOC staff on target. The master events log is a function of the Planning Section in the EOC. Position logs are collected and retained at the end of the emergency. More details on the EOC's function and individual EOC positions can be found in the WL EOC Procedure [13] or the EOC position binders located in the EOC (Room 2-13 in Building 401).

8.7.3 The Incident Command Post

The Incident Command Post (ICP) is a temporary 'facility' where the Incident Commander and their team will gather to coordinate the tactical operations in response to the emergency. For WL, the Incident Command Team on-site will function as the Operations Section for the EOC, with most other functions being facilitated by the EOC. Unless otherwise approved by the EOC, the Incident Commander will always be the Senior Lieutenant on shift for WL Emergency Services Operations (ESO).

The Incident Commander is responsible for determining the point at which an emergency has grown enough to require activation of the EOC. The EOC and Incident Command Post remain in communication throughout the duration of the event.

8.7.4 Radiation Protections

The RP Branch is responsible for supporting the EOC and the ICP in matters of radiological safety. RP provides Health Physics support at the scene, including dosimetry and radiological surveying. It also coordinates and communicates with the event OIC(s) to ensure that emergency procedures are being followed in responding to radiological emergencies. RP also provides: assistance in radiation monitoring and contamination control; monitoring of hazardous environments on-site (including radioactive contamination in the air); and personal protective equipment and emergency decontamination supplies. These supplies undergo regular inspections and maintenance.

8.7.5 Emergency Services Operations

ESO provides firefighting, security, and first aid services as required through the presence of the Nuclear Security Officers and/or Firefighters. Emergency response equipment is available on-site and routinely inspected and maintained by ESO.

Depending on the nature of the event, the WL site main gate may be closed with no one being allowed to enter or exit the site until the All Clear signal (a series of intermittent blasts on the site whistle) is given or a site-wide evacuation is called. The exception would be admittance of resources coming to assist in the emergency response.

In all emergencies at WL the ESO On-Duty Shift Senior Lieutenant is the default IC. ESO personnel will take responsibility for establishing an ICP at the incident site. The IC may establish Unified Command at the incident site if they feel this is warranted, but may not relinquish command of the site without approval of the WL EOC. The IC is responsible for directing emergency response actions until the emergency is terminated, or until they are relieved by the EOC Commander.

The IC may initiate an EOC activation at any point they feel it is necessary. Once the EOC is activated the IC will report to the Operations Section Chief in the EOC. If the Operations Section Chief is not activated they report directly to the EOC Commander. The IC must make effective use of subject matter experts available on-site as required to respond to the emergency.

In the event of an emergency condition in which there is no clearly defined incident scene, the EOC will coordinate emergency response actions.

8.7.6 Corporate Communications

During an emergency situation, Corporate Communications (located at CRL) provides communications support to the CMT and the WL EOC. Corporate Communications will manage conventional and social media and will work with CMT to appoint and prepare a CNL spokesperson, whether at WL or CRL.

The WL CMT representative will be the primary point of contact for the CMT and Corporate Communications staff in CRL. If the WL CMT representative is unavailable or needs assistance, the WL EOC’s Liaison Officer will support as required, collecting data and arranging media interactions on-site, etc.

8.8 Response Group Interactions

An essential feature of the emergency plan is cooperation between those engaged in the operation of facilities and those providing a specialized emergency response service. In the early stages of an emergency, it is critical that all necessary actions be taken in a timely manner and that the IC has access to expert advice from resource units such as RP and Facility Operations.

It may be that an emergency condition exists where there is no clearly defined scene or accident site and, therefore, no obvious location to set up an ICP. In such a situation, ESO would coordinate the initial emergency response actions from the Security Monitoring Room (SMR) until such time as the EOC could be activated. The EOC Commander in the EOC would then take direct control of the emergency, using the On-Duty ESO Shift Supervisor to augment the EOC Operations Section.

9. Emergency Alerting System

9.1 Emergency Signals

The WL site has the ability to alert staff and contractors of hazardous events on-site through a series of alarms and signals. Staff can be advised to stay-in, hold and secure, evacuate a building or the site, or that an event has passed and it is all clear. Alerting is accomplished through the PA system which broadcasts the appropriate tone and a follow up message with information and instructions for staff. The same capability exists at the Waste Management Area (WMA).

Alerting of staff outdoors is accomplished through the combined use of emergency response vehicle sirens, portable radios, and air horns (used at demolition sites). These signals serve to alert staff to the presence of an emergency and move them to a location where they can get more information. Due to the significantly reduced risk for a stay-in at the main campus [6], this has been determined to be adequate for the task of alerting those staff working outdoors. An external speaker provides notification to staff working in the WMA. As there is a risk of a stay-in occurring at the standpipe facility [6], the external speaker will be maintained as the primary alerting system until the risk to workers has decreased to an acceptable level.

9.2 Call Outs

Some of the EOC, RP and Operations staff are expected to be on call at all times. WL maintains two methods of communicating with these staff. The primary method is a secure internet-based notification system with pre-scripted messages and defined target groups. This system is used for emergency call-outs of staff as well as for monthly and quarterly drills. The system is tested twice a day by ESO. The secondary system that is used is a manual phone/email call-out process, also managed by ESO.

On-call staff are expected to keep their CNL-issued alerting devices charged and within earshot. For maximum effectiveness, EOC staff provide personal contact information (email and phone), in addition to their CNL-issued contact information, for the call-out system. EOC staff are expected to be able to respond to the site within 120 minutes of receiving a notification when they are on call. It is expected that the EOC can be staffed to a functional level within 90 minutes of the initial notification. Until the EOC is operational the Senior Lieutenant on shift is responsible for the entire site and all emergency response actions.

In the event of an incident requiring activation of the emergency alerting system, the SMR will initiate contact with the emergency response staff appropriate to the incident.

10. Activating the Plan

10.1 Implementation of the Plan

The emergency plan may be implemented in part or in whole when an emergency or a disaster has occurred or threatens to occur. While specific activation triggers are captured in the SMR Response Flowcharts and the WL EOC procedure [13], there may be situations that arise that don't conform easily to the flowcharts. In these rare occasions, the decision to activate the EOC can be made directly by the ESO Senior Lieutenant, or in collaboration with the EOC Commander and EOC Planning Section Chief. The notification system is set up with a pre-scripted notification that pulls all three positions into a teleconference call to facilitate rapid information sharing and decision making.

The plan is initiated with the activation of the WL EOC. The EOC is activated during operating hours by an announcement of a stay in over the site wide public address (PA) system, or direct communication with EOC staff. The stay in may be initiated by any employee on-site by calling Emergency Services Operations at local 88.

During all phases of an emergency or exercise event, it is important to communicate information clearly and succinctly. It is especially critical to ensure that all personnel understand whether the event is real or simulated. Emergency notification of staff is conducted via emergency signals on-site and/or with verbal announcements over the PA and radio systems. In the event of a failure of these systems, site-wide emails would be used or physically sending runners to other occupied buildings would be a last resort.

Implementation of the plan can be broken down into on-site and off-site situations.

10.1.1 Action by Employees Discovering Emergency Conditions

Emergency procedures are developed for the WL site, taking the form of site-wide emergency procedures which cover the whole site, or Green Bordered Placards which are for specific hazards not addressed by the site wide procedure. These procedures provide direction to employees on how to deal with the variety of events that can occur on-site.

The Site-Wide Emergency Procedure is available online and is also posted on the EmP Blue Boards, situated at the entrances of all the occupied buildings on-site. The specific actions for each emergency type have also been extracted from the procedure and published in a quick reference flipbook with a magnet on the back. Each employee on-site has been issued a copy of the flipbook to place in an area of convenience for them. They are also posted in most un-occupied buildings and in various common areas around the site. The magnet on them is to make them easy to 'post' without the risk of them being buried and lost so they can be quickly accessed when needed.

Green Bordered Placards are used to augment the Site-Wide Emergency Procedure (and flipbooks) when unusual hazards are present. Sometimes a job will have inherent risks based on the activities or will create hazardous conditions in an area that need to be addressed (ex:

entrapment hazard). In these cases, the process created for dealing with these hazards will be documented in a Green Bordered Placard.

Any employee who discovers an emergency condition at WL shall report the nature and location of the emergency to the Security Monitoring Room by one of the following three methods.

- Using a WL landline, dial '88'
- Using a WL radio, switch to the '401 SMR' talkgroup and call for "401 Control"
- Using a cell phone, call the site at (204) 753-2311, then dial ext. 62223 or wait on the line and ask for the SMR.

At that time the SMR will follow their own emergency procedures and flowcharts to respond to the emergency event. Additional steps for employees to take are posted in the Site-Wide Emergency Procedure [5] and the quick reference flipbooks.

10.1.2 Action by Emergency Services Operations Staff

Upon being notified of an emergency event, the SMR Operator will follow the appropriate emergency response flowchart as per protocol. ESO resources will also be dispatched based on flowcharts, procedures, and fire pre-plans. WL ESO will then respond in a manner that is in alignment with their roles and responsibilities as defined in their various operating procedures, and are not covered by this plan. As a general rule, WL ESO will take action to stop the emergency event, or mitigate the effects of the emergency when it is safe for them to do so.

10.2 Off-Site Emergency Response

It is important to appreciate that CNL jurisdiction covers only the WL site and CNL products that are in transit. Surveillance work outside of the area is, however, a routine operational procedure for WL and this surveillance would be continued during an emergency.

According to the current Source Term document there are no probable operational or material handling scenarios at the WL site that would lead to an off-site emergency. It is still necessary to retain emergency response capabilities for off-site radiological emergencies. In the unlikely event that something should occur, MB EMO will be responsible for putting into effect all actions necessary to manage the off-site situation. The WL EOC has the responsibility to ensure that MB EMO receives adequate information upon which to base its actions.

The most probable WL-based scenario with off-site implications would be a motor vehicle accident involving CNL owned radioactive materials being shipped to an alternate storage location. A separate procedure exists for responding to these sorts of events [20].

10.2.1 Monitoring Estimation of Dose

While there are no credible scenarios that would result in off-site radiation doses, WL is committed to ensuring this is evaluated and confirmed for every situation that poses a risk. Monitoring for assessing radiological hazards and doses would include:

1. Airborne releases measured by stack monitors.
2. Releases to the Winnipeg River measured by the outfall sampling system.
3. Radiation fields measured in the area of concern.
4. Airborne and surface contamination measured in the area of concern.
5. Sampling and radiochemical analysis of river water.

Rough estimates of the doses would then be made by comparison of some of the above listed field data with appropriate Derived Release Limits [22]. As described in Section 5, the postulated releases from a realistic worst case event are significantly less than that which would require countermeasures to avert doses to individuals off site.

10.3 Concept of Emergency Operations

The WL EOC operational model is based on the Incident Command System (ICS) principles. The basic operational process is made up of multiple operational periods, which are cyclical in nature. This process ensures the same consistent steps are used (plan, do, check, act) to ensure an effective response and recovery process.

Emergency management also follows a predictable path that repeats after each emergency event. These phases, known as the pillars of emergency management, are:

- Prevention/Mitigation – Once a hazard risk has been identified, the initial goal is to make it impossible for the risk to occur. If the risk cannot be prevented altogether, the goal changes to reducing the impacts of the risk when it does occur.
- Preparedness – This is the process of preparing for the residual risk (risk that cannot be prevented or mitigated), by having response plans and training for responses. These plans include identifying personnel, equipment, and supplies that will be needed to respond to emergency impacts when the hazard occurs. Exercising and evaluating plans and personnel is a major component of this phase. Most of emergency management work is conducted in this phase.
- Response – When the emergency occurs, this is the phase where all the preparedness plans/processes are implemented. This is the shortest phase of emergency management, though it receives the majority of attention and resources.
- Recovery – Almost as soon as the response phase has begun, elements of the recovery planning are implemented. As more of the response concludes, more effort is placed on recovery. Restoring the facility, business function, or site to 'normal' is the goal of the recovery phase. The WL EOC procedure [13] has more information of recovery planning at WL.

As stated above, the EmP program spends most of its time and resources in the preparedness phase of an emergency, constantly updating plans to reflect lessons learned from exercises and industry changes. Once an emergency occurs, the process of response begins, followed closely by recovery. After the event, lessons are captured and used to enhance prevention and mitigation efforts and EmP moves back into an ever-improving preparedness phase.

More details on the WL EOC operating model can be found in the EOC Procedure [13].

10.4 Termination of the Emergency

An emergency may only be terminated in part or in whole by the EOC Commander, or designate, following the advice of the EOC.

When conditions are no longer considered dangerous to life and health, the EOC Commander will inform Emergency Services Operations to initiate the All Clear signal. This is a series of intermittent blasts on the Site Whistle (lasting for 3 minutes) accompanied by an announcement on the site wide PA and radio system.

The EOC shall remain in control of the emergency site as the operations shift from response to recovery. The EOC Commander will consult with the Site Head and management team on a recommended course of recovery. Once recovery operations are sufficiently underway, the EOC will transition its workload and tasks over to the appropriate day-to-day staff and structure. Once this transition is complete, the EOC can be closed, collecting all records and filing appropriate after-action reports.

In some cases, re-entry to the site and its facilities may be restricted to prevent personal injury or contamination. This process is managed by the EOC and communicated to all WL staff as needed.

10.5 EOC Exercises and Training

Exercises shall be planned, conducted, and evaluated in accordance with the requirements listed in the Emergency Preparedness Program Requirements Document [1].

EOC exercises are planned in a five year program as outlined in the WL 5 Year Exercise Plan [14]. Based off of this plan, the WL EmP Program annually prepares a more detailed 12-month schedule. Exercises shall be conducted to train and test the emergency response groups, and to test the adequacy of the procedures. Exercises shall demonstrate the capability of WL's response teams in simulated emergency conditions with on-site impact. Outside organizations (e.g., Pinawa Hospital, RCMP, LGD of Pinawa, and MB EMO) may be invited to participate as appropriate.

Training requirements for emergency personnel are identified in the Emergency Preparedness Program Requirements Document [1]. All WL EOC team members and alternates should have a minimum training of EOC Essentials (or equivalent approved by the WL EmP Program Manager) to be provided to them within 18 months of being assigned to the EOC team. Core EOC members (and their alternates) are also provided an additional three days of training that focuses on the EOC Operations, Planning, and Logistics functions.

10.6 WL Emergency Plan Document Revision Procedure

The WL EmP Program Manager will ensure a formal review of the Emergency Plan is completed every five years. EmP Program documents shall be prepared, revised, and controlled in accordance with the Emergency Preparedness Program Requirements Document [1].

11. Glossary

Crisis: A crisis may be defined as any abnormal situation that actually threatens, or has significant potential to threaten, the assets and/or image of the Corporation and whose resolution extends clearly beyond the control of routine management policies and procedures.

Crisis Management Team (CMT): The CMT is the senior management group, supported by communications staff, which are the public face of the organisation during a crisis. The team is responsible for working with the media during a crisis and supporting the EOC's of the various CNL sites.

Emergency: An emergency, as defined within 900-508730-PRD-001, is a condition calling for immediate response, beyond the scope of normal operating procedures, and which activates the site or facility emergency response organization. An emergency is, or has the potential to become, life threatening and/or a danger to the environment.

Emergency Operations Centre (EOC): The members of the EOC are responsible for the management of the Whiteshell Laboratories during an emergency. The EOC is used to support the Incident Commander and the site emergency operations, balancing those needs with the needs of the rest of the WL Site. The members recommend off site action and maintain communications with municipal, provincial and federal agencies.

Emergency Preparedness: The state of readiness to implement emergency procedures and exceptional measures necessary to mitigate the effects of an emergency, including the organization, resources and communication processes to carry out these measures and to make the status of the situation known to on site and off site personnel.

Evacuation: An evacuation means all but essential services personnel leave the site. The Evacuation signal is a sustained note, accompanied by an announcement over the site wide public address system.

Hazard: A physical condition with potential for injury to human health or safety, damage to property, damage to the environment, threatens nuclear safety or a combination of these elements.

Incident Command Post (ICP): The ICP is responsible for the management of resources at the scene of the emergency. The centre is normally set up as close to the scene of the emergency as is reasonably safe. The ICP is managed by the Incident Commander who coordinates with the EOC as required.

Incident Command System (ICS): A scalable and adaptable system used by first responders and industry across most of North America to manage emergency situations.

Initial Notification Group: The group responsible for the off hours activation of the EOC. The group consists of both EOC Commanders, and both EOC Planning Section Chiefs.

Response Groups: Response Groups are branches, sections or logistical groups that may be required to provide assistance to either the EOC or the ICP. These centres include, but are not limited to, Radiation Protection Branch, Environmental Monitoring, Emergency Services Operations, Engineering and the Officers in Charge and Emergency Stewards.

Risk: The likelihood of a specific, significant consequence occurring within a specified period or in specified circumstances. Risk is calculated as: (potential impact of the event) x (probability of occurrence) = Risk.

Site: The property and facilities of the Whiteshell Laboratories and the surrounding area owned by CNL.

12. References

[1] Emergency Preparedness, Program Requirements Document, 900-508730-PRD-001, 50046216.

[2] Fire Protection Program Description Document, 900-508720-PDD-001, 40793276.

[3] ESO Standard Operating Guidelines, 151-508710-GL-002.

[4] Radiation Protection Program Requirements Document, 900-508740-PRD-001, 40766658.

[5] Whiteshell Laboratories Site-Wide Emergency Procedure, WL-508730-EP-001, 17195762.

[6] Whiteshell Laboratories Source Term, WL-508770-REPT-002.

[7] Whiteshell Laboratories Shift Reduction HAZOP Studies, NSN ESRD 119.

[8] WL Hazard Analysis and Risk Assessment, WL-508730-HA-001.

[9] Emergency Preparedness Program Description Document, 900-508730-PDD-001, 50982494.

[10] Crisis Management Functional Instructional Document, 900-508730-FID-002, 44145640.

[11] Occupational Safety and Health, 900-510400-PDD-001.

[12] Environment Policy, 900-509200-POL-001.

[13] Whiteshell Laboratories Emergency Operations Centre Operating Procedure, WL-508730-PRO-559, 16653396.

[14] WL 5 Year Exercise Plan, EMP-508730-PLA-002.

[15] Health Canada, Federal Nuclear Emergency Plan, Part I Master Plan, 2014.

[16] Manitoba Emergency Plan, 2018.

[17] The Local Government District of Pinawa 2021 Emergency Plan, 2020.

[18] Public Safety Canada, Federal Emergency Response Plan, 2011.

[19] Manitoba Government, Manitoba Environmental Emergency Coordination Annex, 2018

[20] Transportation Accidents Involving Hazardous/Dangerous Goods, 900-508730-MCP-002, 12646535.

[21] Responsibility for Facilities and the Safety of Operations at the Whiteshell Laboratories, WL-508200-PRO-212, 44167779.

[22] Derived Release Limits for AECL’s Whiteshell Laboratories, WL-509211-RRD-001.

Appendix A Seismicity, Meteorology and Population

Seismicity

WL is situated in seismic zone 0. Seismic activity at WL has been recorded and analyzed by Natural Resources Canada since the installation of a short period vertical seismograph near WL in 1978 [A-1]. This station and others in the Canadian Shield are estimated to have the capability to locate seismic events down to a threshold magnitude of 2.5 on the Richter scale. Based upon a review of historical earthquake records and recent monitoring data, the southern two thirds of Manitoba appear to be aseismic at current detection levels [A-2].

Meteorology

The climate of the Whiteshell area is between a temperate continental and boreal climate, and so conditions vary from extreme cold in winter to extreme heat in summer. The record low temperature for WL is -47.8°C (1966 February) and the record high temperature is 37.5°C (1995 June). Thirty two years of records show that January is the coldest month and July is the warmest, with monthly mean temperatures of 16.6°C and 19.3°C, respectively (see Table 3) [A-3].

Table 3: Monthly Mean Temperatures (°C) at Whiteshell Laboratories (1981 - 2010)

January	February	March	April	May	June
-16.6	-13.2	-5.7	3.9	11.2	16.4
July	**August**	**September**	**October**	**November**	**December**
19.3	18.2	12.3	5.1	-4.5	-13.1

The average annual precipitation is 578 mm, and most of this occurs as showers in the summer season. The greatest recorded 24 hour rainfall at WL was 168 mm (1973 June).

Winter snowfall averages 113 cm at WL [A-3]. The greatest 24 hour snowfall on record is 48.0 cm (1997 April). Snow on the ground is usually continuous from early November to mid-April, and the depth reaches a peak of about 45 cm in February or March.

The Winnipeg River system usually freezes up in early December. Spring break up and clearing of ice from the river occurs in April.

The wind direction frequency has a double peak (Figure 3), one in the north northwest and one in the south southeast direction [A-4]. These winds are approximately parallel to the Winnipeg River valley at this location. The average wind speed is 9.3 km/h, considerably less than the long term average of 18.6 km/h at Winnipeg. This difference can be largely attributed to the measurements of wind speed 10 m above ground at Winnipeg airport, and 6 m above ground at WL; there is also the effect of the boreal forest at WL compared to the grassland around Winnipeg and the pavement at Winnipeg airport. Spring is generally the windiest season with an average wind speed of 10.1 km/h.

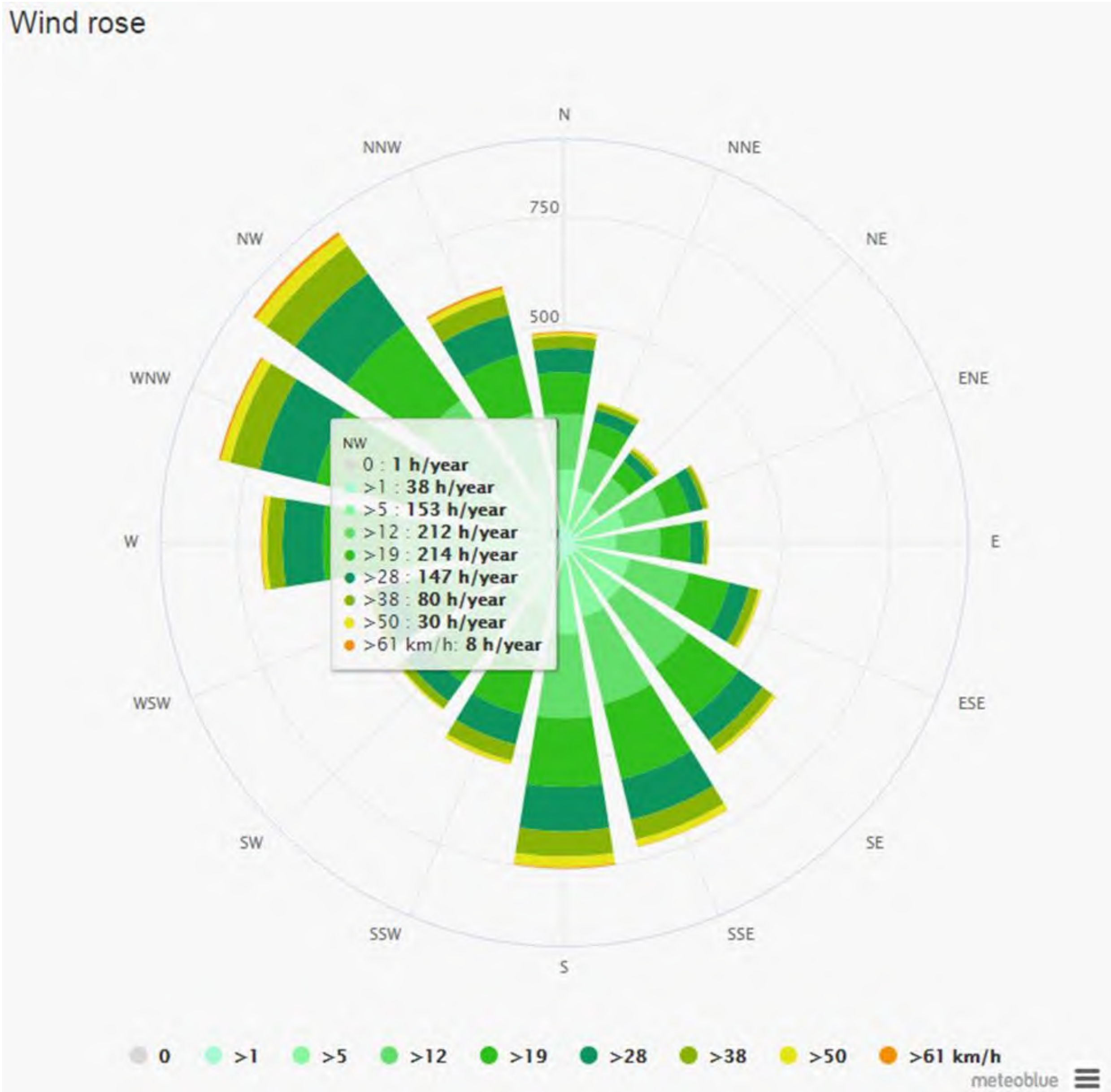

Figure 3: Wind Direction Frequency Distribution at WL

Thunderstorm activity reaches a peak in summer and significant hail has occurred twice in the last 20 years. Although tornadoes are relatively rare in the boreal forest, they have caused extensive damage to southern Manitoba communities on occasion. The most severe tornado damage occurred in 1978 when at least two tornadoes passed through southern Manitoba near WL, and another in 2006. Environment Canada statistics indicate that there were an average of 9.6 tornado strikes per year in Manitoba. Although the tornado frequency is highest in the southwest corner, tornadoes do appear in eastern portions as well.

Distribution of Population

The area surrounding WL is sparsely populated. The nearest population centres are Lac du Bonnet (population approximately 2800, located 8.6 km north), Pinawa (population approximately 1500, located 13.4 km west-southwest), Awanipark (population less than 100, located 3.5 km south of the main campus), River Hills (population less than 100, located 11.8 km south) and Seven Sisters (population less than 100, located 8.9 km south-southeast).

References to Appendix A

[A-1] R.J. Wetmiller, 1979. Seismic Monitoring at the Whiteshell Nuclear Research Establishment. Atomic Energy of Canada Limited Technical Record, TR-86.

[A-2] P.W. Basham and M.G. Cajka, 1985. Contemporary Seismicity in Northwestern Ontario. **IN** the Geoscience Program - Proceedings of the Seventeenth Information Meeting of the Nuclear Fuel Waste Management Program, Volume II. Atomic Energy of Canada Limited Technical Record, TR-299, 367-374.

[A-3] Environment Canada, Canadian Climate Normals 1981-2010. (2022/02/16). Retrieved from http://climate.weather.gc.ca/climate_normals/results_1981_2010_e.html?searchType=stnName&txtStationName=Pinawa&searchMethod=contains&txtCentralLatMin=0&txtCentralLatSec=0&txtCentralLongMin=0&txtCentralLongSec=0&stnID=3751&dispBack=1

[A-4] Meteoblue.com, Climate Pinawa Provincial Park. (2022/02/16). Retrieved from https://www.meteoblue.com/en/weather/forecast/modelclimate/pinawa-provincial-park_canada_6104825.

Notice of Violation (Corporation)

Date of notice: October 13, 2023
AMP number: 2023-AMP-04

Violation committed by:	**Amount of penalty:**
Canadian Nuclear Laboratories Ltd.	**$ 14,860**

Violation

Failure to comply with a condition of a licence in violation of 48(c) of the *Nuclear Safety and Control Act.*

Specifically, Canadian Nuclear Laboratories Ltd.'s Nuclear Research and Test Establishment Decommissioning Licence, NTREDL-W5-8.00/2024, condition 10.2 states that: *"The licensee shall implement and maintain a fire protection program."* Section 10.2 of the associated the Licence Condition Handbook NRTEDL-LCH-08.00/2024, provides criteria used to verify that licence condition 10.2 is being met, and provides amongst other criteria, that Canadian Nuclear Laboratories Ltd. comply with CSA 393:13, *Fire protection for facilities that process, handle, or store nuclear substances.*

Relevant facts

I, Kavita Murthy, Director General of the Nuclear Cycle and Facilities and designated officer authorized by the Canadian Nuclear Safety Commission (CNSC) to issue notices of violations, believe on reasonable grounds that Canadian Nuclear Laboratories Ltd. committed the above violation. The facts relevant to the violation and the penalty calculation are as follows:

1 Canadian Nuclear Laboratories Ltd., located at 286 Plant Road Chalk River, Ontario, holds a CNSC issued licence (NTREDL-W5-8.00/2024) to operate and decommission the Whiteshell Laboratories located in Pinawa, Manitoba.

2 Condition 10.2 states that: *"The licensee shall implement and maintain a fire protection program."* Section 10.2 of the associated the Licence Condition Handbook NRTEDL-LCH-08.00/2024, provides criteria used to verify that licence condition 10.2 is being met, and provides amongst other criteria, that Canadian Nuclear Laboratories Ltd. comply with CSA 393:13, *Fire protection for facilities that process, handle, or store nuclear substances*.

   a. Clause 11.5.5.2 of CSA 393:13 states that *"All fire response team members will receive firefighter training to a level response commiserate with the facilities hazards as* *determined by the needs analysis, as well as training in site design, including nuclear facility layout, major systems, and nuclear safety features, at levels appropriate for their specific response roles."*

b. Clause 11.5.8.3 of CSA 393:13 states that *"All personal protective clothing and equipment shall be maintained in a state of readiness at all times."*

c. Clause 10.11.1 of CSA 393:13 outlines how fire protective equipment is to be inspected, tested, maintained, and operated.

3 On April 27, 2023, Canadian Nuclear Laboratories Ltd. reported, in accordance with REGDOC-3.1.2, that Whiteshell Laboratories lacked properly trained and equipped fire response staff, and that this had a direct impact on the ability to maintain minimum complement for the fire brigade at the Whiteshell Laboratories site. Additional deficiencies with the training and equipment of firefighters, as well as the maintenance of fire protective equipment were subsequently identified.

a. Canadian Nuclear Laboratories Ltd. conducted an assessment of thirty-eight (38) of a total forty-eight (48) shift firefighters which determined that only twenty (20) of these thirty-eight (38) firefighters were adequately qualified.

b. Canadian Nuclear Laboratories Ltd. identified bunker gear that were missing pieces or expired, and deficiencies with self contained breathing apparatuses.

c. For some building fire protection equipment (e.g., fire extinguishers, detectors, and sprinklers), the required inspection testing and maintenance could not be confirmed by Canadian Nuclear Laboratories Ltd.

4 On April 30, 2023, Whiteshell Laboratories received spare equipment from Chalk River Laboratories.

5 On May 1, 2023, Canadian Nuclear Laboratories Ltd. sent a rotation of four Chalk River Laboratories firefighters to Whiteshell Laboratories to supplement minimum complement and assume response duties to better enable Whiteshell Laboratories shift staff to continue further assessments and training.

6 On May 4, 2023, Canadian Nuclear Laboratories Ltd. determined that Incident Commander training was incomplete for eight (8) Whiteshell Laboratories Emergency Services Organization staff. Chalk River Laboratories firefighters that were complementing the shifts had the required training but had not been assigned the Incident Commander role.

7 On May 5, 2023, and May 12, 2023, Canadian Nuclear Laboratories Ltd. conducted training sessions to qualify the necessary number of personnel to perform the role of Incident Commander.

8 On May 8, 2023, CNSC staff held a focused technical meeting (virtually) with Canadian Nuclear Laboratories Ltd. to discuss the preliminary event report, Canadian Nuclear Laboratories Ltd.'s immediate measures, any impacts on Chalk River Laboratories' fire response capabilities as a result of providing support to Whiteshell Laboratories, the next steps and timelines for action completions. This meeting focused on fire response and fire response equipment and did not include any discussion on deficiencies in fire protective equipment (as this was unknown at the time).

9 On May 15, 2023, a CNSC Designated Officer issued a request under subsection 12(2) of the *General Nuclear Safety and Control Regulations* for Canadian Nuclear Laboratories Ltd. to take specific actions to identify and address the cause of the programmatic failure of the fire protection program at Whiteshell Laboratories.

10 On May 19, 2023, Canadian Nuclear Laboratories Ltd. provided a detailed event report. The detailed event report identified deficiencies with facility fire protective systems. This was inconsistent with statements in the preliminary event report that these fire protective systems *"…have been verified through a records check to be functioning correctly or are up-to-date."*

11 On May 30, 2023, CNSC staff conducted a visit to the Whiteshell Laboratories site. During the site visit:

a. Canadian Nuclear Laboratories Ltd. stated that annual servicing and hydrostatic testing of fire extinguishers were not performed. As a result, Canadian Nuclear Laboratories Ltd. replaced all fire extinguishers on site. This was confirmed by CNSC staff during the site walkdown.

b. Canadian Nuclear Laboratories Ltd. stated that the fire pumps that supply the water for the fire hydrants did not meet the National Fire Protection Association (NFPA) requirements. Also, seven (7) fire hydrants were out of service. CNSC staff observed that Canadian Nuclear Laboratories Ltd. had pre-deployed 4" Hi Volume fire hoses from operable hydrants to non-functional ones as a compensatory measure.

c. A number of emergency lights were out of service, as they were not tested as per the NFPA standards. CNSC staff observed that signs were posted indicating this non-compliance and flashlights were on hand for staff to use upon entry.

d. The fixed suppression system for the hot cell facility was also out of service.

e. CNSC staff confirmed the implementation of newly acquired bunker gear and associated personal protective equipment for the fire fighters.

f. In order to demonstrate the qualification of the fire fighters at Whiteshell Laboratories, Canadian Nuclear Laboratories Ltd. was requested to provide training records. Upon review of the records, CNSC observed that several of these records were not dated, had incorrect dates, or had incomplete information. Following the site visit Canadian Nuclear Laboratories Ltd. provided training records with these corrections.

12 On August 21, 2023, while preparing for a CNSC inspection, Canadian Nuclear Laboratories Ltd. determined it did not have records of a pre-employment medical assessment for ten (10) firefighters hired between July 17, 2023 and August 21, 2023.

13 On August 22, 2023, CNSC staff conducted a reactive inspection of Whiteshell Laboratories.

14 On August 23, 2023 while preparing to submit all firefighter annual medical assessment records as requested by CNSC staff during the inspection, it was discovered that eight (8) annual medical assessments for existing Whiteshell Laboratories firefighters had lapsed during the months of July and August.

15 On August 24, CNSC staff issued a preliminary facts and findings report for the reactive inspection of Whiteshell Laboratories. In addition to the deficiencies with firefighter medical assessments, this report identified inappropriate storage of combustibles, incorrect colour-coding of a fire hydrant, improper maintenance and identification of fire separations, and out-of-date pre-fire plans.

Whereas it is understood that the complete implementation of the corrective actions require time, the non-compliances identified in August 2023 indicate that Canadian Nuclear Laboratories Ltd.'s oversight of its fire safety program continues to be deficient and Canadian Nuclear Laboratories Ltd. is not complying with the requirements in its management system. Based on my review of this matter, I am of the opinion that an administrative monetary penalty will deter recurrence of the above violation and promote future compliance with CNSC regulatory requirements. In consideration of the seven factors in section 5 of the *Administrative Monetary Penalties Regulations (Canadian Nuclear Safety Commission),* the amount of the penalty was determined based on the following relevant facts:

1. Compliance history: Assessed score = 1

Deficiencies in the fire safety program, including the issue of training and qualifying staff, and maintaining complete records was identified in April 2023. For staff hired as recently as July 2023, likely as a result of the previously identified deficiencies, it is reasonable to expect that Canadian Nuclear Laboratories Ltd. would have ensured that all records were up to date and current. It is also expected that annual qualifications of existing firefighters would not be permitted to lapse given the current focus on these requirements.

2. Intention or negligence: Assessed score = 2

Negligence was demonstrated in Canadian Nuclear Laboratories Ltd.'s failure to adequately maintain records of these qualifications. At this point there is no information which would indicate an explicit intention to commit this violation.

3. Actual or potential harm: Assessed score = 1

This non-compliance with implementation of a fire protection program could have had a potential impact on the health and safety of persons or on the environment as Canadian Nuclear Laboratories Ltd. was not able to sustain an effective fire response capability at Whiteshell Laboratories. Regulatory dose and release limits are expected to be met for postulated fire scenarios without crediting manual suppression activities. However, manual intervention is credited to meet the goals of CSA 393:13 to mitigate, recover and terminate a fire event, thus minimizing risk to persons, the environment, and conservation of radioactive material. Medical examination records indicate fitness to perform duty and not having these records could have resulted in an unfit person being responsible for fire safety.

4. Competitive or economic benefit: Assessed score = 0

There was no competitive or economic benefit to Canadian Nuclear Laboratories Ltd. as a result of its non-compliance.

5. Efforts to mitigate or reverse effects: Assessed score = 0

Canadian Nuclear Laboratories has made reasonable effort to mitigate the effects of the non-compliance by arranging medical assessments for the Whiteshell Laboratories firefighters that were lacking them.

6. Assistance to Commission: Assessed score = 0

Canadian Nuclear Laboratories Ltd. provided all reasonable assistance to the CNSC throughout this issue.

7. Attention of Commission: Assessed score = 0

Canadian Nuclear Laboratories Ltd. identified the initial non-compliance and initiated mitigating measures prior to involvement of the CNSC. However, the ongoing non-compliances regarding medical assessments of firefighters were only identified as a result of a CNSC inspection.

Penalty calculation:

(See *Administrative Monetary Penalties Regulations (Canadian Nuclear Safety Commission)* SOR/2013-139)

(a) **Category of violation**

Category A ☐ Category B ☐ **Category C** ☒

(b) **Penalty range**

Category	Minimum	Maximum	Maximum – minimum
A	$1,000	$12,000	$11,000
B	$1,000	$40,000	$39,000
C	**$1,000**	**$100,000**	**$99,000**

(c) **Determining factors**

Factors	Scale of regulatory significance	Assessed score
1. Compliance history	0 ☐ +1 ☒ +2 ☐ +3 ☐ +4 ☐ +5 ☐	1
2. Intention or negligence	0 ☐ +1 ☐ +2 ☒ +3 ☐ +4 ☐ +5 ☐	2
3. Actual or potential harm	0 ☐ +1 ☒ +2 ☐ +3 ☐ +4 ☐ +5 ☐	1
4. Competitive or economic benefit	0 ☒ +1 ☐ +2 ☐ +3 ☐ +4 ☐ +5 ☐	0
5. Efforts to mitigate or reverse effects	-2 ☐ -1 ☐ 0 ☒ +1 ☐ +2 ☐ +3 ☐	0
6. Assistance to Commission	-2 ☐ -1 ☐ 0 ☒ +1 ☐ +2 ☐ +3 ☐	0
7. Attention of Commission	-2 ☐ -1 ☐ 0 ☒ +1 ☐ +2 ☐ +3 ☐	0
	Total	**4**
	÷ **29** [(1)] [rounded to 2 decimal points]=	**0.14**
	x 99000	
	[total] =	**13,860**
	+ $ 1000 [minimum for the category] =	**14860**

[(1)]29 being the maximum value of regulatory significance

To request a review

As a person subject to an administrative monetary penalty, you have the right to request a review of the amount of the penalty or the facts of the violation, or both. Your request must be made in writing indicating the reasons why you are requesting a review and providing supporting information.

If you choose to request a review, you must do so in writing by November 15, 2023 to:

Canadian Nuclear Safety Commission
c/o Denis Saumure
Commission Registrar
P.O. Box 1046, Station B
Ottawa, ON K1P 5S9

Fax: (613) 995-5086
Telephone: (613) 282-9537
Email: registry.greffe@ccsn-ccsn.gc.ca

Payment

You may pay this administrative monetary penalty by sending a cheque to:

> Receiver General for Canada
> c/o Canadian Nuclear Safety Commission
> Finance Division
> P.O. Box 1046, Station B
> Ottawa, ON K1P 5S9

For other payment methods and further instructions, please refer to the attached notice of payment due.

Should you neither pay the penalty nor exercise your right to a review, you will be considered as having committed the violation and will be liable to the penalty set out herein.

Issued by

Digitally signed by Murthy, Kavita
DN: C=CA, O=GC, OU=CNSC-CCSN, CN="Murthy, Kavita"
Reason: I am approving this document
Location: Ottawa, Ontario, Canada
Date: 2023.10.18 16:06:24-04'00'
Foxit PDF Editor Version: 12.1.2

2023-10-18

Kavita Murthy — Date

Kavita Murthy
Designated Officer
Director General of the Directorate for Nuclear Cycle and Facilities Regulation

Telephone: (613) 222-1703
Email: kavita.murthy@cnsc-ccsn.gc.ca

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

UNPROTECTED/NON PROTÉGÉ

ORIGINAL/ORIGINAL

CMD: 19-H4

Date signed/Signé le : AUGUST 6, 2019

Reference CMD(s)/CMD(s) de référence : 12-M47, 14-M7, 18-M30, 18-H103

A Licence Renewal

Un renouvellement de permis

Canadian Nuclear Laboratories Ltd.

Laboratoires Nucléaires Canadiens Ltée

Whiteshell Laboratories

Laboratoires de Whiteshell

Commission Public Hearing

Audience publique de la Commission

Scheduled for:

October 2019

Prévue pour :

octobre 2019

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

e-Doc 5756806 (WORD)
e-Doc 5961001 (PDF)

Summary

This CMD presents information about the following matter of regulatory interest with respect to Canadian Nuclear Laboratories:

- Canadian Nuclear Laboratories application for the Nuclear Research and Test Establishment Decommissioning Licence for the Whiteshell Laboratories

CNSC staff recommend the Commission take the following actions:

- Renew the Whiteshell Laboratories licence from January 1, 2020 to December 31, 2029.
- Delegate authority as set out in section 4.7 of this CMD.

The following items are attached:

- The proposed licence, NRTEDL-W5-08.06/2029
- The draft Licence Conditions Handbook
- The current licence, NRTEDL-W5-08.05/2019
- The Environmental Protection Review report

Résumé

Le présent CMD présente de l’information sur un ensemble de questions d’ordre réglementaire concernant les Laboratoires Nucléaires Canadiens (LNC) :

- La demande de Laboratoires Nucléaires Canadiens visant à renouveler le permis de déclassement de l’établissement de recherche et d’essais nucléaires pour les Laboratoires de Whiteshell

La Commission pourrait considérer prendre les mesures suivantes :

- Renouveler le permis pour les Laboratoires de Whiteshell du 1er janvier 2020 au 31 décembre 2029.
- Accepter la délégation des pouvoirs telle qu’elle est établie à la section 4.7 du présent CMD

Les pièces suivantes sont jointes :

- Le permis proposé, NRTEDL-W5-08.06/2029
- L’ébauche du Manuel des conditions de permis
- Le permis actuel, NRTEDL-W5-08.05/2019
- Le Rapport d’examen de la protection de l’environnement

Signed/signé le

August 6, 2019

Kavita Murthy for.

Haidy Tadros

Director General

Directorate of Nuclear Cycle and Facilities Regulation

Directrice générale de la

Direction de la réglementation du cycle et des installations nucléaires

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EXECUTIVE SUMMARY

The current Whiteshell Laboratories (WL) licence, NRTEDL-W5-08.05/2019, is valid until December 31, 2019. Canadian Nuclear Laboratories (CNL) has applied to renew the licence for a period of 10 years, until December 31, 2029.

The purpose of this Commission Member Document (CMD) is to provide the results of CNSC staff's assessment of the CNL application, including conclusions and recommendations to inform the Commission decision on the licence renewal. In their assessment of the application, CNSC staff reviewed all 14 safety and control areas (SCAs) and took the licensee's past performance into consideration.

Based on this assessment, CNSC staff conclude that CNL has made and will continue to make adequate provisions for the protection of the environment and the health and safety of persons, and that there will be no adverse effects on the health and safety of persons or the environment as a result of the decommissioning of WL.

This conclusion is supported by CNSC staff's Environmental Protection Review (EPR) report for the WL site. The EPR report is attached to this CMD.

The matter before the Commission in this CMD **does not include in situ decommissioning (ISD)** of the WR-1 reactor. ISD of WR-1 is currently undergoing an environmental assessment under the Canadian Environmental Assessment Act (CEAA), 2012. This will be presented to the Commission at a separate public hearing. ISD of WR-1 is out of scope of this licence consideration.

The public, Indigenous groups and other stakeholders were invited to participate in the regulatory licence renewal process. To enable their participation, up to $50,000 was made available through the CNSC Participant Funding Program (PFP).

This CMD has two parts. Part one presents CNSC staff's review and assessment of CNL's licence application and a summary of CNL's performance in the operation of WL since 2008. Part two presents CNSC staff's proposed licence and licence conditions handbook (LCH).

Referenced documents in this CMD are available to the public upon request.

PART ONE

This Commission Member Document (CMD) is presented in two parts.

Part One includes:

[1] An overview of the matter being presented;

[2] Overall conclusions and overall recommendations;

[3] General discussion pertaining to the safety and control areas (SCAs) that are relevant to this submission;

[4] Discussion about other matters of regulatory interest; and

[5] Addenda material that complements items 1 through 4.

Part Two provides all available information pertaining directly to the current and proposed licence.

1. OVERVIEW

1.1 Background

CNL is authorized to decommission the Whiteshell Laboratories (WL), comprising both nuclear and non-nuclear facilities under a CNSC issued Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-08.05/2019[1].

The WL site is located approximately 100 km northeast of Winnipeg near the town of Pinawa, Manitoba. Figure 1 illustrates the WL site location in relation to surrounding communities. The WL site encompasses an area of 4,375 hectares and includes facilities such as the Whiteshell Reactor (WR-1), the shielded facilities, the radioactive waste management facilities and structures, the concrete canister storage area and various research laboratories and support buildings. The WL site was operated by Atomic Energy of Canada Limited (AECL) as a nuclear research facility for approximately 40 years. During this time WR-1 operated for a period of 20 years under an operating licence issued by the Atomic Energy Control Board. In 2002 AECL applied for and was granted a decommissioning licence. In October 2014, the Commission approved the transfer of the licence from AECL to CNL. CNL remains the current licensee.

Figure 1: Location of WL (source Google)

Since 2002, significant decommissioning progress has been made with activities including: demolition of redundant buildings, phased decommissioning of the main research building, severing or redirecting services where necessary, construction of new enabling facilities, repurposing of buildings to support decommissioning and initiating subsurface investigations into the conditions of various containment structures inside the waste management area. An aerial view the WL site can be seen in figure 2.

Figure 2: Aerial view of WL in 2018 (Source: CNL)

Licensing History

The decommissioning licence was first issued by the Commission in November 2002 for a six-year period. This was followed by the Commission renewing the licence in December 2008 for a ten-year period. Licence amendments were approved by the Commission in 2010 and 2012 to reflect requested changes in report submission dates, reference documents and action levels. In October 2014, the Commission approved the transfer of all AECL licences, including the Whiteshell licence, to the Canadian Nuclear Laboratories. In January 2016, the Commission approved an administrative licence amendment that revised the licence to the standardized format with an associated LCH. In March 2018, the WL licence was renewed by the Commission for a 1-year term until December 2019. Details of the 2018 one year licence renewal are provided below.

CNL's 2018 Licensing Request

In September 2017, CNL submitted an application to renew the WL decommissioning licence for a 10-year period. With this application, CNL submitted a proposal for the in-situ decommissioning (ISD) of the WR-1 reactor. CNL's proposal to conduct ISD of the WR-1 reactor was a change from the original decommissioning approach of dismantlement and triggered the requirement for an environmental assessment (EA) under the Canadian Environmental Assessment Act (CEAA), 2012 [2].

As part of the CEAA 2012 process, a draft environmental impact statement (EIS) for the proposed ISD of the WR-1 reactor was submitted by CNL and made available to the public for comment. CNL determined that additional time was needed to address the large number of comments raised by the public, Indigenous groups, Métis communities and regulators in relation to the draft EIS that was developed in support of the EA. Note that this EA, and the associated licensing request for the ISD of WR-1, is not part of the current licence application.

Consequently, on March 13, 2018, CNL requested that the Commission renew their existing licence for a one-year period ending December 31, 2019, under the same terms and conditions as the previous licence. This short-term renewal request was granted by the Commission on August 1, 2018 with no changes to the terms, conditions or licensed activities.

The current decommissioning licence includes a decommissioning strategy for the WL site that was previously accepted by the Commission in 2002 and does not authorize the ISD of WR-1. The proposed ISD of WR-1 is out of scope of this licence application and safety case. CNL must seek separate Commission authorization for the newly proposed decommissioning strategy for WR-1.

Current Relicensing Request

CNL's current decommissioning licence NRTEDL-W5-8.05/2019 remains valid until December 31, 2019. On November 15, 2018 CNL requested a 10 year renewal of the WL licence in order to continue on-going decommissioning activities and provide adequate time to complete the safety case for the ISD of the WR-1 reactor. The matter before the Commission in this CMD does not include ISD of WR-1. The proposed ISD of WR-1 is out of scope of this licence consideration.

Reporting on Licensee Performance

CNSC staff conduct ongoing regulatory oversight and compliance verification activities at the WL site. Regular updates on licensee performance and project status have and will continue to be brought to the Commissions' attention via regulatory oversight reports (RORs) at public meetings. In relation to interim reporting, CNSC staff have kept the Commission informed of the status of decommissioning activities in 2012 (interim status report) [3], 2014 (annual performance report) [4], 2016 (status report) [5], and in 2018 (progress update) [6]. This CMD builds on the information provided in those documents. CNSC staff will next update the Commission on the status of CNL's performance at the WL site in a ROR to be presented to the Commission at a public hearing in November 2019. This ROR will discuss CNL's performance at all its licensed facilities.

1.2 Highlights

The purpose of this CMD is to provide the Commission with the results of CNSC staff's assessment on CNL's application for renewing the WL site licence. This CMD provides CNSC staff's conclusions and recommendations to inform the

Commission decision on the licence application. CNSC staff's assessment of the application takes into consideration the results of CNSC staff's compliance verification activities, CNL's operational performance history and information submitted by CNL in support of the application.

CNSC staff have prepared a proposed licence that uses the standard format and incorporates the standard licence conditions applicable to the WL site.

CNSC staff typically present supporting information for the previous licence period in submissions regarding licence applications. In this case, since the previous licence period was only 12 months, CNSC staff have provided supporting information dating back to 2009 for more meaningful trending for the Commission.

This CMD provides a summary of CNSC staff's review of all safety and control areas (SCAs).

1.3 Overall Conclusions

CNSC staff have concluded the following with respect to paragraphs 24(4)(a) and (b) of the *Nuclear Safety and Control Act* (NSCA) [7], in that the licensee:

1. Is qualified to carry out the activity authorized by the licence.
2. Will, in carrying out that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

1.4 Overall Recommendations

CNSC staff recommend the following:

1. accept CNSC staff's conclusions and exercise the Commission's authority under the NSCA [7] to renew the CNL licence of the Whiteshell Laboratories from January 1, 2020 to December 31, 2029
2. authorize the delegation of authority as set out in subsection 4.7 of this CMD

2. MATTERS FOR CONSIDERATION

2.1 Environmental Protection Review Report

CNSC staff have determined that this licence application request is not on the designated project list under the *Canadian Environmental Assessment Act, 2012* and therefore does not trigger an EA under CEAA 2012. Addendum D of this CMD provides an Environmental Protection Review Report under the NSCA and its Regulations. The EPR is a science-based environmental technical assessment by CNSC staff of CNL's application for renewal of the decommissioning licence for the WL site. CNSC staff conclude that the licensee has, and will, continue to make adequate provision for the protection of the environment and health of persons.

2.2 Relevant Safety and Control Areas (SCAs)

The functional areas of any licensed facility or activity consist of a standard set of safety and control areas (SCAs). Each SCA is comprised of "specific areas" of regulatory interest; however, the applicable specific areas associated with each SCA vary between facility types. See Addendum C, "Safety and Control Framework", for further information about SCAs.

In the following table, the rating level for each SCA relevant to the WL site is indicated. The rating indicates the overall compliance with regulatory requirements (refer to Addendum A, "Rating Levels").

Functional Area	Safety and Control Area	Rating Level[1]
Management	Management System	SA
	Human Performance Management	SA
	Operating Performance	SA
Facility and Equipment	Safety Analysis	SA
	Physical Design	SA
	Fitness for Service	SA
Core Control Processes	Radiation Protection	SA
	Conventional Health and Safety	SA
	Environmental Protection	SA
	Emergency Management and Fire Protection	SA
	Waste Management	SA
	Security	BE
	Safeguards and Non-Proliferation	SA
	Packaging and Transport	SA

Each SCA is discussed in detail in Section 3, *General Assessment of SCAs*.

[1] FS = Fully Satisfactory, SA = Satisfactory, and BE = Below Expectations

2.3 Other Matters of Regulatory Interest

The following table identifies other matters that are relevant to this CMD.

OTHER MATTERS OF REGULATORY INTEREST	
Area	**Relevant to this CMD?**
Aboriginal Consultation	Yes
Other Consultation	Yes
Cost Recovery	Yes
Financial Guarantees	Yes
Improvement Plans and Significant Future Activities	Yes
Licensee's Public Information Program	Yes
Nuclear Liability Insurance	Yes

The relevant "other matters" of regulatory interest are discussed in section 4.

2.4 Regulatory and Technical Basis

The regulatory and technical basis for the matters discussed in this CMD are provided in Addendum B to this document.

3. GENERAL ASSESSMENT OF SCAS

The relevant specific areas that comprise the SCAs for the WL site are identified in Addendum C, section C.2.

3.1 Management System

The Management System SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy safety culture.

The specific areas that comprise this SCA at the WL site include:

- Management system
- Organization
- Performance assessment, improvement and management review
- Operating experience (OPEX) - (no significant observations to report)
- Change management - (no significant observations to report)
- Configuration management - (no significant observations to report)
- Records management - (no significant observations to report)
- Management of contractors - (no significant observations to report)

3.1.1 Trends

The following table indicates the overall rating trends for the Management System over the current licensing period:

TRENDS FOR MANAGEMENT SYSTEM				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. The licensee has maintained a management system in accordance with CNSC requirements over this licensing period. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories.				

3.1.2 Discussion

In order to meet CNSC requirements for this specific area, the licensee must implement and maintain the management system requirements set out in Canada Standards Association (CSA) standard N286-12, *Management system requirements for nuclear facilities*. The management system brings together, in a planned and integrated manner, the processes necessary to satisfy the requirements that must be met to safely carry out the licensed activity. During the current licensing period, CNL has implemented and maintained a management system at the WL site.

CNSC staff performed a desktop review of CNL's implementation of their management system program at the WL site, and conclude that the program meets all applicable regulatory requirements and CNSC expectations. In addition, CNSC staff have reviewed CNL's updates to the WL Decommissioning Quality Assurance Plan. In each update to the document, CNSC staff comments were resolved satisfactorily by CNL. All inspection findings from the previous licensing period have been closed to CNSC staff's satisfaction by the licensee.

3.1.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.1.3.1 Past Performance

Management System

During the licensing period under review, CNL has provided CNSC staff with updates to their management system. The major update in this time period was the adoption of the CSA N286-12 standard requirements. This update applied to all CNL sites, as CNL made the decision to integrate management system requirements into one CNL-wide program.

CNL sites, such as WL, have developed Quality Assurance Plans to describe site-specific aspects of the CNL management system and the site-specific functions, responsibilities and authorities. Other changes described in the management system updates submitted included reorganizing the company document structure and format and also changes in responsibilities. CNSC staff confirmed that the WL Decommissioning Quality Assurance Plan incorporates all the requirements necessary to meet the CSA N286-12 standard.

CNSC staff verify elements of CNL's management system during all inspections conducted on the site. This is done through CNSC staff review of CNL's records, verification of the licensee's implementation of document control, training program and general maintenance of the programs relevant to the safe and secure conduct of the licensed activities.

Overall, the WL management system continues to meet CNSC requirements.

Organization

WL is owned and was historically operated by AECL, a federal crown corporation. In 2013 the Government of Canada announced its decision to engage a private-sector contractor to manage operations at WL under a government owned-contractor operated (Go-Co) business model [8]. CNL was established as a wholly-owned subsidiary of AECL in 2014. AECL applied to the Canadian Nuclear Safety Commission, under subsection 24(2) of the Nuclear Safety and Control Act, to transfer five licences to CNL. Based on its consideration of the matter, following a hearing held on October 22, 2014 the Commission concluded that CNL met the conditions of subsection 24(4) of the NSCA and approved the transfer of the licences. CNL then assumed responsibility for the day-to-day operations of WL.

In 2015, the management of CNL was contracted to Canadian National Energy Alliance (CNEA), completing the transition to the Go-Co model [9].

Under the Go-Co arrangement, AECL retains ownership of all the assets of WL while CNL remains the licensee with a CNEA-selected executive team. AECL's role is now focused on the oversight of the Go-Co contract to ensure CNL's performance meets the government objectives for the contract.

As part of the Go-Co transformation management, CNL created new:

- corporate profile, mission, vision and values,
- governance model/Board of Directors/Executive Team,
- organization structure, and
- roles, responsibilities, accountabilities and authorities.

CNSC staff confirmed that CNL has appropriately documented the changes to the CNL organization. CNSC staff have no concerns regarding the changes to the CNL organization and have confirmed CNL's organization is suitable to ensure continued safe operation and compliance with regulatory requirements.

Performance assessment, improvement and management review

CSA N286-12 requires that problems are identified, controlled, documented and resolved by the nuclear facility operator. CNL documents issues and opportunities for improvement through a problem identification and resolution mechanism referred to as ImpAct.

CNSC staff verify ImpAct initiation, routing, trending, approval, and effectiveness by performing routine desktop reviews of ImpAct reports. Field verification of the completion of followup actions, where appropriate, are integrated into site inspection activities. As a result of these reviews CNSC staff conclude that CNL continues to meet CNSC regulatory requirements in this area.

3.1.3.2 Regulatory Focus

CNSC staff will verify the implementation of the revised WL Decommissioning Quality Assurance Manual during compliance activities.

CNSC staff will continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation to ensure WL continues to meet applicable regulatory documents, codes and standards for the upcoming proposed 10-year licence period.

3.1.3.3 Proposed Improvements

CNL has stated that they will implement the revised WL Decommissioning Quality Assurance Plan that was recently accepted by CNSC staff. CNL will also implement a continuous improvement program to ensure that the integrated management system enables effective and efficient management of the company.

3.1.4 Conclusion

There are no challenges with CNL's implementation of this SCA.

Based on CNSC staff's assessments of CNL's application, supporting documents, and correction of inspection findings, CNSC staff conclude the licensee continues to maintain an effective management system in accordance with regulatory requirements.

3.1.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 1.1 requires CNL to implement and maintain a management system. Compliance verification criteria for this licence condition are included in the draft LCH.

3.2 Human Performance Management

The Human Performance Management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure a sufficient number of licensee personnel are in all relevant job areas and have the necessary knowledge, skills, procedures, and tools in place to safely carry out their duties

The specific areas that comprise this SCA at the WL site include:

- Human performance program
- Personnel training
- Fitness for duty

3.2.1 Trends

The following table indicates the overall rating trends for the Human Performance Management over the current licensing period:

TRENDS FOR HUMAN PERFORMANCE MANAGEMENT				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. The licensee has maintained a human performance management program in accordance with CNSC requirements over this licensing period. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories.				

3.2.2 Discussion

CNL is required to implement and maintain a human performance program in order to ensure a sufficient number of qualified workers are available in all relevant job areas, and they have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. Compliance inspections conducted by CNSC staff during the current licensing period included verifications of the training records of staff in safety-related positions and a general verification of the licensee's maintenance of a complement of competent and knowledgeable workforce. CNSC staff conclude that programs related to CNL's Human Performance Management activities at WL have met applicable regulatory requirements and CNSC expectations.

3.2.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.2.3.1 Past Performance

Human Performance Program

For the past few years, CNL has been transitioning to a new management system structure. As part of that work, they have been developing corporate-level program documents applicable to all activities at CNL sites.

The main elements of the corporate Performance Assurance Program at CNL are as follows:

- Operating Experience (OPEX) and Corrective Action Program (CAP),
- Assessment,
- Human Performance,
- Continual Improvement, and
- Performance Measures and Analysis.

The six elements of the Human Performance Program are operationalized through the application and use of:

- Event Free Day Reset,
- Event Free Tools,
- Observation and Coaching,
- Operational Decision-Making,
- Safety Culture Assessment, and
- Dynamic Learning Activities.

The suite of management system documents relevant to human performance include Procedures, Management Control Procedures (MCP), Operating Instructions, and other documents that will be used to manage and support human performance.

Though CNL is still in the process of updating its management system documents, a review of the top two governing documents for the Performance Assurance Program has been completed by CNSC staff. Staff comments will be communicated to CNL, and follow-up will be performed on CNL's response. CNSC staff comments represent opportunities for improvement, and do not raise any impediments for the renewal of the WL site licence.

Personnel Training

CNL is required by the *General Nuclear Safety and Control Regulations* to ensure there are a sufficient number of properly trained and qualified workers to safely conduct the licensed activities. REGDOC 2.2.2, *Personnel Training* provides additional requirements. CNL has incorporated the requirements of REGDOC 2.2.2 in to their corporate-wide training program.

Compliance inspections conducted by CNSC staff during the current licensing period included verifications of training records. These reviews showed that training records were maintained and that CNL employees were provided appropriate training.

Fitness for Duty

In 2017, CNL provided the CNSC with a gap analysis and implementation plan for REGDOC-2.2.4, *Fitness for Duty: Managing Worker Fatigue* (Fatigue), and in 2018, a gap analysis and implementation plan for REGDOC-2.2.4, *Fitness for Duty, Volume II: Managing Alcohol and Drug Use* (Alcohol and Drug), with the purpose of providing the measures by which CNL will meet the requirements of REGDOC-2.2.4.

For Vol I of the REGDOC (Fatigue), CNL has indicated that they have revised scheduling requirements to meet REGDOC-2.2.4.

For Vol II (Alcohol and Drug), CNL has proposed timelines of July 2019 for implementation of all program and testing requirements of this REGDOC except random testing. A date has yet to be determined for implementation of random testing. Licensees have requested that their implementation dates for this REGDOC be delayed to allow discussion of industry-proposed amendments regarding the use of oral fluid testing. CNSC staff have agreed to this delay and are assessing the industry-proposed amendments. Should the REGDOC be amended, the revised draft will be subject to Commission approval at a future date.

3.2.3.2 Regulatory Focus

CNSC staff will focus on monitoring the implementation of the requirements of REGDOC 2.2.4.

A few refinements to licensee program documentation has been identified by CNSC staff. Once responses to those recommendations have been made, CNSC staff will be able to determine appropriate compliance activities. As stated in section 3.2.3.1, CNSC staff comments do not raise any impediments for the renewal of the WL site licence.

3.2.3.3 Proposed Improvements

CNL plans to implement the requirements of REGDOC 2.2.4 volumes I and II.

CNSC staff will continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and reviews of relevant program documentation.

3.2.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain an effective human performance program for WL in accordance with regulatory requirements.

3.2.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 2.1 requires CNL to implement and maintain a human performance program, and condition 2.2 requires CNL to implement and maintain a training program. Compliance verification criteria for the two licence conditions are included in the draft LCH.

3.3 Operating Performance

The Operating Performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

The specific areas that comprise this SCA at the WL site include:

- Conduct of licensed activity
- Procedures
- Reporting and trending

3.3.1 Trends

The following table indicates the overall rating trends for the Operating Performance over the current licensing period:

TRENDS FOR OPERATING PERFORMANCE				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. The licensee has maintained an operating program in accordance with CNSC requirements over this licensing period. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories.				

3.3.2 Discussion

CNL is required by the Class I Nuclear Facilities Regulations to ensure measures, policies, methods and procedures for safely operating and maintaining the nuclear facility are in place. Verification of the licensee's compliance with the requirements of this SCA are an integral part of all of CNSC's compliance activities ranging from desktop reviews of reports, documents and events to site inspections. CNSC staff confirm that CNL has implemented and maintains an effective Operating Program in order to ensure licensed activities are performed safely and in compliance with regulatory requirements. CNSC staff conclude that CNL's Operating Performance at the WL site met all applicable regulatory requirements and CNSC staff's expectations. CNSC staff are satisfied that licensed activities at the WL site are conducted in a safe manner.

3.3.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.3.3.1 Past Performance

Conduct of Licensed Activity

Nuclear facilities at the WL site are governed by CNL's Facility Authorization and facility-specific Conduct of Operations documents, which indicate the operational limits and conditions for the various facilities. Facilities in permanent safe shutdown state or undergoing active decommissioning are governed by storage-with-surveillance plans or decommissioning plans, respectively. These governing documents prescribe how each facility is operated and maintained to ensure nuclear safety and that the risk to the public remains low.

CNSC staff carried out many verification activities since 2009 on CNL's operations across the WL site and found that overall, all nuclear facilities at the WL site have been operating safely. As CNL transitions to its new management system structure, operating procedures and instructions are being revised to align to the new format.

In accordance with the current LCH, CNL continues to provide information regarding the operating performance of nuclear facilities at the WL site in annual reports submitted to CNSC staff. CNSC staff evaluate the information provided in these reports to ensure CNL remains in compliance with regulatory requirements.

Procedures

CNL's Management System consists of high level documentation supported by lower level procedures. CNL maintains a comprehensive suite of procedures across all programs and facilities at the WL site. Since 2009, CNL has continually updated the facility-specific procedures as needed to support ongoing process improvements at the WL site.

CNSC staff review procedure level documents as part of ongoing compliance verification activities. Based on these reviews, CNSC staff conclude that the changes made to CNL's procedures were carried out in accordance with CNL's change control process and there were no significant changes to operating documentation that could have affected the safe operation of the facilities at the WL site.

Reporting and Trending

Detailed requirements for reporting unplanned situations or events at the WL site to the CNSC are included in the WL LCH. CNL has complied with the requirements for submission of these reports since 2009.

Events reported to the CNSC by CNL are presented in table 1.

Table 1: Reportable Events for the WL Site (2009-2018)

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total	6	24	10	5	4	5	0	5	4	0

CNSC staff review all reported events to identify if there are any regulatory concerns and report significant events to the Commission at public meetings of the Commission. There were no event initial reports (EIR) related to the WL site presented to the Commission since 2009.

CNL also submits annual reports on compliance monitoring and operating performance of facilities at the WL site, as required by licence condition 5.1 of the current licence. CNSC staff reviewed these reports and no significant regulatory issues were identified during the review.

3.3.3.2 Regulatory Focus

CNSC staff continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation.

CNSC staff will focus compliance verification activities on operational activities at the WL site. As the licensee's activities on the WL site continues its steady shift towards decommissioning and demolition activities and the transport of waste offsite, CNSC staff's compliance activities will focus on verification of the safe conduct of these activities.

3.3.3.3 Proposed Improvements

The regulatory document REGDOC-3.1.2, *"Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills* is referenced in the proposed WL LCH. This document sets out requirements and guidance for reports and notifications that licensees must submit to the CNSC. This REGDOC outlines the types of reports that are required to be submitted to the CNSC, and the applicable timeframe for reporting.

3.3.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain an effective operating program for the WL site in accordance with regulatory requirements.

3.3.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 3.1 requires CNL to implement and maintain an operating program, which includes a set of operating limits. Licence condition 3.2 requires CNL to implement and maintain a program for reporting to the Commission or a person authorized by the Commission. The recommended delegation of authority for licence condition 3.2 is detailed in section 4.7 of this CMD. Compliance verification criteria for both licence conditions are included in the draft LCH.

3.4 Safety Analysis

The Safety Analysis SCA covers maintenance of the safety analysis that supports the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

The specific areas that comprise this SCA at the WL site includes:

- Deterministic safety analysis
- Hazard analysis
- Criticality safety

3.4.1 Trends

The following table indicates the overall rating trends for the Safety Analysis over the current licensing period:

TRENDS FOR SAFETY ANALYSIS				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. The licensee has over this licensing period maintained a safety analysis program in accordance with CNSC requirements. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories.				

3.4.2 Discussion

CNL is required by the Class I Nuclear Facilities Regulations to prepare formal Safety Analysis Reports (SAR) for Class I nuclear facilities. CNL has implemented a safety analysis program that ensures systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and to consider the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

CNSC staff note that the scope, content and detail of the safety analysis for the WL site is not the same as for an operating nuclear power reactor. There is no operating reactor on site and there are no activities related to fissionable material on this site, other than storage of low-risk irradiated fuel. The CNSC applies a graded approach to safety analysis, commensurate with the level of risk of the facility.

CNSC staff conducted desktop reviews of CNL's safety analysis documentation and conclude that CNL's Safety Analysis at the WL site met applicable regulatory requirements and CNSC expectations.

3.4.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.4.3.1 Past Performance

Deterministic Safety Analysis

CNL maintains SARs for all Class I nuclear facilities at the WL site.

CNL updates the SARs over time as operational requirements change. Updates are carried out in accordance with the requirements of the licensing basis. When CNL updates the SARs, they are provided to CNSC staff for review. CNSC staff monitors changes in the SAR to ensure continued compliance with the licensing basis.

Criticality Safety

There remain no activities associated with fissionable material at the WL site, other than storage of used fuel in the Concrete Canister Storage Facility (CCSF) and the waste management area's standpipes, which CNL and CNSC staff consider to be low risk. CNSC staff continue to monitor any changes to the risk that result from activities to remediate the standpipes and CCSF.

CNL is required to implement and maintain a nuclear criticality safety program compliant with RD-327, *Nuclear Criticality Safety*. The nuclear criticality safety program at CNL is a corporate-wide program, and is used at both the WL and CRL sites. CNL has developed a suite of nuclear criticality safety program documents acceptable to CNSC staff. CNL maintains and updates its criticality safety documents (CSD). CNSC staff reviewed changes to the CSDs as they were updated by CNL. Based on the reviews, CNSC staff concluded that CNL continues to make changes and updates to CSDs that are consistent with CNSC regulatory requirements.

Hazard Analysis

CNL carried out code compliance reviews and Fire Hazard Analysis for the WL site facilities in accordance with CSA-N393, *Fire protection for facilities that process, handle, or store nuclear substances*. These reviews are discussed in section 3.5.3, Fire Protection Program, of this CMD.

3.4.3.2 Regulatory Focus

CNSC staff continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation, new and/or revised safety analyses and criticality safety documents.

3.4.3.3 Proposed Improvements

CNL is required to continually update its safety analyses to reflect the current operational state of all facilities on site.

3.4.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain a Safety Analysis program at the WL site in accordance with regulatory requirements.

3.4.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 4.1 requires CNL to implement and maintain a safety analysis program. Licence condition 4.2 requires CNL to implement and maintain a nuclear criticality safety program. Compliance verification criteria for both licence conditions are included in the draft LCH.

3.5 Physical Design

This SCA relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

Given that the WL site is undergoing decommissioning, there is very little activity on physical design.

The specific areas that comprise this SCA at the WL site include:

- Design governance
- Site characterization - (no significant observations to report)
- Facility design
- Structure design - (no significant observations to report)
- System design - (no significant observations to report)
- Component design - (no significant observations to report)

3.5.1 Trends

The following table indicates the overall rating trends for the Physical Design over the current licensing period:

TRENDS FOR PHYSICAL DESIGN				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories. CNSC staff conclude that CNL's Physical Design performance meets regulatory requirements.				

3.5.2 Discussion

CNL is required to implement and maintain a design program so that design of facilities is managed using a well-defined systematic approach. Implementing and maintaining a design program confirms that safety-related structures, systems and components (SSC), and any modifications to them, continue to meet their design basis taking new information and changes in the external environment into account. It also confirms that SSCs continue to be able to perform their safety functions under all facility conditions. An important cross-cutting element of a design program is design basis management.

CNSC staff confirm that CNL has implemented and maintained a design program to ensure the ability of systems, structures and components to meet and maintain their design basis. CNSC staff conclude that CNL's physical design measures at the WL site meet all applicable regulatory requirements and CNSC expectations.

3.5.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.5.3.1 Past Performance

Design governance

Fire Protection Program

CNL's Fire Protection Program at the WL site identifies how protection from fire is achieved through planned, coordinated and controlled activities to reduce the risk to the health and safety of persons and to the environment from a fire. CNL continues to maintain its fire protection program in accordance with the current licence and associated LCH, the National Building Code, the National Fire Code [10] and CSA standards. During the current licence period, CNSC and CNL fire protection staff at the WL site held meetings to discuss the progress of projects, and any other programmatic matters or subjects of interest. CNSC staff conclude that the fire protection program at the WL site meets regulatory requirements and the WL site is performing satisfactorily.

CNL carried out fire protection assessments, which include code compliance reviews (CCR) and Fire Hazard Analysis (FHA), for the WL site facilities in accordance with the CSA-N393 standard, as well as key standards referenced herein, such as the National Building Code of Canada, National Fire Code of Canada, associated NFPA standards etc.

CNL has submitted to CNSC staff their CCR which demonstrates that they are in compliance with the programmatic and operational requirements of the CSA standard. The opportunities for improvement identified as part of the self-assessment were also provided to CNSC. CNSC staff assessed CNL's CCR and conclude that the findings from the CNL CCRs are not considered to be risk significant and CNL's proposed modifications will increase the safety margin of the facility with respect to fire protection.

CNSC staff conducted two inspections at WL in 2012 & 2018 which included a review of compliance with the regulatory requirements on fire protection. Seven actions were raised as a result of the 2012 inspection. These actions addressed: the storage of combustible materials, damage to fire doors, obstruction of sprinkler discharge and fire alarm system upgrades. CNSC staff have confirmed that all actions have been adequately addressed by CNL. As a result of an inspection conducted in May 2018 CNSC staff recommended that CNL ensure all legacy safety-related equipment that are no longer in use be clearly labelled and/or made inaccessible to workers in order to prevent workers from trying to use such equipment in the case of an accident or emergency. CNSC staff verified CNL's implementation of this recommendation during two subsequent inspections conducted in October 2018 and June 2019.

Pressure Boundary Program

During the current licence period, CNL updated and revised their Pressure Boundary Quality Assurance Manual WL-508140-QAM-001 and associated pressure boundary procedure. CNSC staff reviewed the information submitted by CNL and concluded the pressure boundary systems at the WL site meet regulatory requirements.

Facility Design

CNL constructed some new facilities to support the on-going decommissioning activities at the WL site. CNSC staff reviewed elements related to the design of facilities and the FHA prior to the operation of new facilities. These new facilities were not related to ISD of WR-1. CNSC staff reviewed and assessed CNL's application of appropriate sets of codes and design standards for the new facilities. Reviews carried out by CNSC staff included the design of:

- Shielded Modular Above-Ground Storage Building, and
- Soil Storage Compound

CNSC staff concluded CNL met regulatory requirements related to the design of its facilities, and the operation of these new facilities remained within the design basis.

During the next licence period, CNL plans to design and construct facilities for the remediation of the Standpipes and Intermediate Level Waste Bunkers. Standpipes are vertical, in-ground storage structures, located within the WL WMA which provide storage for ILW or HLW waste packages. One hundred seventy-one (171) standpipes were constructed within the WMA. CNL expects that these structures will be emptied of their contents and removed during the next licence period. CNL will construct a number of supporting facilities for the removal, characterization, packaging, and shipment of the ILW and HLW waste from the Standpipes and Intermediate Level Waste Bunkers. CNSC staff will review the design of these facilities prior to their operation.

3.5.3.2 Regulatory Focus

CNSC staff continue to monitor CNL's performance in this SCA at the WL site through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation, and review of designs for new or modified facilities.

3.5.3.3 Proposed Improvements

CNL is required to update the pressure boundary procedure WLD-508140-PRO-001, *Whiteshell Laboratories Code Classification and Design Registration of Pressure-Retaining Systems/Components* (part of Pressure boundary program) to include the decommissioning of pressure boundary systems/components.

CNSC staff continue to review the design of facilities prior to the operation of new facilities at the WL site. This will include a review of the standpipe and intermediate bunker remediation facility design.

3.5.4 Conclusion

There are no challenges with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain programs for pressure boundary and design at the WL site in accordance with regulatory requirements.

3.5.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 5.1 requires CNL to implement and maintain a design program. Licence condition 5.2 requires CNL to implement and maintain a pressure boundary program. Compliance verification criteria for both licence conditions are included in the draft LCH.

3.6 Fitness for Service

The fitness for service SCA covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that verify all equipment is available to perform its intended design function when called upon to do so.

The specific areas that comprise this SCA at the WL site include:

- Maintenance
- Structural integrity

3.6.1 Trends

The following table indicates the overall rating trends for the Fitness for Service over the current licensing period:

TRENDS FOR FITNESS FOR SERVICE				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4].				

The licensee has over this licensing period maintained a fitness for service program in accordance with CNSC requirements. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories.

3.6.2 Discussion

CNL is required to implement and maintain a fitness for service program to cover activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time.

Elements of the fitness for service program requirements are incorporated into CNSC inspections carried on at the site, with CNSC inspectors verifying that: in-service inspections of safety related structures are carried out by CNL as required, safety related equipment is maintained in good working order and ,where required, components are appropriately calibrated and are tested at the requisite frequency. The fitness for service program at the WL site focuses on in-service inspections of the concrete bunkers in the Waste Management Area (WMA).

3.6.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.6.3.1 Past Performance

Maintenance

As part of their management system, CNL is required by CSA N286-12 to have processes in place to maintain systems, structures and components (SSCs). CNSC staff reviewed CNL's governing documents for the conduct of maintenance at the WL site and concluded that the program meets regulatory requirements.

CNSC staff have found that SSCs observed during CNSC inspections were well-maintained. Based on CNSC inspection results and reviews conducted of CNL submitted information, CNSC staff conclude that CNL has met and will continue to meet the regulatory requirements related to this specific area.

Structural Integrity

CNL is required to conduct annual inspections of the WL WMA concrete bunkers in accordance with the Periodic Inspection Plan (PIP), and report the results annually to CNSC staff.

Additionally, CNL performs quarterly inspections of the Concrete Canister Storage Facility (CCSF). These CCSF inspections have shown no significant cracking or spallation.

In October 2018 CNSC staff performed an inspection on CNL's Waste Management Program at the WL site, during which CNSC staff confirmed that the CCSF inspections had been performed by CNL at the required frequency, and that actions were identified by CNL to correct any deficiencies. CNSC staff also visually inspected the CCFS canisters and found them to be in good condition.

Based on CNSC staff inspections and reviews of the PIP and CCSF inspection reports submitted by CNL, CNSC staff conclude that CNL has met and will continue to meet the regulatory requirements related to this specific area.

3.6.3.2 Regulatory Focus

CNSC staff continue to maintain oversight of the fitness for service program until the facilities are decommissioned.

CNSC staff continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation.

3.6.3.3 Proposed Improvements

No improvements within this SCA are proposed.

3.6.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain effective fitness for service programs at the WL site in accordance with regulatory requirements.

3.6.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 6.1 requires CNL to implement and maintain a fitness for service program. Compliance verification criteria for this licence condition are included in the draft LCH

3.7 Radiation Protection

The radiation protection SCA covers the implementation of a radiation protection program in accordance with the *Radiation Protection Regulations*. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained As Low As Reasonable Achievable (ALARA).

The specific areas that comprise this SCA at the WL site include:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated dose to public

3.7.1 Trends

The following table indicates the overall rating trends for the Radiation Protection over the current licensing period:

3.7.2 Discussion

During the current licensing period, CNL has implemented and maintained a Radiation Protection (RP) program at the WL site that protected the health and safety of persons and ensured occupational exposures are below regulatory dose limits and maintained ALARA. From 2009-2018 the average effective doses to workers at WL has remained very low, typically less than 10% of the 1 mSv annual dose limit for members of the public.

CNSC staff conclude that CNL's implementation of their RP program at the WL site meets all applicable regulatory requirements and CNSC expectations. CNSC staff are satisfied that licensed activities at the WL site are conducted in a safe manner.

3.7.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.7.3.1 Past Performance

CNSC staff's assessment of performance considers indicators such as: monitoring of performance data, event reviews and results of inspection.

Application of ALARA

CNL has a documented ALARA program that identifies the methods and processes in place at the WL site to control dose and minimize exposures. This program integrates ALARA into design, planning, management and control of radiological activities. The ALARA program is based on current industry best practices and operating experience.

CNL's application of ALARA within the RP program includes management commitment and oversight, personnel qualification and training, provision of design features to optimize exposure, provision of protective equipment and clothing, ALARA assessments and reviews for higher risk radiological activities.

Radiological work assessments and radiological work plans/procedures are prepared and used to provide assurance that work activities at the WL site will be consistent with the ALARA principle and provide effective control to prevent unplanned exposures. These documents incorporate radiological control hold and back-out points, individual and collective dose estimates, and control measures to ensure worker safety.

CNSC staff are satisfied with the implementation of CNL's RP program at the WL site and conclude that the program meets all applicable regulatory requirements and expectations related to the application of ALARA.

Worker Dose Control

The *Radiation Protection Regulations* require that all licensees implement a RP program to control the occupational doses received by persons.

The RP program at the WL site has been effectively implemented to ensure doses received by workers are monitored, controlled and maintained well below regulatory limits.

CNL operates a CNSC licensed dosimetry service to monitor, assess, records and report doses received by employees and contractors as a result of licensed activities at the WL site. The RP program includes the criteria and procedures necessary to provide assurance that licensed dosimetry will be provided in accordance with regulatory requirements for all potential hazard types. The implementation of the RP program relating to personal dosimetry meets regulatory requirements.

At the WL site, all workers (e.g. full time workers, contractors) that have a reasonable probability of receiving an occupational dose greater than 1 mSv/year are identified as Nuclear Energy Workers (NEWs) in accordance with RP program criteria.

During the period from 2009 to 2018, no person received an exposure that exceeded the annual dose limit of 50 mSv/year for a NEW:

- The maximum annual individual effective dose[2] received by a NEW over this period was 1.7 mSv (approximately 3.3% of the 50 mSv annual effective dose limit).
- The maximum equivalent dose[3] to the skin received by a NEW over this period was 4.1 mSv (approximately 0.8% of the annual 500 mSv equivalent dose limit for the skin).
- The maximum equivalent dose to the skin of the hands and feet received by a NEW over this period was 36.7 mSv (approximately 7.3% of the annual 500 mSv equivalent dose limit for the hands and feet).

Figure 3 illustrates the distribution of annual effective dose to workers at the WL site for the years 2009 – 2018.

Figure 4 illustrates the average and maximum effective doses to WL workers for the years 2009 – 2018. Average effective doses to workers remained very low

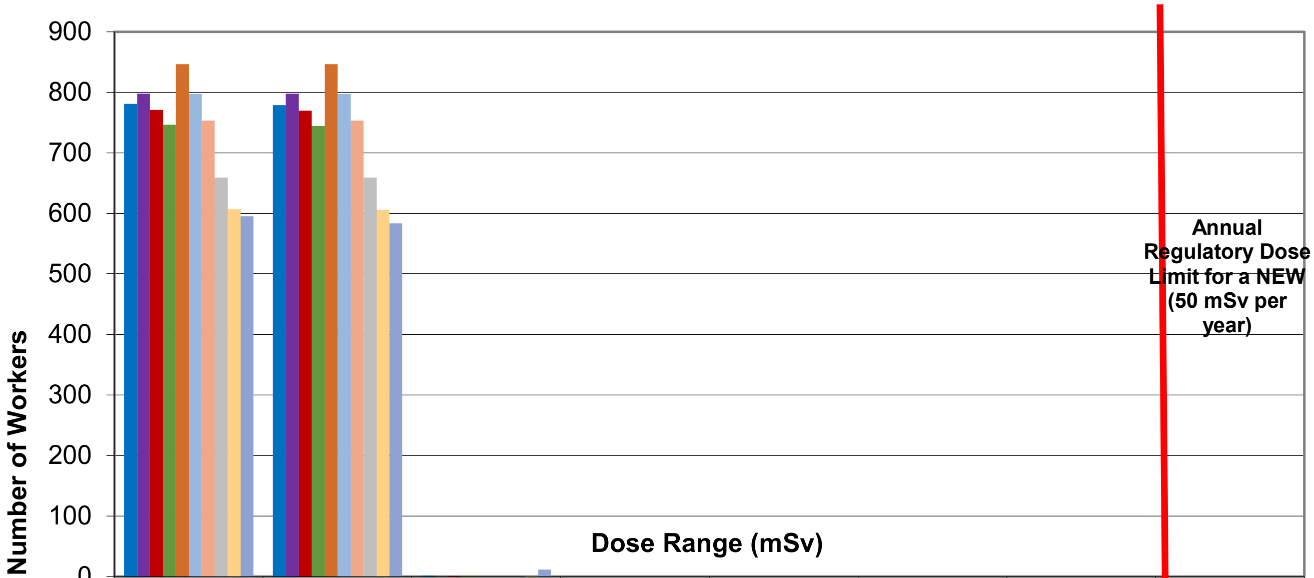
[2] Effective dose is a measure of the total detriment, or risk, due to an exposure to ionizing radiation. It is calculated by multiplying the equivalent dose of radiation received by and committed to each organ or tissue by the weighting factor for that tissue/organ and then summing the products.

[3] The equivalent dose is a measure of detriment to an organ or tissue. It is calculated by multiplying the absorbed dose of radiation by its radiation weighting factor (radiation type specific). It is designed to reflect the amount of detriment caused regardless of the type of radiation.

throughout the licensing period, typically less than 10% of the 1 mSv annual dose limit for members of the public.

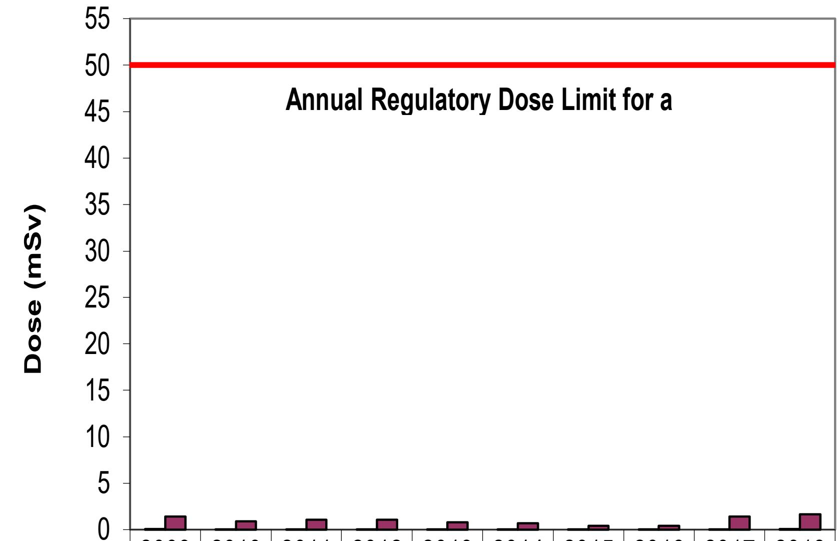
The average and maximum effective and equivalent doses, along with the effective dose distribution data demonstrate that CNL is maintaining effective control over worker exposures at the WL site.

Figure 3: Effective dose distribution to CNL-WL workers from 2009 to 2018



	Number of Workers Monitored	≤ 1 mSv	> 1 - 2 mSv	> 2 - 5 mSv	> 5 - 10 mSv	> 10 - 20 mSv	> 20 - 50 mSv	> 50 mSv
2009	781	779	2	0	0	0	0	0
2010	798	798	0	0	0	0	0	0
2011	771	770	1	0	0	0	0	0
2012	746	744	2	0	0	0	0	0
2013	846	846	0	0	0	0	0	0
2014	797	797	0	0	0	0	0	0
2015	753	753	0	0	0	0	0	0
2016	659	659	0	0	0	0	0	0
2017	607	606	1	0	0	0	0	0
2018	595	583	12	0	0	0	0	0

Figure 4: Average and maximum effective doses to CNL-WL workers from 2009 to 2018



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Average	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Maximum	1.4	0.9	1.1	1.1	0.8	0.7	0.4	0.4	1.4	1.7

*Average doses are calculated values rounded to the nearest tenth of a mSv (e.g. 0.0 mSv denotes from 0.00 mSv to 0.04 mSv).

Table 2: Dose to the skin of the hands and feet to CNL-WL's workers from 2009 to 2018

Dose Statistic	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average extremity dose (mSv)	1.2	0.4	0.4	1.0	0.2	0.4	0.1	0.1	1.5	5.0	500 mSv/yr
Maximum extremity dose (mSv)	6.2	1.8	1.9	4.3	0.7	1.3	0.7	0.1	11.4	36.7	

Table 3: Skin doses to CNL-WL's workers from 2009 to 2018

Dose Statistic	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Annual Regulatory Dose Limit for a NEW
Average skin dose (mSv)	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	500 mSv/yr
Maximum skin dose (mSv)	4.1	1.2	1.2	4.0	1.3	1.6	0.7	0.4	2.9	3.7	

CNSC staff are satisfied with the implementation of CNL's RP program at the WL site, and confirm that the program meets all applicable regulatory requirements and expectations related to worker dose control

Radiation Protection Program Performance

CNL has effectively implemented the RP program at the WL site. This program satisfies the requirements of the *Radiation Protection Regulations* and includes a number of performance indicators to continuously monitor RP program performance.

In 2016, CNL began revising RP documentation in order to reflect and support the radiological activities performed at all CNL sites and to harmonize it with CNL's revised company-wide management system.

CNL has established action levels for effective dose, equivalent dose (for skin and the skin on the hands and feet), internal exposure and skin exposure due to a skin contamination event. If any of the action levels are reached or exceeded, CNL must notify CNSC staff and conduct an investigation of the circumstances so that corrective actions can be taken well before a regulatory dose limit is exceeded.

RP program inspections were conducted by CNSC staff throughout the licensing period. Findings from these inspections confirmed compliance with regulatory requirements. Findings of a non-compliant nature were non-safety significant and corrected in a timely manner. Currently there are no open findings of regulatory non-compliance in the RP SCA.

CNSC staff are satisfied with the implementation of the RP program at the WL site. The program meets regulatory requirements and adequate oversight is being applied by the licensee to monitor the implementation and the performance of the RP program

Radiological Hazard Control

CNL continued to maintain and implement RP program requirements for contamination monitoring and control at all of their facilities at the WL site.

CNL’s RP program ensures there are adequate measures in place to monitor and control radiological hazards. This includes, but is not limited to: contamination control, radiation dose rate control, and airborne monitoring and control.

Contamination control at the WL site ensures contamination is prevented from leaving radiologically controlled areas, and the spread of contamination within these areas is minimized. This is achieved by establishing radiological zones with prescribed contamination limits, classifying areas according to their radiation hazard potential, restricting access to authorized personnel, ensuring each radiological area is posted, routine monitoring of workplaces for contamination, minimizing contamination levels, and monitoring personnel and material prior to leaving contaminated or potentially contaminated areas. During CNSC staff inspections of the site, inspectors have regularly verified the effectiveness of the licensee’s program of radiological zone control.

Based on CNSC staff’s assessments through inspection observations and record reviews, radiological hazards continued to be effectively controlled at the WL site.

Estimated Dose to the Public

There was no significant dose to the public during the previous licence period. Data on the maximum effective dose to a member of the public for the last 5 years is provide in Table 4.

Table 4: Maximum effective dose to a member of the public, CNL-WL, 2014-18

Dose data	2014	2015	2016	2017	2018	Regulatory dose limit
Maximum effective dose mSv)	1.4E-03	4.2E-05	7.5E-05	4.8E-05	3.6E-05	1 mSv/year

3.7.3.2 Regulatory Focus

Since 2009, CNL focused on monitoring and improving the RP program documentation. CNSC staff will continue to evaluate the processes used by CNL to verify that the protection of the workers is optimized and that the radiological exposures remain ALARA. As CNL updates the RP program, CNSC staff conduct desktop reviews to ensure the requirements of the *Radiation Protection Regulations* continue to be met.

3.7.3.3 Proposed Improvements

CNL is in the process of revising some of the Action Levels for use at the WL site. These new Action Levels will be subject to CNSC staff review and acceptance. The revision of the Action Levels was initiated in 2017 in accordance with the guidance in section 9.1, Radiation Protection, of the current LCH. The licensee is expected to conduct a documented review and, if necessary, revise Action Levels at least once per licence period in order to validate their effectiveness. The results of such reviews should be provided to the CNSC. CNL has had a productive on-going dialog with CNSC staff on the justification for the proposed revisions to the Action Levels. CNSC staff are confident that the new Action Levels s will be in effect prior to the end of the current licence period.

CNSC staff will continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and reviews of relevant program documentation.

3.7.4 Conclusion

There are no challenges with CNL's adherence with the RP regulations and CNL's implementation of RP requirements under this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain an effective radiation protection program at the WL site in accordance with regulatory requirements.

3.7.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 7.1 requires CNL to implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days. Compliance verification criteria for this licence condition are included in the draft LCH.

3.8 Conventional Health and Safety

The Conventional Health and Safety SCA relates to the implementation of a program to manage workplace safety hazards and to protect workers.

The specific areas that comprise this SCA at the WL site include:

- Performance
- Practices
- Awareness

3.8.1 Trends

The following table indicates the overall rating trends for the Conventional Health and Safety over the current licensing period:

TRENDS FOR CONVENTIONAL HEALTH AND SAFETY				
Overall Compliance Ratings				
2014	2015	2016	2017	2018
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories. CNSC staff conclude that CNL's Conventional Health and Safety performance meets regulatory requirements.				

3.8.2 Discussion

CNL has implemented and maintains a conventional health and safety program to manage workplace safety hazards and to protect personnel and equipment. The nature of the activities related to decommissioning, dismantlement and demolition of redundant structures at the WL site make conventional health and safety an important program, for this site.

CNSC staff on inspection routinely observe workers' compliance with requirements related to proper use of personal protective equipment (PPE), use of proper signage and barriers and the general state of work sites. CNSC staff conclude that CNL's Conventional Health and Safety SCA at the WL site met all applicable regulatory requirements and CNSC expectations.

3.8.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.8.3.1 Past Performance

Practices

In addition to the NSCA [7] and its associated regulations, CNL's activities must comply with Part II: *Occupational Health and Safety* of the *Canada Labour Code* [11], its *Canada Occupational Health and Safety Regulations*, and other applicable federal and provincial health and safety acts and regulations.

CNL's occupational health and safety program applies to all work performed by CNL employees, and to work performed by others on sites and work places controlled by CNL.

CNSC staff verified CNL safety practices during compliance inspections. CNSC staff are satisfied with CNL's performance at the WL site in the aspects related to conventional health and safety.

Awareness

CNL actively promotes conventional health and safety through the provision of information, training, instructions, and supervision. Employees are encouraged to participate, and to report concerns (e.g., unsafe conditions, non-compliances, or events) in order to identify hazards and ensure measures are put in place to prevent injury and illness.

On May 30, 2019 CNL conducted a company-wide full day Safety Stand Down. The Safety Stand Down was dedicated to raising safety awareness, strengthening work practices, and taking immediate action to address emergent safety issues, in effort to improve CNL's performance related to industrial safety. CNSC staff were present as observers at the Safety Stand Down event. In addition to the all-day event in May, CNL has held company-wide themed meetings in response to incidents at any of the CNL sites to increase awareness and incorporate lessons learned. CNSC staff routinely monitor these meetings, and as needed, follow up on corrective actions during inspections.

Since 2009, CNL improved aspects of the conventional health and safety program based on industry best practices and the results of internal focused audits, self-assessments, effectiveness reviews and health and safety inspections.

The findings from these reviews, audits, inspections and self-assessments resulted in internal actions being raised to improve site wide health and safety performance. These internal actions focused on continuing to increase awareness of occupational hazards and the potential for injury to workers, as well as on methodologies to reduce the frequency of occurrence.

CNSC staff monitors CNL employee reports of safety concerns through the initiation of ImpActs as stated in section 3.1.3.1. CNSC staff are satisfied with CNL's promotion of health and safety awareness at WL.

Performance

The key performance indicators for conventional health and safety are the number of recordable lost-time injuries (RLTI) that occur per year, RLTI severity and RLTI frequency. An RLTI is defined as an injury that takes place at work, and results in the worker being unable to return to work and carry out their duties for a period of time. The RLTI frequency and RLTI severity are both based on 100 full time workers (100 FTE = 200,000 hours worked).

$$RLTI\ frequency = 200{,}000\ hrs\ X\ \frac{\#\ of\ lost\ time\ injuries}{person\ hours\ worked}$$

$$RLTI\ severity = 200{,}000\ hrs\ X\ \frac{\#\ of\ working\ days\ lost}{person\ hours\ worked}$$

Data on RLTI, RLTI Frequency and RLTI Severity since 2009 is included in table 5 below.

Table 5: Recordable lost-time injuries (RLTI), frequency and severity at WL

Year	RLTIs	RLTI Frequency	RLTI Severity
2009	5	1.6	8.5
2010	7	2.0	12.2
2011	8	2.1	13.1
2012	5	1.2	9.2
2013	7	1.6	14.4
2014	4	0.90	12.2
2015	0	0	0
2016	1	0.29	1.46
2017	3	0.86	7.67
2018	1	0.28	1.45

3.8.3.2 Regulatory Focus

CNSC staff continue to monitor CNL's performance in this SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant program documentation.

CNSC staff continue to focus regulatory oversight in this area as decommissioning and demolition activities are planned by CNL. As the CNL occupational health and safety program is updated, CNSC staff conduct desktop reviews to ensure regulatory requirements continue to be met.

3.8.3.3 Proposed Improvements

No improvements to this SCA are proposed.

3.8.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain an effective conventional health and safety program at the WL site in accordance with regulatory requirements.

3.8.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 8.1 requires CNL to implement and maintain a conventional health and safety program. Compliance verification criteria for this licence condition are included in the draft LCH.

3.9 Environmental Protection

The Environmental Protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

The specific areas that comprise this SCA at the WL site include:

- Effluent and emissions control (releases)
- Environmental management system (EMS)
- Assessment and monitoring
- Protection of the public
- Environmental risk assessment

3.9.1 Trends

The following table indicates the overall rating trends for the Environmental Protection over the current licensing period:

TRENDS FOR ENVIRONMENTAL PROTECTION				
Overall Compliance Ratings				
2014	2015	2016	2017	2018
SA	SA	SA	SA	SA
Comments				
The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. Performance levels for Environmental Protection SCA have been consistent from year to year, with satisfactory ratings given from 2009 to 2018. CNSC staff conclude that CNL's Environmental Protection performance meets regulatory requirements.				

3.9.2 Discussion

CNL submitted its Integrated Environmental Monitoring Program as the framework for its Environmental Protection Program (EnvP) at the WL site [12]. The basis for the program is the WL Comprehensive Study Report (CSR) [13] conducted in 2001 and the WL Site's Dose Model [14]. These two assessments generated conclusions which were used to design and update the monitoring program, as well as any recommendations for further work required to adequately determine WL's environmental risk.

CNL's Integrated Environmental Monitoring Program achieves three main tasks:

- Direct release monitoring
- Contaminant pathways monitoring and
- Biological effects monitoring as applicable to all individual monitoring

The Integrated Environmental Monitoring Program aligns with the principles of the associated CSA Standards and consists of the following three distinct programs:

- the Effluent Verification Monitoring Program (EVMP)
- the Environmental Monitoring Program (EMP)
- the Groundwater Monitoring Program (GWMP)

The WL Radiological and Non-radiological EMP, EVMP and GWMP are being revised to comply with CSA Standards N288.4-10 and N288.5-11. CNL has committed to the following implementation dates to update their EVMP and EMP to be in compliance with these CSA standards:

- CSA N288.4-10, Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills, by January 01, 2020
- CSA N288.5-11, Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills, by January 01, 2020
- CSA N288.7-15, Groundwater protection programs at Class I nuclear facilities and uranium mines and mills, by January 01, 2020

CNL has established Derived Release Limits (DRLs) [14] and action levels [15], at the WL site, to ensure that the releases of radionuclides from the facility's operations would not exceed the established regulatory limit of 1 mSv/yr and the public and environment are protected.

To complement ongoing compliance activities, the CNSC has implemented its Independent Environmental Monitoring Program (IEMP). The IEMP results around the WL site indicate that the public and the environment in the vicinity of WL are protected. The IEMP report for the WL site is published on the CNSC's website *http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/whiteshell.cfm*. Additional information on the IEMP is presented in Addendum D, Environmental Protection Review Report, of this CMD.

3.9.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.9.3.1 Past Performance

Effluent and emissions control (releases)

CNL has implemented and maintained an EVMP at the WL site. CNL's EVMP provides details on WL's radioactive and non-radioactive release monitoring including the decision for the need and development of the program, as well as identifying the rationale behind the current monitoring schedule. The EVMP also provides the WL site specific details on the execution of the program.

As per CNSC reporting requirements in the current LCH, CNL provides its EVMP results through the issuance of the annual report, to confirm compliance with the applicable regulations. CNSC staff review of CNL's EVMP monitoring results [16 to 33] for WL for the licence period of 2009 to 2018, indicates that releases were below regulatory limits. The minimum and maximum weekly releases are included in tables 6 and 7.

Table 6: The weekly releases to water from the WL site operations

Parameter	Releases (range Min & Max) (*Bq/wk*)	Release limits (*Bq/wk*)	
		2009-2015	2016*-2018
Cs-137	1.22E+00-1.30E+07	2.41E+11	1.16E+10
Sr-90	3.30E+06 -1.3E+07	1.46E+12	1.3E+10
Gross Alpha Particulates	2.90E+06 -9.50E+06	2.8E+11	1.1E+09

** = Release limits were revised in 2016 to meet CSA N288.1-08*

Table 7: The weekly releases to air from the WL site operations

Parameter	Releases (range Min & Max) (*Bq/wk*)	Release limits (*Bq/wk*)	
		2009- 2015	2016*-2018
Tritium	4.00E+08-3.66E+09	7.64E+14	1.65E+14
Gross Beta Particulates (Cs-137)	4.31E+03 -1.5E+04	1.19E+10	6.92E+09
Gross Alpha Particulates (Pu-239)	1.70E+03 - 2.20E+03	7.6E+14	1.73E+09

** = Release limits were revised in 2016 to meet CSA N288.1-08*

Based on review and assessment of the EVMP results [16 to 33] presented in CNL's reports, CNSC staff conclude that the EVMP currently in place for the WL site continues to protect the public and the environment.

Environmental Management System (EMS)

CNL has established and implemented an Environmental Management System (EMS) for the WL site that meets CNSC requirements outlined in REGDOC 2.9.1, *Environmental Principles, Assessment and Protection Measures*. The EMS assesses environmental risks associated with its nuclear activities to ensure these activities are conducted in a way that prevents or mitigates adverse environmental effects. CNL's EMS has been registered to International Standards Organization (ISO) 14001:2004 Standard, Environmental Management Systems – Requirements with Guidance for Use.

Assessment and Monitoring

CNL has implemented a radiological environmental monitoring procedure that defines the requirements, responsibilities and process for radiological environmental monitoring at the WL site and in the surrounding areas. This procedure is in accordance with general requirements for radiological effluent and environmental monitoring of Management, Monitoring of Emissions and Environmental Monitoring Programs.

The purpose of CNL's environmental monitoring procedure is to:

- Measure contaminants in surrounding environmental media including ground water of the facility or site.
- Determine the impacts of the site or facility operation on people and the environment.
- Verify the effectiveness of emission controls and the adequacy of effluent monitoring.

CNL provides its environmental monitoring results through the issuance of the annual report. The annual report is reviewed by CNSC staff to confirm compliance with the applicable regulation. CNSC staff review of environmental monitoring results [16 to 33] for the licence period of 2009 to 2018, indicate that:

- Monitoring of potential atmospheric effluent exposure pathways did not indicate any significant dose contributions from the operations of the WL site.
- Radioactive contaminants in Winnipeg River water remained below allowable levels defined in the Canadian Drinking Water Guidelines [42].
- The groundwater monitoring program has demonstrated that there is no significant radioactive parameters (gross beta, gross alpha, tritium and uranium) migration from the waste management facilities.

This procedure follows and is consistent with CSA-N288.4-M90. CNL has committed to implement the new CSA standards N288.4-10 and N288.7-15 by January 01, 2020.

CNSC staff review of EMP monitoring results [16 to 33] for the licence period of 2009 to 2018, indicate that total estimated doses due to radioactivity in WL effluents were in the range of 4.8 x 10-5 mSv/yr and 1.8 x 10-3 mSv/yr (liquid pathway) and 2.0 x 10-6 and 8.0 x 10-6 mSv/yr (airborne pathway). This indicates that the releases of radionuclides in the environment resulted in a low level of dose to the public. The estimated maximum effective radiation dose to the public from WL's operations continues to be well below the regulatory dose limit of 1 mSv/yr. The detailed results of public dose are presented in section 3.7, Radiation Protection, of this CMD.

Based on review and assessment of the environmental monitoring results [16 to 33] presented in CNL's reports, CNSC staff conclude that the EVMP currently in place for WL continues to protect the public and the environment.

Protection of the public

This specific area within the Environmental Protection SCA is related to ensuring that members of the public are not exposed to "unreasonable" risk with respect to hazardous substances discharged from the nuclear facilities.

CNSC staff conducted a review of EVMP non-radiological monitoring results [16 to 33] for the licence period of 2009 to 2018, which indicated that:

- Starting in 2013 with the conversion from centralized, fuel oil heating operations to localized electrical or propane heating (and the continuing shut down and demolition of site buildings), non-radiological emissions to air (greenhouse gases) dropped significantly. Overall airborne emission remained below the National Pollutant Release Inventory (NPRI) reporting threshold except for particulate matter (PM10 & 2.5) which was reported to NPRI.
- Liquid effluents non-radiological monitoring results have been consistent over the licence period and in general remained below the monthly CNL internal guidelines for chemical substances in liquid effluents.

Greenhouse gas (GHG) emissions from the WL site include carbon dioxide, methane and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill and open-pit wood burning. They are measured in CO2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

The GHG emissions from the site have had a decreasing trend (from 8056 tonnes/yr in 2011 to 1678 tonnes/yr in 2018), which CNL has attributed to the decrease in fuel required to heat the site as buildings are decommissioned and elimination of the use of Number 2 Fuel in 2013, which was historically the greatest contributor of GHG emissions at the WL site. Table 8 provides the total estimated annual greenhouse gas emissions from the WL site.

Table 8: Total estimated annual greenhouse gas emissions from the WL site (2011-2018)

Year	2011	2012	2013	2014	2015	2016	2017	2018
Greenhouse Gas (CO_2e tonnes/yr)*	8,056	6,310	4,260	1,940	1,957	1,883	1,873	1,678

* CO_2e tonnes: A unit of measure used to compare between greenhouse gases with different Global Warming Potentials. For example, the Global Warming Potentials for methane is 25. This means that emissions of one metric ton of methane are equivalent to emissions of 25 metric tons of CO_2. In 2013, the GWP for methane and nitrous oxide were changed from 21 to 25 and 310 to 298 respectively under the Canadian Environmental Protection Act Notice with Respect to Reporting of Greenhouse Gases for 2013.

Environmental risk assessment

From the perspective of environmental risk assessment (ERA), CNSC staff have reviewed the CSR and the follow-up monitoring results as well as safety reports submitted annually for the Whiteshell Laboratories Decommissioning Project. The CSR concluded that the decommissioning project is not likely to cause significant adverse environmental effects taking into account the mitigation measures implemented by the licensee.

As part of future decommissioning activities, an updated ERA for the lagoon and landfill areas of the WL site is currently underway. CNSC staff will review this assessment, when submitted.

As required under CNL's licence, a series of annual safety reports were submitted for the WL site. CNSC staff review of these reports indicate that radiation levels and radioactive contamination from operations at the site resulted in radiation doses to members of the public below regulatory limits and guidelines.

Monitoring of pathways for exposure to potential liquid effluent(s) from operational and decommissioning activities at the WL site indicated very small contributions to downstream concentrations of radionuclides (Cs-137) in fish in the Winnipeg River. Similarly, radioactive contaminants in the Winnipeg River were well below the Canadian drinking water guidelines. Dose to members of the public from liquid effluents at WL was calculated to be 4.8 X 10-5 mSv/yr.

Levels of radioactivity in groundwater, soil and vegetation in the vicinity of the WL site indicated that there was no significant migration of radioactive contamination from the waste management facilities at the WL site.

Sampling and analysis of groundwater from the waste management areas and the lagoon and landfill areas for non-radiological parameters (chromium, copper, iron, lead, zinc, arsenic, mercury, nitrate, nitrite, ammonia, chloride, volatile organic compounds and HB-40) indicated that concentrations of these substances were either below their respective limits of detection or were below guideline values.

Furthermore, monitoring of pathways for exposure to atmospheric emissions did not indicate any measurable dose contributions above background levels from operational and decommissioning activities at the WL site. Airborne contaminants that were monitored included ambient gamma, gross beta, gross alpha, Sr-90, Cs-137, and K-40. Airborne emissions were negligible, with an estimated public dose of 2 X 10-6 mSv/yr.

For non-human biota, dose modelling for aquatic species (fish, clams) and measured radionuclide concentrations in incidental animal road kill (deer, grouse) indicated dose levels below United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) benchmarks.

Finally, results of the CNSC's IEMP reported in 2018 indicated that there is no human health impact expected in the vicinity of the WL site. This sampling campaign included air, water, soil, sediment, vegetation and food stuffs (fish, vegetables, etc.) taken from publically accessible areas near the WL site and analyzed for a range of radiological contaminants such as gross alpha, gross beta, tritium, Cs-137, and Co-60. The detailed results of the IEMP are presented in Addendum D, Environmental Protection Review Report.

Based on the available information from the CSR, and the follow-up monitoring results as well as safety reports submitted annually for the site and the CNSC IEMP, CNSC staff conclude that risk to human health and the environment can be characterized as low, with an overall trend that indicates stable performance of the WL site.

3.9.3.2 Regulatory Focus

CNSC staff will continue to monitor CNL's performance in the Environmental Protection SCA through regulatory oversight activities including onsite inspections and desktop reviews of relevant environmental protection program documentations.

CNSC staff will review the ERA for the lagoon and landfill sites at the WL site, once they are submitted by CNL. It is also expected that CNL will conduct a site-wide ERA in accordance with REGDOC-2.9.1-2017 and the CSA Standard N288.6-12 *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* during the next licensing period.

3.9.3.3 Proposed Improvements

CNL has noted that over the next licence period, through the implementation of the following standards/regulatory requirements, they expect to achieve, improvements in the WL Environmental Protection Program:

- REGDOC-2.9.1 (2017), Environmental Principles, Assessment and Protection Measures, version 1.1, section 4.6;

- CSA N288.4-10 (R2015), Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills;
- CSA N288.5-11 (R2016), Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills;
- CSA N288.6-12 (R2017), Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills;
- CSA N288.7-15, Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills; and
- CSA N288.8-17, Establishing and Implementing Action Levels for Releases to the Environment from Nuclear Facilities,
- The federal requirements for the total residual chlorine in wastewater come into force in 2021 for CNL's lagoon. WL will continue to adjust the site's chlorination practices to meet and exceed the new requirements.

CNSC staff have accepted CNL's plan and schedule for the implementation of these standards, and through regular program updates, CNSC staff track and monitor licensee's compliance with its commitments. There are no concerns with licensee's implementation schedule.

3.9.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on the CNSC staff assessments of CNL's safety and control measures at the WL site regarding the specific areas of the Environmental Protection SCA and upon review of CNL's licensing applications, supporting documentation and past performance, CNSC staff conclude that there are no significant concerns related to the protection of the public and the environment. CNL continues to maintain and implement an environmental protection program at WL in accordance with CNSC requirements.

3.9.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 9.1 requires CNL to implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days. Compliance verification criteria for this licence condition are included in the draft LCH.

CNSC staff will include the following in the Environmental Protection section of the draft LCH; "The licensee shall conduct an updated site-wide environmental risk assessment (ERA) in accordance with the CSA Standard N288.6-12 *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* taking into account current conditions at the WL site".

3.10 Emergency Management and Fire Protection

The Emergency Management and Fire Protection SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions.

The specific areas that comprise this SCA at the WL site include:

- Conventional emergency preparedness and response;
- Nuclear emergency preparedness and response; and
- Fire emergency preparedness and response.

3.10.1 Trends

The following table indicates the overall rating trends for the Emergency Management and Fire Protection over the current licensing period:

TRENDS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories. CNSC staff conclude CNL's Emergency Management and Fire Protection performance meets regulatory requirements.				

3.10.2 Discussion

The current licence requires CNL to implement and maintain an emergency preparedness program and a fire protection program. The approach to Emergency Preparedness and Fire Protection for the WL site is based on a combination of detailed planning and hazard identification and risk assessments at all facilities. This is complemented by drills and emergency exercises conducted in partnership with the emergency response teams in local municipalities. CNSC staff have assessed that the WL site continues to meet regulatory requirements and is performing satisfactorily with respect to this SCA.

3.10.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.10.3.1 Past Performance

CNL completes drills and exercises annually at the WL site, in accordance with the WL five-year drill and exercise plan. Drill and exercise topics include fires, active threats, hazardous goods events (e.g., PCBs, chlorine, fuel), radiation events, and transportation accidents involving radiological materials. The drill and exercise plan was revised during the previous licence period to reflect the current status of the site.

Nuclear Emergency Preparedness and Response

CNL is required to implement to requirements of REGDOC 2.10.1, *Nuclear Emergency Preparedness and Response*. REGDOC 2.10.1 has been incorporated into CNL's corporate-wide emergency preparedness program, as well as the WL site emergency procedures. To evaluate the emergency preparedness of a licensee, CNSC staff assess the licensee emergency plan and preparedness program as well as the results of emergency exercises. Emergency preparedness at the WL site is governed by the CNL document WL-508730-ERP-001, *Whiteshell Laboratories Emergency Response Plan*. The WL Site Emergency Response Plan includes, but is not limited to, radiological emergencies and outlines the interfaces with the Manitoba Emergency Plan.

Fire Emergency Preparedness and Response

The CNL Fire Protection program documentation identifies how fire response is achieved on the site. A gap analysis was performed in 2016 by CNL against the operational requirements of CSA-N393, *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*, as requested by the CNSC. A corrective action plan to address the gaps identified was developed and implemented. This corrective action plan was reviewed and assessed by CNSC staff through a desktop review and found to be acceptable. The implementation of this corrective action plan is complete and will be verified by CNSC staff during upcoming inspections.

CNL has a multi-disciplinary emergency response force on site at WL and mutual aid partners (Pinawa and Lac Du Bonnet fire departments) off site.

CNSC staff confirm that the fire response program at the WL site meets regulatory requirements.

Conventional Emergency Preparedness and Response

CNL continues to maintain effective conventional emergency response programs. Emergency response personnel are available on site 24 hours a day to respond to any type of emergency. Training and equipment continue to be maintained for medical response, hazardous materials and other conventional hazards that may be present. CNSC staff conclude CNL's conventional emergency response programs meet regulatory requirements.

3.10.3.2 Regulatory Focus

CNSC staff continue to monitor CNL emergency response programs and their performance in drills and exercises to ensure continuous learning and improvement, and ensure that CNL's emergency response capabilities are maintained.

CNSC staff continue to focus on the site emergency plan during regular compliance activities to ensure the plan remains scalable and flexible to respond to any emergency at site and reflects changing infrastructure at site.

3.10.3.3 Proposed Improvements

No additional changes are proposed for this SCA.

3.10.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

CNL has sufficient provisions in place for emergency preparedness and response capability that would mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment and the health and safety of persons. CNSC staff are satisfied that CNL has made sufficient preparations to respond to any emergency that may arise on the WL site.

Based on CNSC staff assessment, CNSC staff conclude that CNL emergency management and fire protection programs meet regulatory requirements.

3.10.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 10.1 requires CNL to implement and maintain an emergency preparedness program. Licence condition 10.2 requires CNL to implement and maintain a fire protection program. Compliance verification criteria for both licence conditions are included in the draft LCH.

3.11 Waste Management

The Waste Management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This SCA also covers the planning for decommissioning.

The specific areas that comprise this SCA at the WL site includes:

- Waste characterization

- Waste minimization
- Waste management practices
- Decommissioning plans

3.11.1 Trends

The following table indicates the overall rating trends for the Waste Management over the current licensing period:

TRENDS FOR WASTE MANAGEMENT				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. CNL continues to be rated SA for their waste management performance at the Whiteshell Laboratories. CNSC staff conclude CNL's Waste Management performance meets performance objectives and applicable regulatory requirements.				

3.11.2 Discussion

The Waste Management SCA includes a waste management program and a plan for the decommissioning of the WL site. CNL has implemented and maintains a waste management program that documents the activities to control the safe management of radioactive waste during all steps of its management. CNL prepared a program overview decommissioning plan that describes the decommissioning strategy and final end-state planned. CNL has also implemented and maintains a decommissioning program.

The singular focus of CNL at the WL site has been decommissioning and demolition of redundant structures on the site, all of which generate waste; waste management is therefore an area of primary focus of CNSC's regulatory activities. CNSC staff have evaluated CNL's compliance through oversight activities such as desktop reviews and compliance inspections. CNSC staff conclude that CNL's Waste Management SCA at the WL site meets all applicable regulatory requirements.

CNSC staff recommendations related to this SCA did not consider the proposed ISD of WR1 reactor. Any proposed activities specifically related to the proposed ISD of WR1 are out of scope of this application and will potentially be considered by the commission in a separate hearing.

3.11.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.11.3.1 Past Performance

Under CNL's waste management program at the WL site, wastes are generated from operational activities and decommissioning projects. Associated with their waste management program, CNL is segregating, packaging, storing and reusing or recycling radioactive, hazardous and conventional wastes. Waste management and decommissioning activities at the WL site were presented to the Commission most recently in the progress update (CMD 18-M30) [5], and the status update (CMD 16-M12) [6]. The following describes updates since these reports were presented.

Waste Characterization and Waste Minimization

CNL maintains a waste management program to control and minimize the volume for all waste streams of waste generated from licensed activities. Waste generated at the WL site are radiologically screened and segregated at the source as either "Likely Clean" or "Radiological Contaminated". Likely Clean waste is monitored for radiological clearance. If the waste is confirmed clean (i.e. not radiologically contaminated), the waste is either dispositioned for reuse or recycling where possible, or disposed of in the WL landfill or transferred to an appropriate storage or process facility for hazardous material. Radiologically contaminated waste is decontaminated to meet clearance criteria where feasible or characterized and sent to the Waste Management Area (WMA) for processing or storage.

CNSC staff confirmed through on-site inspections that CNL continues to characterize waste at the various steps in the management of radioactive waste to meet acceptance criteria of the receiver. CNSC staff verify licensee compliance with waste segregation and labelling requirements at the WL site as a standard part of site inspections.

Waste Management Practices

The WMA provides processing and storage facilities for radioactive waste. It consists of the Shielded Modular Above Ground Storage (SMAGS) building, bunkers and Quonset buildings used to store low-level waste (LLW) and intermediate-level waste (ILW) generated from WL decommissioning activities. CNL conducts projects to re-characterize radioactive waste as necessary, and to assess waste conditions, environmental conditions and potential environmental impacts. CNL performs inspections of WMA to confirm waste is stored in a safe manner.

CNL is executing the decommissioning of the WMA in accordance with detailed decommissioning plans. This work includes improving access to the area, reducing and repackaging existing waste, and preparing facilities to be decommissioned. The detailed decommissioning plans include the proposed waste management practices and are evaluated and approved by CNSC staff. Following the completion of decommissioning of a building or a location on site, the licensee is required to submit a post-decommissioning report called the end-state report to the CNSC. This report is reviewed by CNSC staff to verify licensee's compliance with the approved plans.

Some of the WL decommissioning activities that have been conducted by CNL at the WMA since the last update to the Commission (CMD 18-M30 [5]) are listed below:

- On-going preparation for the extraction of waste from the ILW bunkers and standpipes. This work began in 2017 and includes the design/construction of systems for remediating these facilities (60% design complete).
- The completion of the construction work for expansion of the protected area in the WMA that surrounds the standpipes. This is required to allow space for the extraction of wastes noted above. The expanded protected area encompasses the standpipes and the ILW bunkers.
- Completion of the development of a modular workspace complex at the entrance of the WMA to control and coordinate worker access to the WMA.
- In 2017, CNL completed waste segregation and repackaging. Since 2016, most WR-1 and some other WMA wastes have been sorted and repackaged, in order to reduce fire loading in storage buildings and to reduce waste volumes. Repackaged wastes have been placed into steel containers and transferred to storage in the SMAGS building.
- Completion of the shipment to CRL of over sixty Cs-137 and Cf-252 sources and approximately 1500 m^3 of soil waste from the former Experimental Cesium Pond.

CNSC staff have evaluated CNL's compliance through oversight activities such as desktop reviews and compliance inspections. CNSC staff are satisfied that CNL is carrying out waste management practices and decommissioning work in accordance with the licensing basis.

Decommissioning Plans

CNL is planning, preparing for, executing and completing decommissioning activities, in accordance with detailed decommissioning plans.

The WL site is undergoing decommissioning in a staged manner. CNL's planning for decommissioning includes all nuclear and non-nuclear facilities at the site and these decommissioning plans are submitted to the CNSC as separate volumes. 12 Volumes are planned for the entire decommissioning of the WL site. Volume 1 is the program overview document which describes the overall decommissioning strategy of the site and a general overview of individual facilities. The subsequent volumes are submitted to CNSC as separate decommissioning plans for each facility on the WL site. Not all volumes of the detailed decommissioning plan have been developed, as they are developed when so required by CNL.

As stated in the previous section, since the last licensing renewal in 2009 CNL has progressed with decommissioning at the WL site.

3.11.3.2 Regulatory Focus

CNSC staff will continue to carry out verification activities as CNL conducts decommissioning activities at the WL site. CNSC staff will continue to monitor

CNL's performance in this SCA through compliance verification activities including onsite inspections, desktop reviews of relevant program documentation. This SCA will remain an area of focus in the next licensing period, as CNL continues to pursue decommissioning activities generating radioactive waste that must be stored and managed at the WL site until a final solution is determined.

3.11.3.3 Proposed Improvements

To better align with the current regulatory requirements and standards, CNL is updating their Volume 1 Program Overview DDP to align with CSA N294-09, *Decommissioning of Facilities Containing Nuclear Substances* and CNSC Regulatory Document, G-219, *Decommissioning Planning for Licensed Activities*.

3.11.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessment of CNL's application, supporting documents and past performance, CNSC staff conclude that CNL continues to implement and maintain an effective waste management program at the WL site in accordance with regulatory requirements.

3.11.5 Recommendation

Two licence conditions are included in the proposed licence for this SCA. Licence condition 11.1 requires CNL to implement and maintain a waste management program. Licence condition 11.2 requires CNL to maintain a decommissioning plan. Compliance verification criteria for both licence conditions are included in the draft LCH.

3.12 Security

The Security SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

The specific areas that comprise this SCA at the WL site include:

- Facilities and equipment
- Response arrangements
- Security practices
- Drills and exercises

3.12.1 Trends

The following table indicates the overall rating trends for the Security over the current licensing period:

TRENDS FOR SECURITY				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	BE
Comments				
The ratings for the time period of 2009 and 2010 were SA for each year. The rating for 2011 was FS. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both FS. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. During 2018, CNSC staff identified a deficiency in the security arrangements at the WL site. These issues have been the subject of enforcement actions, including an Order against CNL, and have led CNSC staff to evaluate CNL's 2018 performance in the SCA of Security at the WL site as 'below expectations' (BE).				

3.12.2 Discussion

The information supporting the performance rating will be presented to the Commission in a separate classified document (CMD 19-H4.A). During 2018, CNSC staff identified a deficiency in the security arrangements at the WL site. These issues have been the subject of enforcement actions, including an Order against CNL, and have led CNSC staff to evaluate CNL's 2018 performance in the SCA of Security at the WL site as 'below expectations' (BE). CNL has proposed corrective actions that are acceptable to CNSC staff. CNSC staff continue to monitor implementation of these corrective actions.

3.12.3 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 12.1 requires CNL to implement and maintain a security program. Compliance verification criteria for this licence condition are included in the draft LCH.

3.13 Safeguards and Non-Proliferation

The Safeguards and Non-Proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the Treaty on the Non-Proliferation of

Nuclear Weapons (NPT). This SCA comprises a safeguards program and a non-proliferation program.

The scope of the non-proliferation program for the WL site is limited to the tracking and reporting of foreign obligations and origins of nuclear material. This tracking and reporting assists the CNSC in the implementation of Canada's bilateral Nuclear Cooperation Agreements with other countries. The import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* require separate authorization from the CNSC, consistent with section 3(2) of the *General Nuclear Safety and Control Regulations*.

The specific areas that comprise this SCA at the WL site includes:

- Nuclear material accountancy and control
- Access and assistance to the IAEA
- Operational and design information
- Safeguards equipment, containment and surveillance

3.13.1 Trends

The following table indicates the overall rating trends for the Safeguards and Non-Proliferation over the current licensing period:

TRENDS FOR SAFEGUARDS AND NON-PROLIFERATION				
Overall Compliance Ratings				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments The ratings for the time period of 2009 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. This SCA has been rated SA each year over the licensing period. Non-Proliferation was added to this SCA in 2012. Compliance ratings from 2008-2011 are for the former Safeguards-only SCA. CNSC staff conclude that CNL's Safeguards and Non-Proliferation performance meet regulatory requirements.				

3.13.2 Discussion

CNL has an effective safeguards program that conforms to measures required by the CNSC to meet Canada's international safeguards obligations as well as other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.

The CNSC regulatory mandate includes ensuring conformity with measures required to implement Canada's international obligations on the peaceful uses of nuclear energy. Pursuant to the *Treaty on the Non-Proliferation of Nuclear Weapons*, Canada has entered into a Comprehensive Safeguards Agreement and Additional Protocol with the IAEA (hereafter, the safeguards agreements). The objective of the Canada/IAEA safeguards agreements is for the IAEA to provide annual assurance to Canada and to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no indication of undeclared material.

The CNSC provides the mechanism, through the *Nuclear Safety and Control Act*, the regulations and a licence condition, for the IAEA to implement the safeguards agreements. Conditions for the application of IAEA safeguards are contained in the licence, and the criteria in order to meet the conditions are contained in the LCH.

3.13.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections. The compliance rating takes into consideration the CNSC staff assessment in all specific areas included for the WL site within this SCA. IAEA and CNSC's safeguards activities at the WL site were presented to the Commission most recently in the Interim Status Report on the Progress of Decommissioning activities (CMD 12-M47) , and the CNSC staff report on the performance of CNL sites for 2013 (CMD 14-M79), the following describes updates since these reports were presented.

3.13.3.1 Past Performance

Nuclear Material Accountancy and Control

During the licensing periods under review, CNL provided the CNSC and IAEA with all reports and information necessary to comply with the safeguards regulatory requirements, including those related to nuclear material accounting and reporting. Reports are now submitted electronically through the CNSC's Nuclear Materials Accountancy Reporting (NMAR) portal. NMAR was fully implemented in 2016.

Access and Assistance to the IAEA

CNL continues to grant access and assistance to the IAEA for inspection activities at the WL site. Details of the IAEA inspections can be found in the following table:

Table 9: IAEA inspection activities

Year	SNRI	PIV	DIV	Total
2014	1	0	1	2
2015	0	1	1	2
2016	0	0	1	1
2017	0	0	0	0
2018	0	0	1	1
Total Inspections				6

SNRI - Short Notice Random Inspection

PIV - Physical Inventory Verification

DIV - Design Information Verification

The IAEA indicated that the results from their inspection activities at the WL site were satisfactory and no actions were requested from CNL.

Operational and Design Information

During the licensing period, CNL submitted annual Operational Programs and quarterly updates as required. These documents provide a forward-looking plan of CNL's activities which assists the IAEA in planning inspections.

CNL has also provided timely annual Additional Protocol submissions to CNSC staff which include a description of each building on the WL site, the scale of its operations, and future plans for nuclear fuel research and development activities

Safeguards Equipment, Containment and Surveillance

CNL continues to provide assistance to the IAEA for the installation and maintenance of IAEA's containment measures at the WL site. During the licensing period, the IAEA performed a technical visit at the WL site to identify locations to install equipment which will become part of the equipment-based safeguards approach once CNL begins shipping out nuclear material from the WL site.

Overall, CNL programs for safeguards and non-proliferation at the WL site continued to meet CNSC requirements and expectations.

3.13.3.2 Regulatory Focus

CNSC staff will continue to monitor CNL's performance through participation in IAEA inspections, evaluations independent of the IAEA, and ongoing assessments of compliance with the various reporting requirements.

3.13.3.3 Proposed Improvements

The regulatory document REGDOC-2.13.1, *Safeguards and Nuclear Material Accountancy*, is referenced in the proposed WL LCH. This document sets out requirements and guidance for safeguards programs for applicants and licensees who possess nuclear material, operate a uranium and/or thorium mine, carry out specified types of nuclear fuel-cycle related research and development work, and/or carry out specified types of nuclear-related manufacturing activities. The REGDOC-2.13.1 supersedes RD-336, which only sets out requirements and guidance for accounting and reporting of nuclear material.

3.13.4 Conclusion

There are no challenges with CNL's implementation of this SCA.

CNSC staff have assessed CNL documentation and analyses under the Safeguards and Non-Proliferation SCA, and have found them to be acceptable and compliant with regulatory requirements.

3.13.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 13.1 requires CNL to implement and maintain a safeguards program. Compliance verification criteria for this licence condition are included in the draft LCH.

3.14 Packaging and Transport

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances to and from the licensed facility.

The specific areas that comprise this SCA at the WL site include:

- Package design and maintenance;
- Packaging and transport; and
- Registration for use.

3.14.1 Trends

The following table indicates the overall rating trends for the Packaging and Transport over the current licensing period:

TRENDS FOR PACKAGING AND TRANSPORT				
OVERALL COMPLIANCE RATINGS				
2014	**2015**	**2016**	**2017**	**2018**
SA	SA	SA	SA	SA
Comments				
The ratings for the period of 2008 to 2011 were SA for each year. These were reported in the CMD 12-M47, *Interim Status Report on the Progress of Decommissioning Activities at Whiteshell Laboratories* [3]. The ratings for 2012 and 2013 were both SA. These were reported in CMD 14-M79, *Annual Performance Report AECL's Nuclear Sites and Projects: 2013* [4]. CNL continues to be rated SA in this SCA at the Whiteshell Laboratories. CNSC staff conclude that CNL's Packaging and Transport program ensures compliance with the regulations.				

3.14.2 Discussion

CNSC regulates the transport of nuclear substances through a series of safety-centred regulatory requirements covering the entire journey of a shipment, from the time it is initially packaged to arrival at its destination.

Regulatory control of packaging and transport of nuclear substances is generally exerted through:

- certifying of packages used for transporting nuclear substances
- registering users of the certified packaging
- licensing the transport of nuclear substances
- issuing licences for the import and export of nuclear substances

Requirements for licensing vary depending on the type of nuclear substance being transported, and the origin and destination of the shipment. The type of package required depends on the nuclear substance being transported and its quantity, and the mode of transportation being used. To be certified by the CNSC, packages must meet stringent performance criteria for shielding, containment, ability to withstand impacts, and ability to withstand heat. Safety during transport relies heavily on the design of the transport package.

Package designs are combined with additional regulatory controls, including labelling, placarding, quality assurance and maintenance records, allowing nuclear substances to be carried safely in all modes of transport such as road, rail, air and sea transportation. This philosophy is universally accepted for transport and has guided the development of the International Atomic Energy Agency (IAEA) and Canadian Nuclear Safety Commission (CNSC) regulations on the packaging and transport of nuclear substances. All nuclear substances are transported in packages that are selected based on the nature, form and quantity or activity of the nuclear substance. There are general design requirements that apply to all package types to ensure that they can be handled safely and easily, secured properly and are able to withstand routine conditions of transport.

CNL has developed and implemented a packaging and transport program to ensure compliance with the *Packaging and Transport of Nuclear Substances Regulations*, *2015* and the *Transportation of Dangerous Goods Regulations* for all shipments to and from the WL site. This program covers elements of package design, package maintenance, and the registration for use of certified packages as required by the regulations. CNSC's compliance activities in this SCA have included desktop reviews of the companywide corporate program as well as inspections at both the WL site and at CNL's Chalk River Laboratories site, which is the primary destination for nuclear substances transported from the WL site. There are no concerns with CNL's implementation of its packaging and transport program.

3.14.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

3.14.3.1 Past Performance

CNL has developed and implemented a packaging and transport program that ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations* for all shipments leaving their sites, including WL. CNL's packaging and transport program also covers elements of package design and maintenance as well as the registration for use of certified packages as required by the regulations.

The *Packaging and Transport of Nuclear Substances Regulations, 2015* apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage and unloading of packages.

CNL is required to have appropriate training for personnel involved in the handling, offering for transport and transport of dangerous goods at their facility, and is required to issue a training certificate to those workers in accordance with the *Transportation of Dangerous Goods Regulations*. During inspections, CNSC inspectors verify that licensee personnel involved in transport hold valid training certificates.

There were no events reported under the *Packaging and Transport of Nuclear Substances Regulations, 2015* for consignments transported from the WL site.

The transportation of nuclear substances has been a frequent and routine activity at the WL site during the current licence period. In 2018 alone, 303 radioactive transport packages were safely sent offsite [43]. This included the transportation of 1,333.8 m³ of low-level waste and 7.9 m³ intermediate-level waste to CRL.

CNL's packaging and transport program is corporate-wide. In 2019, CNSC staff conducted packaging and transport inspections at both the Chalk River Laboratories (which receives shipments from the WL site) and at the WL site itself. CNSC staff were satisfied that CNL's packaging and transport program ensures compliance with the regulations.

3.14.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate CNL's performance in this SCA through regulatory oversight activities including inspections and reviews of compliance reports and other licensee submissions. This SCA will remain an area of focus in the next licensing period, as CNL develops a final long-term solution to the radioactive waste stored and generated at the WL site.

3.14.3.3 Proposed Improvements

No improvements within this SCA are proposed.

3.14.4 Conclusion

There are no challenges to with CNL's implementation of this SCA.

Based on CNSC staff assessments of the licence renewal application, supporting documents and past performance, CNSC staff conclude that CNL's packaging and transport program is effectively implemented at the WL site and ensures compliance with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

3.14.5 Recommendation

One licence condition is included in the proposed licence for this SCA. Licence condition 14.1 requires CNL to implement and maintain a packaging and transport program. Compliance verification criteria for this licence condition is included in the draft LCH.

4. OTHER MATTERS OF REGULATORY INTEREST

4.1 Indigenous Consultation and Engagement

The common law duty to consult with Indigenous groups applies when the Crown contemplates actions that may adversely impact potential or established Indigenous and/or treaty rights. The CNSC ensures that all of its licensing decisions under the NSCA [7] uphold the honour of the Crown and consider Indigenous peoples' potential or established Indigenous and/or treaty rights pursuant to section 35 of the Constitution Act, 1982 [44].

4.1.1 Discussion

CNSC staff have identified the First Nation and Métis groups who may have an interest in the proposed relicensing of CNL's decommissioning activities at Whiteshell Laboratories in Pinawa, Manitoba. These groups include the Sagkeeng Anicinabe, Brokenhead Ojibway Nation, Black River First Nation, Hollow Water First Nation, Manitoba Metis Federation, Northwest Angle No.33, Shoal Lake #40 First Nation, Iskatewizaagegan #39 Independent First Nation, Wabaseemoong Independent Nations, and Grand Council of Treaty 3.

These groups were identified due to the proximity of their communities, treaty areas and/or traditional territories to the WL site, or due to previously expressed interest in being kept informed of CNSC licensed activities occurring in or proximal to their traditional territories.

CNSC staff sent letters of notification for this proceeding in January 2019 to the Indigenous groups identified above, providing information regarding the proposed licence renewal application, the availability of participant funding to facilitate participation in the hearing process, and details on how to participate in the Commission's public hearing process. Follow-up phone calls were conducted with the identified groups in March 2019 to ensure they had received the letters and to answer any questions about the regulatory process and how to get involved in the Commission proceedings.

CNSC REGDOC-3.2.2 *Indigenous Engagement*, published in February 2016, sets out requirements and guidance for licensees whose proposed projects may raise the Crown's duty to consult. While the CNSC cannot delegate its obligation, it can delegate procedural aspects of the consultation process to licensees. The information collected and measures proposed by licensees to avoid, mitigate or offset adverse impacts from the proposed licence renewal may be used by CNSC staff in meeting its consultation obligations.

Based on the information received and reviewed, CNSC staff determined that CNL's continuation of decommissioning operations at the WL site will not result in novel impacts. All proposed decommissioning activities under this license will occur in the existing project footprint and there is a low probability of emissions or waste being produced that could adversely impact the surrounding environment. This licence renewal application is not anticipated to result in adverse impacts on any potential or established Indigenous and/or treaty rights.

Therefore, CNSC staff are of the opinion that the decision on the licence renewal for CNL's WL decommissioning activities does not raise the duty to consult.

4.1.2 Conclusion

This licence application by CNL does not raise a duty to consult, therefore the guidance set out in CNSC REGDOC-3.2.2 pertaining to formal engagement do not apply. However, CNSC staff encourage CNL to continue to engage with interested Indigenous communities on the licence application and on-going activities of interest to the communities.

The CNSC ensures that all of its licensing decisions under the NSCA [7] uphold the honour of the Crown and consider the broader interests of Indigenous peoples who exercise Indigenous and/or treaty rights within proximity to the licensed activities or facilities. On this basis CNSC staff continue to pursue an approach of meaningful Indigenous engagement integrated into the licence application review and hearing process.

Indigenous groups (Sagkeeng Anicinabe and the Manitoba Metis Federation) have provided the CNSC with Indigenous Knowledge (IK) studies pertaining to the WL site and the proposed WR1 in-situ decommissioning project.

For more information regarding these IK studies, please see the Environmental Protection Review Report (appendix D).

4.2 Other Consultation

The CNSC made available up to $50,000 through its PFP to Indigenous peoples, members of the public and stakeholders in providing value-added information to the Commission through informed and topic-specific interventions. This funding was offered to review CNL's application and associated documents and to prepare for and participate in the Commission's public hearing.

4.2.1 Discussion

The deadline for applications was May 10, 2019. A Funding Review Committee (FRC), independent from CNSC staff, reviewed the funding applications received, and made recommendations on the allocation of funding to eligible applicants. Based on recommendations from the FRC, the CNSC awarded participants up to 63,299.50 in funding to the following recipients, who are required to submit a written intervention and make an oral presentation at the Commission's public hearing in October 2019:

- Canadian Environmental Law Association
- Concerned Citizens of Renfrew County
- Northwatch
- Sagkeeng First Nation
- Manitoba Metis Federation

4.2.2 Conclusion

The CNSC continues to actively promote ongoing communication and dissemination of regulatory and scientific information through social media channels, webinars, outreach in the local communities and postings on the CNSC web site. The CNSC has various mechanisms and processes such as the PFP and mail outs to encourage the public to participate in the Commission's public hearing, as described above. The CNSC has offered assistance to interested members of the public, Indigenous groups, and other stakeholders, through the PFP, to prepare for and participate in the Commission's public hearing.

4.3 Cost Recovery

A Class I licensed nuclear facility is subject to the requirements of Part 2 of the CNSC *Cost Recovery Fees Regulations* (CRFR). CNSC staff have concluded that CNL is compliant with the CNSC's CRFR for the WL site.

4.3.1 Discussion

Through review of CNSC records, CNSC staff have determined that CNL is in good standing with respect to CRFR requirements for the WL site. CNL has paid their cost recovery fees in full.

4.3.2 Conclusion

CNSC staff confirm that CNL is in good standing with respect to CRFR requirements for the WL site.

4.4 Financial Guarantees

The WL licence requires CNL to maintain in effect a financial guarantee for decommissioning of the WL site that is acceptable to the Commission. CNSC Regulatory Guides G-219, *Decommissioning Planning for Licensed Activities* and G-206, *Financial Guarantees for Decommissioning of Licensed Activities* provides guidance on calculating the financial guarantees.

4.4.1 Discussion

With respect to a financial guarantee required by the paragraph 3(1)(l) of the *General Nuclear Safety and Control Regulations* (GNSCR), CNSC Regulatory Document, G-206, *Financial Guarantees for the Decommissioning of Licensed Activities*, (2000) states that an expressed commitment from a federal or provincial government is an acceptable form of financial guarantee.

This commitment was last expressed to the CNSC in a letter from the Federal Minister of Natural Resources to Dr. Binder dated July 31, 2015 [45]. This letter states that AECL will retain ownership of the lands, assets and liabilities associated with CNL's licences, including the Whiteshell Licence, and states that the liabilities of AECL are the liabilities of Her Majesty in Right of Canada.

4.4.2 Conclusion

CNSC staff confirm that a financial guarantees in a format that meets G-206 requirements is in place for the WL site.

4.5 Licensee Public Information Program

A public information and disclosure program (PIDP) is a regulatory requirement for licence applicants. CNSC document RD/GD-99.3 *Public Information and Disclosure*, sets out the requirements for public information and disclosure. The primary goal of the program, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public.

This information promotes transparency and improves the public's understanding of the licensed activities and operations. The program includes a commitment to and protocol for ongoing, timely communication of information related to the licensed facility during the course of the licence period.

CNSC expectations of a licensee's public information program and disclosure protocol are commensurate with the level of risk of the facility and the level of public interest in the licensed activities. The program and protocol may be further influenced by the complexity of the nuclear facility's lifecycle and activities, and the risks to public health and safety and the environment perceived to be associated with the facility and activities.

4.5.1 Discussion

The WL licence requires CNL to implement and maintain a PIDP. CNSC staff have reviewed CNL's PIDP and determined that it:

- identifies clear goals and measurable objectives in terms of dissemination of information to targeted audiences
- is available to the public and is posted on the licensee's web site
- targets multiple audiences such as local residents, elected and government representatives, media, business leaders, youth, interest groups, and community organizations
- provides contact information for members of the public who want to obtain additional information

CNL presents their public outreach and Indigenous engagement activities to CNSC staff each month at regularly scheduled meetings. CNSC staff have attended a sample of CNL outreach activities, including the WL Public Liaison committee meetings and the Whiteshell Site Open House.

CNSC staff will continue to monitor CNL's compliance with CNSC RD/GD-99.3 and ongoing implementation of the PIDP.

4.5.2 Conclusion

CNSC staff conclude that CNL's PIDP meets the regulatory requirements of RD/GD-99.3 *Public Information and Disclosure*. CNSC staff continue to oversee CNL's implementation of the PIDP to ensure that CNL meets its obligations regarding dissemination and notifying the public and Indigenous communities on its licensed activities. CNSC staff have also communicated with CNL to refine and update the PIDP on a regular basis to meet the changing information needs of their target audiences.

4.6 Nuclear Liability Insurance

The WL site is currently designated, pursuant to section 7 of the *Nuclear Liability and Compensation Act* (NLCA) [46], as a nuclear installation in Item 17 of the Schedule (Section 2) of the *Nuclear Liability and Compensation Regulations* (NLCR) [47].

4.6.1 Discussion

The WL site contains several facilities which are authorized to contain nuclear material as defined in the NLCA. These facilities fall under various risk categories, as defined in paragraph 4(1) of the NLCR, and are listed in Column 4 of Item 17 in the Schedule.

Because the Concrete Canister Storage Facility is a “Nuclear Fuel Waste Management Facility”, it is the facility in this list with the highest risk. As a result, the WL site falls under the “Nuclear Fuel Waste Management Facility Class” pursuant to paragraph 4(2) of the NLCR, and the operator’s liability amount is prescribed at $13 million pursuant to paragraph 5(c) of the NLCR.

4.6.2 Conclusion

CNL has maintained nuclear liability insurance for WL under the *Nuclear Liability Act* [46] and continues to maintain nuclear liability insurance under the *Nuclear Liability and Compensation Act* (NLCA) [47] which came into force on January 1, 2017.

4.7 Delegation of Authority

The Commission may include in a licence any condition it considers necessary for the purposes of the NSCA. The Commission may delegate authority to CNSC staff with respect to the administration of licence conditions, or portions thereof.

There is one proposed licence condition in the proposed licence that contains the phrase “the Commission or a person authorized by the Commission”: LC 3.2 Operating Performance.

Licence condition 3.2 states “The licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission.”

CNSC staff recommend the Commission delegate its authority for the purposes described in the above licence conditions to the following staff:

- Director, Canadian Nuclear Laboratories Regulatory Program Division
- Director General, Directorate of Nuclear Cycles and Facilities Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

5. OVERALL CONCLUSIONS AND RECOMMENDATIONS

CNSC staff have concluded the following with respect to paragraphs 24(4)(a) and (b) of the *Nuclear Safety and Control Act* (NSCA) [7], in that CNL:

1. is qualified to carry out the activities authorized by the licence; and
2. will in carrying out the licensed activities, has made, and will continue to make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

Therefore, CNSC staff recommend that the Commission:

1. accept CNSC staff's conclusions and exercise its authority under the NSCA [7] to renew the licence to authorize Canadian Nuclear Laboratories to continue to decommission the Whiteshell Laboratories from January 1, 2020 to December 31, 2029
2. authorize the delegation of authority as set out in subsection 4.7 of this CMD

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[4] CMD 14-M79, Annual Performance Report AECL's Nuclear Sites and Projects: 2013, e-Doc 4528291

[5] CMD 16-M12, Status Update for CNL Prototype Waste Facilities and Whiteshell Nuclear Laboratories, e-Doc 4952931

[6] CMD 18-M30, Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and the Port Hope Area Initiative, e-Doc 5554206

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[17] Whiteshell Effluent Monitoring Report “Canadian Nuclear Laboratories (CNL) Submission of Whiteshell Laboratories (WL) Annual Report” - WL-00583-ASR-2009

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[21] Whiteshell Effluent Monitoring Report “Canadian Nuclear Laboratories (CNL) Submission of Whiteshell Laboratories (WL) Annual Report” - WL-00583-ASR-2013

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ACRONYMS

Acronym	Definition
AECL	Atomic Energy of Canada Limited
AL	Action Levels
ALARA	As Low As Reasonably Achievable
CAP	Corrective Action Program
CCSF	Concrete Canister Storage Facility
CEAA	*Canadian Environmental Assessment Act*
CMD	Commission Member Document
CNL	Canadian Nuclear Laboratories
CRL	Chalk River Laboratories
CRFR	Cost Recovery Fees Regulations
CSA	Canada Standards Association
CSD	Criticality Safety Documents
CSR	Comprehensive Study Report
DDP	Detailed Decommissioning Plan
EA	Environmental Assessment
EIR	Event Initial Report
EMS	Environmental Management System
EnvP	Environmental Protection Program
EPR	Environmental Protection Review
ERA	Environmental Risk Assessment
EVMP	Effluent Verification Monitoring Program
FTE	Full Time Equivalent
GHG	Greenhouse Gas
Go-Co	Government Owned Contractor Operated
GWMP	Groundwater Monitoring Program
GWP	Global Warming Potential
IAEA	International Atomic Energy Agency

Acronym	Definition
IEMP	Independent Environmental Monitoring Program
ILW	Intermediate-Level Waste
ISO	International Standards Organization
LCH	Licence Conditions Handbook
LLW	Low-Level Waste
MCP	Management Control Procedures
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Act
NLCA	*Nuclear Liability and Compensation Act*
NLCR	*Nuclear Liability and Compensation Regulations*
NPRI	National Pollutant Release Inventory
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRTEDL	Nuclear Research and Test Establishment Decommissioning Licence
NSCA	*Nuclear Safety and Control Act*
OPEX	Operating Experience
PIDP	Public Information and Disclosure Program
PFP	Participant Funding Program
RLTI	Recordable Lost-Time Injuries
ROR	Regulatory Oversight Reports
RP	Radiation Protection
SAR	Safety Analysis Reports
SCAs	Safety and Control Areas
SMAGS	Shielded Modular Above Ground Storage
SSC	Structures, Systems and Components
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactor

GLOSSARY

For definitions of terms used in this document, see REGDOC-3.6 Glossary of CNSC Terminology, which includes terms and definitions used in the *Nuclear Safety and Control Act* (NSCA) [7] and the regulations made under it, and in CNSC regulatory documents and other publications. REGDOC-3.6 is provided for reference and information.

A. RATING LEVELS

Fully Satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the safety and control area (SCA) or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the SCA meets requirements and CNSC expectations. Any deviation is minor and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the SCA deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the SCA is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken and no alternative plan of action has been provided. Immediate action is required.

B. BASIS FOR THE RECOMMENDATION(S)

B.1 Regulatory Basis

The recommendations presented in this CMD are based on compliance objectives and expectations associated with the relevant SCAs and other matters. The regulatory basis for the matters that are relevant to this CMD are as follows.

Management System

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(d) that an application for a licence for a Class I nuclear facility shall contain the proposed management system for the activity to be licensed, including measures to promote and support safety culture.
- The *General Nuclear Safety and Control Regulations* require that an application for a licence shall contain, under the following paragraph:
    - 3(1)(k), the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the NSCA [7] and the Regulations made under the NSCA, including the internal allocation of functions, responsibilities and authority.
    - 15(a), the persons who have the authority to act for them (the applicant/licensee) in their dealings with the Commission.
    - 15(b), the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed equipment or prescribed information encompassed by the licence.

Human Performance Management

- It is a requirement of the *General Nuclear Safety and Control Regulations* under section 12, that the licensee shall:
    - 12(1)(a), ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the NCSA, the Regulations made under the NSCA [7], and the licence.
    - 12(1)(b), train the workers to carry on the licensed activity in accordance with the NSCA, the Regulations made under the NSCA, and the licence.
    - 12(1)(e), require that every person at the site of the licensed activity to use equipment, devices, clothing, and procedures in accordance with the NSCA, the Regulations made under the NSCA, and the licence.
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(d.1) that a licence application contain the proposed human performance program for the activity to be licensed, including measures to ensure workers' fitness for duty.
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(m) that a licence application contain information on the proposed responsibilities, qualification requirements, and training program for workers including the procedures for the requalification of workers.

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(n) that a licence application contain information on the results that have been achieved in implementing the program for recruiting, training, and qualifying workers in respect of the operation and maintenance of the nuclear facility.

Operating Performance

- Paragraph 6(d) of the *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contains the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility.
- Subsection 24(5) of the *Nuclear Safety and Control Act* (NSCA) [7] states that the licence may contain any term or condition that the Commission considers necessary for the purpose of the NSCA.

Safety Analysis

- 3(1)(i) of the *General Nuclear Safety and Control Regulations* requires that an application for a licence shall contain a description and the results of any test, analysis, or calculation performed to substantiate the information included in the application.
- It is a requirement of the *Class I Nuclear Facilities Regulations* that an application for a licence to operate a Class I nuclear facility shall contain the following information under paragraph:
  - 6(c), a final safety analysis report demonstrating the adequacy of the design of the nuclear facility.
  - 6(h), the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects.

Physical Design

- Paragraph 3(1)(d) of the *General Nuclear Safety and Control Regulations* requires that an application for a licence shall contain a description of any nuclear facility, prescribed equipment, or prescribed information to be encompassed by the licence.
- Other requirements set out in paragraphs 3(a), 3(b), 6(a) and 6(b) of the *Class I Nuclear Facilities Regulations* require more specific information to be submitted in the licence application related to the site and design of the facility and the final safety analysis report.
- Paragraphs 6(c) and 6(d) of the *Class I Nuclear Facilities Regulations* require that an application for a licence contain a final safety analysis report demonstrating the adequacy of the design of the facility and proposed measures, policies, methods, and procedures for operating and maintaining the facility.

Fitness for Service

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(d) that an application for a licence to operate a Class I nuclear facility contain the proposed measures, policies, methods, and procedures for operating and maintaining the nuclear facility.

Radiation Protection

- The *General Nuclear Safety and Control Regulations* require, under subsection 3(1) that a licence application contain the following information under paragraph:
  - 3(1)(e), the proposed measures to ensure compliance with the *Radiation Protection Regulations*.
  - 3(1)(f), any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*.
- The *Radiation Protection Regulations* require, under sections 4 to 6 that the licensee implements a radiation protection program, ascertain and record doses, and take the required actions in the case that an action level has been reached.
- The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain the following information under paragraph:
  - 6(e), the proposed procedures for handling, storing, loading, and transporting nuclear substances and hazardous substances.
  - 6(h), the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measure that will be taken to prevent or mitigate those effects.

Conventional Health and Safety

- It is a requirement of the C*lass I Nuclear Facilities Regulations* under paragraph 3(f) that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the proposed worker health and safety policies and procedures.
- The WL's activities and operations must comply with the *Canada Labour Code* [11], *Part II: Occupational Health and Safety*.

Environmental Protection

- The *General Nuclear Safety and Control Regulations*, under paragraphs 12(1)(c) and (f) require that each licensee take all reasonable precautions to protect the environment and the health and safety of persons, and to control the release of radioactive nuclear substances and hazardous substances within the site of the licensed activity and into the environment.
- The *Radiation Protection Regulations* prescribe the dose limit for the general public, which under subsection 1(3) is 1mSv per calendar year.
- In addition, Sections 3 and 6 of the *Class I Nuclear Facilities Regulations* must be met by the applicant. The application for a licence shall contain under paragraph:

- □ 3(e), the name, form, characteristics, and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on.
- □ 3(g), the proposed environmental protection policies and procedures.
- □ 3(h), the proposed effluent and environmental monitoring programs.
- □ 6(e), the proposed procedures for handling, storing, loading, and transporting nuclear substances and hazardous substances.
- □ 6(h), the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects.
- □ 6(i), the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical, and radiological characteristics.
- □ 6(j), the proposed measures to control releases of nuclear substances and hazardous substances into the environment.

Emergency Management and Fire Protection

- 12(1)(c) of the *General Nuclear Safety and Control Regulations* states that every licensee shall "take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities, and of nuclear substances".
- 12(1)(f) of the *General Nuclear Safety and Control Regulations* states that every licensee shall "take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment of the licensed activity…".
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(k) that a licence application contain information on the licensee's proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to:
  - □ Assist offsite authorities in planning and preparing to limit the effects of an accidental release.
  - □ Notify offsite authorities of an accidental release or the imminence of an accidental release.
  - □ Report information to offsite authorities during and after an accidental release.
  - □ Assist offsite authorities in dealing with the effects of an accidental release.
  - □ Test the implementation of the measures to prevent or mitigate the effects of an accidental release.

Waste Management

- It is a requirement of the *General Nuclear Safety and Control Regulations* under paragraph 3(1)(j) that an application for a licence include the name, origin, quantity, form, and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed, or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste.

Security

- Paragraph 3(1)(e) of the *General Nuclear Safety and Control Regulations* requires that an application for a licence contains the proposed measures to ensure compliance with the *Radiation Protection Regulations*, the *Nuclear Security Regulations* and the *Packaging and Transport of Nuclear Substances Regulations, 2015*.
- Paragraph 12(1)(c) of the *General Nuclear Safety and Control Regulations* requires the licensee to take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances.
- Paragraph 6(k) of the *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contains the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances to the environment, the health and safety of persons and the maintenance of national security.
- Paragraph 2(a) of Part 1 of *Nuclear Security Regulations* states that Part 1 applies to Category I, II or III nuclear material.
- Subsection 24(5) of the *Nuclear Safety and Control Act* (NSCA) [7] states that the licence may contain any term or condition that the Commission considers necessary for the purpose of the NSCA.

Safeguards and Non-Proliferation

- Subsection 24(5) of the *Nuclear Safety and Control Act* (NSCA) states that the licence may contain any term or condition that the Commission considers necessary for the purpose of the NSCA.
- Paragraph 12(1)(i) of the *General Nuclear Safety and Control Regulations* requires the licensee to take all necessary measures to facilitate Canada’s compliance with any applicable safeguard agreement.
- Paragraph 6(f) of the *Class I Nuclear Facilities Regulations* requires that an application for a licence to operate a Class I nuclear facility contains the proposed measures to facilitate Canada’s compliance with any applicable safeguards agreement. The applicable safeguards agreements are:
    - *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/164); and

- □ *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/164/Add. 1).

Packaging and Transport

- CNL is required to comply with the *Packaging and Transport of Nuclear Substances Regulations, 2015*, and Transport Canada's *Transportation of Dangerous Goods Regulations*.

Cost Recovery

- Paragraph 24(2)(*c*) of the *Nuclear Safety and Control Act* requires that a licence application is accompanied by the prescribed fee.
- The *Canadian Nuclear Safety Commission Cost Recovery Fees Regulations* (CRFR) set out the specific requirements based on the activities to be licensed.

Financial Guarantee

- The *General Nuclear Safety and Control Regulations* requires under paragraph 3(1)(l) that a licence application contains a description of any proposed financial guarantee relating to the activity to be licensed.

Licensee Public Information Program

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(j) that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain information on the licensee's public information program.

B.2 Technical Basis

The technical basis for the recommendations presented in this CMD are as follows. The following CNSC regulatory documents and CSA standards are relevant to WL.

Management System

- CSA N286 *Management system requirements for nuclear facilities*
- REGDOC-2.1.2 *Management System: Safety Culture*
- CSA N286.0.1 *Commentary on N286-12, Management system requirements for nuclear facilities*

Human Performance Management

- REGDOC-2.2.4 *Fitness for Duty: Managing Worker Fatigue*
- RD-363 *Nuclear Security Officer Medical, Physical, and Psychological Fitness*
- REGDOC-2.2.4 *Fitness for Duty, Volume II: Managing Alcohol and Drug Use, version 2*
- G-323 *Ensuring Presence of Sufficient Qualified Staff at Class I Nuclear Facilities: Minimum Staff Complement*
- REGDOC-2.2.2 *Personnel Training, version 2*

Operating Performance

- REGDOC-3.1.2 *Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills*

Safety Analysis

- IAEA SSR-4 *Safety of Nuclear Fuel Cycling Facilities*
- IAEA TECDOC-1267 *Procedures for Conducting Probabilistic Safety Assessment for Non-reactor Nuclear Facilities*
- IAEA GSR Part 4, Rev. 1 *Safety Assessment for Facilities and Activities*
- RD-327 *Nuclear Criticality Safety*
- REGDOC 2.4.3 *Nuclear Criticality Safety*
- GD-327 *Guidance for Nuclear Criticality Safety*

Physical Design

- NFPA-801 *Standard for Fire Protection for Facilities Handling Radioactive Materials*
- CSA-N393 *Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances*
- *National Fire Code of Canada*
- *National Building Code of Canada*
- G-276 *Human Factors Engineering Program Plans*
- G-278 *Human Factors Verification and Validation Plans*
- CSA N285.0 *General requirements for pressure-retaining system and components in CANDU nuclear power plants*
- CSA B51 *Boiler, Pressure Vessel and Pressure Piping Code*
- CSA N285.0.1 *Commentary on CSA N285.0-12, General requirements for pressure-retaining systems and components in CANDU nuclear power plants*

Fitness for Service

- REGDOC-2.6.3 *Aging Management*
- REGDOC-2.6.2 *Maintenance Programs for Nuclear Power Plants*

Radiation Protection

- G-129, Rev. 1 *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable* (ALARA)*"*
- G-228 *Developing and Using Action Levels*
- G-91 *Ascertaining and Recording Radiation Doses to Individuals*
- GD-150 *Designing and Implementing a Bioassay Program*

Conventional Health and Safety

- None provided

Environmental Protection

- REGDOC-2.9.1 *Environmental Principles, Assessments and Protection Measures, version 1.1*
- CSA N288.4 *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.5 *Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.6 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills*
- CSA N288.7 *Groundwater protection programs at Class I nuclear facilities and uranium mines and mills*
- CSA N288.8 *Establishing and implementing action levels to control releases to the environment from nuclear facilities*
- CSA N288.1 *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*
- CSA N288.2 *Guidelines for calculating the radiological consequences to the public of a release of airborne radioactive material for nuclear reactor accidents*

Emergency Management and Fire Protection

- REGDOC-2.10.1 *Nuclear Emergency Preparedness and Response, Version 2*
- CSA N1600 *General requirements for nuclear emergency management programs*
- *Canadian Guidelines for Intervention During a Nuclear Emergency*
- *Canadian Guidelines for the Restriction of Radioactively Contaminated Food and Water Following a Nuclear Emergency*
- CSA-N393*Fire protection for Facilities that Process, Handle, or Store Nuclear Substances*
- *National Fire Code of Canada*
- *National Building Code of Canada*

Waste Management

- CSA N292.0 *General principles for the management of radioactive waste and irradiated fuel*
- CSA N292.2 *Interim dry storage of irradiated fuel*
- CSA N292.3 *Management of low- and intermediate-level radioactive waste*
- CSA N292.6 *Long-term management of radioactive waste and irradiated fuel*
- REGDOC-2.11.1 *Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management*

- CSA N292.5 *Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances*
- CSA N294*Decommissioning of Facilities Containing Nuclear Substances*
- G-219 *Decommissioning Planning for Licensed Activities*

Security

- REGDOC-2.12.1 *High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices*
- REGDOC-2.12.2 *Site Access Security Clearance*
- REGDOC-2.12.3 *Security of Nuclear Substances: Sealed Sources*
- CSA N290.7 *Cyber-security for nuclear power plants and small reactor facilities*
- G-208 *Transportation Security Plans for Category I, II or III Nuclear Material*
- G-274 *Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities*

Safeguards and Non-proliferation

- REGDOC-2.13.1 *Safeguards and Nuclear Material Accountancy*

Packaging and Transport

- IAEA SSR-6 *Regulations for the Safe Transport of Radioactive Material (2012 Edition)*
- RD-364 *Joint Canada-United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages*
- REGDOC-2.14.1 *Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015*

C. SAFETY AND CONTROL AREA FRAMEWORK

C.1 Safety and Control Areas Defined

The safety and control areas identified in section 2.2, and discussed in summary in sections 3.1 through 3.14 are comprised of specific areas of regulatory interest which vary between facility types.

The following table provides a high-level definition of each SCA. The specific areas within each SCA are to be identified by the CMD preparation team in the respective areas within section 3 of this CMD

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee staff is sufficient in number in all relevant job areas and that licensee staff have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
	Operating Performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Facility and Equipment	Safety Analysis	Maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled.
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
	Environmental Protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.
	Emergency Management and Fire Protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.
	Waste Management	Covers internal waste-related programs which form part of the facility’s operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning.
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.
	Safeguards and Non-Proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements as well as all other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*.
	Packaging and Transport	Programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

C.2 Specific Areas for this Facility Type

The following table identifies the specific areas that comprise each SCA for the Whiteshell Laboratories site:

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
Management	Management System	▪ Management System ▪ Organization ▪ Performance Assessment, Improvement and Management Review ▪ Operating Experience (OPEX) ▪ Change Management ▪ Configuration Management ▪ Records Management ▪ Management of Contractors
	Human Performance Management	▪ Human Performance Programs ▪ Personnel Training ▪ Fitness for Duty
	Operating Performance	▪ Conduct of Licensed Activity ▪ Procedures ▪ Reporting and Trending
Facility and Equipment	Safety Analysis	▪ Deterministic Safety Analysis ▪ Hazard Analysis ▪ Criticality Safety
	Physical Design	▪ Design Governance ▪ Site Characterization ▪ Facility Design ▪ Structure Design ▪ System Design ▪ Components Design
	Fitness for Service	▪ Maintenance ▪ Structural Integrity

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
Core Control Processes	Radiation Protection	▪ Application of ALARA ▪ Worker Dose Control ▪ Radiation Protection Program Performance ▪ Radiological Hazard Control ▪ Estimated Dose to Public
	Conventional Health and Safety	▪ Performance ▪ Practices ▪ Awareness
	Environmental Protection	▪ Effluent and Emissions Control (releases) ▪ Environmental Management System (EMS) ▪ Assessment and Monitoring ▪ Protection to the Public ▪ Environmental Risk Assessment
	Emergency Management and Fire Protection	▪ Conventional Emergency Preparedness and Response ▪ Nuclear Emergency Preparedness and Response ▪ Fire Emergency Preparedness and Response
	Waste Management	▪ Waste Characterization ▪ Waste Minimization ▪ Waste Management Practices ▪ Decommissioning Plans
	Security	▪ Facilities and Equipment ▪ Response Arrangements ▪ Security Practices ▪ Drills and Exercises

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
	Safeguards and Non-Proliferation	▪ Nuclear Material Accountancy and Control ▪ Access and Assistance to the IAEA ▪ Operational and Design Information ▪ Safeguards Equipment, Containment and Surveillance
	Packaging and Transport	▪ Package Design and Maintenance ▪ Packaging and Transport ▪ Registration for Use

D. ENVIRONMENTAL PROTECTION REVIEW REPORT

e-Doc 5753726 (Word)

e-Doc 5933012 (PDF)

Canada's Nuclear Regulator

Environmental Protection Review Report: **Canadian Nuclear Laboratories Whiteshell Laboratories – NRTEDL-W5-8.05/2019 Licence Renewal**

JULY 2019

e-Doc: 5753726 (Word)
e-Doc: 5933012 (PDF)

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

REVISION HISTORY

The following table identifies the revision history of this document.

Revision number	Change	Summary of changes	Date
000	Initial release	N/A	
001			

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EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) conducts Environmental Protection Reviews (EPRs) for all licence applications with potential environmental interactions, in accordance with its mandate under the *Nuclear Safety and Control Act* (NSCA), to ensure the protection of the environment and the health of persons. An EPR is a science-based environmental technical assessment by CNSC staff as set out in the NSCA. The fulfillment of other aspects of the CNSC's mandate, such as safety and security, are met through other regulatory oversight activities.

This EPR Report was written by CNSC staff for the Commission, Indigenous peoples and the public. It describes the scientific, evidence-based findings from CNSC staff review of the application by Canadian Nuclear Laboratories (CNL) to renew the Whiteshell Laboratories (WL) Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-W5-8.05/2019. The licence application proposes the continued operations of the WL site over a period of 10 years, from January 1, 2020 to December 31, 2029. During this licensing period, CNL is proposing to continue the decommissioning activities planned for the WL site, including the decommissioning of the Concrete Canister Storage Facility, Waste Management Area, Shielded Facilities and other remaining buildings and infrastructure.

This EPR Report does not consider CNL's proposed *In Situ* Decommissioning of the Whiteshell Reactor #1 (WR-1) Project, which is undergoing a separate regulatory review process under both the *Canadian Environmental Assessment Act, 2012* and the NSCA. Hence, the proposed *in situ* strategy to decommission the WR-1 facility is outside the scope of this licence renewal.

The CNSC's EPR Report can be read as a stand-alone document that focuses on items that are of current public and regulatory interest such as releases of radiological and hazardous substances to the receiving environment, as well as effects on valued ecosystem components and species at risk, during ongoing operations and decommissioning activities.

This EPR Report includes CNSC staff's assessment of the documents submitted in support of the licence application, as well as but not limited to, the following:

- predictions of radionuclides and hazardous substances in the receiving environment, as presented in the 2001 Comprehensive Study Report (CSR) for the Whiteshell Laboratories Decommissioning Project, previously accepted by the Commission
- CNSC staff verification that environmental monitoring data reported by CNL are within those predicted in the 2001 CSR
- CNL's environmental monitoring and reporting requirements including:
    - Annual Compliance Monitoring Reports
    - Progress Reports on the Environmental Assessment Follow-Up Program for WL
- the results of CNSC's Independent Environmental Monitoring Program
- the results from other regional monitoring programs and/or health studies completed by other levels of government in proximity to the WL site
- the results of the Manitoba Metis Federation's Indigenous knowledge study submitted to the CNSC

The information provided in this EPR Report supports the environmental protection conclusions made by CNSC staff in CMD 19-H4 that CNL has made, and will continue to make adequate provision for the protection of the environment, the health and safety of persons as decommissioning activities continue.

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Environmental Protection Review (EPR) is to report the outcome of Canadian Nuclear Safety Commission (CNSC) staff review of licensing and environmental compliance activities conducted under the *Nuclear Safety and Control Act* (NSCA). This review serves to assess whether Canadian Nuclear Laboratories (CNL) has made, and will continue to make, adequate provisions to protect the environment and health and safety of persons at the WL site.

This EPR Report presents information that supports CNSC staff's recommendations in CMD 19-H4 regarding the proposed licence renewal of the Whiteshell Laboratories (WL) Nuclear Research and Test Establishment Decommissioning Licence, NRTEDL-W5-8.05/2019, as it pertains to environmental protection. CNL has requested to renew the licence for a period of 10 years, from January 1, 2020 to December 31, 2029 [1]. The current licence expires on December 31, 2019 [2].

This EPR Report does not consider CNL's proposed *In Situ* Decommissioning of the Whiteshell Reactor #1 (WR-1) Project, which is undergoing a separate regulatory review process under both the *Canadian Environmental Assessment Act, 2012* and the NSCA. Hence, the proposed *in situ* strategy to decommission the WR-1 facility is outside the scope of this licence renewal.

CNSC staff assess the health of persons and the environment at every phase of a project and its activities, and throughout all phases of a facility's lifecycle. EPR Reports are prepared to provide science-based transparent information to the public and that supports staff's recommendations to the Commission. The fulfillment of other aspects of the CNSC's mandate, such as safety and security, are met through other regulatory oversight activities that are outside the scope of this report.

This EPR Report is based on information submitted by CNL, compliance and technical assessment activities completed by the CNSC staff, and independent verification activities, including the following:

- regulatory oversight (section 2.0)
- CNSC staff review of the WL decommissioning strategy and program overview [3] (section 1.2)
- CNSC staff review of CNL's Environmental Assessment (EA) Follow-Up Program (FUP) (section 2.2) [4]
- CNSC staff review of CNL's Annual Compliance Monitoring Reports (formerly referred to as Annual Safety Reports) [5 to 33], and other supplementary documents provided by CNL in support of the 2019 Application for Renewal [34 to 35]
- Independent Environmental Monitoring Program (IEMP) results (section 4.0) [36]
- health studies and other regional monitoring programs in proximity to the WL site (sections 5.0 and 6.0)
- an Indigenous knowledge (IK) study submitted by the Manitoba Metis Federation (MMF) [37 to 38], which focused on the *In Situ* Decommissioning of the WR-1 Project but also

provided relevant information on the Indigenous perspectives of the impact of the WL site on MMF Citizens (section 7.0)

A review has been conducted for all environmental components related to the project, but only a selection of topics related to environmental performance of the facility are presented in detail in this report. These were selected based on licensing requirements, as well as those that have historically been of interest to the Commission, Indigenous peoples and the public.

This EPR Report can be read as a stand-alone document that focuses on topics related to the environmental performance of the facility include emissions (atmospheric releases) and liquid releases to the environment, their potential transfer through key environmental pathways and associated potential exposures and or effects on valued ecosystem components including human and non-human biota. The focus is on nuclear and hazardous substances associated with WL site activities, with additional information provided on other substances of public and/or regulatory interest such as greenhouse gas (GHG) emissions. CNSC staff also present information on any relevant regional environmental or health monitoring or studies conducted by the CNSC (i.e., IEMP) or other levels of government.

Additionally, the IK study produced by MMF, while produced for the proposed *In Situ* Decommissioning of the WR-1 Project, identified a number of site-wide valued components (VCs) of significance to their rights, culture and interests, in and around the WL site. Indigenous perspectives and cultural context enhance the CNSC's understanding of potential impacts of projects, strengthening the rigour of project reviews and regulatory oversight. This information was considered in this review, and is presented in later sections of this report.

1.2 Project Background

This section of the report provides general information on the WL site. This includes a description of the site location and a basic history of the WL site activities and licensing. More detailed information is provided with respect to the proposed decommissioning strategy for the WL facility and activities completed over the previous licensing period, followed by information on activities planned for the proposed licence period.

This information is intended to provide context for later sections of this report, which discuss completed and ongoing decommissioning activities.

1.2.1 Site Description

The WL site is located in Pinawa, Manitoba, approximately 100 kilometres (km) northeast of Winnipeg, on the shore of the Winnipeg River. Historically owned and operated by Atomic Energy Canada Limited (AECL) and comprised of 4,375 hectares of land, the WL site was established in the 1960s in order to conduct nuclear research activities.

The WL site was commissioned in 1964 and operated for approximately 40 years under a Nuclear Research and Test Establishment Operating Licence (NRTEOL) [39]. CNL took over management of the WL site in 2015, and although AECL remains the site owner, operations are managed by CNL under a government-owned, contractor-operated ("Go-Co") model.

See figures 1.1 and 1.2, for maps of the site location.

Figure 1.1: Overview of site and surrounding features (figure adapted from Whiteshell Reactor #1 EIS figure 1.0-1) [40]

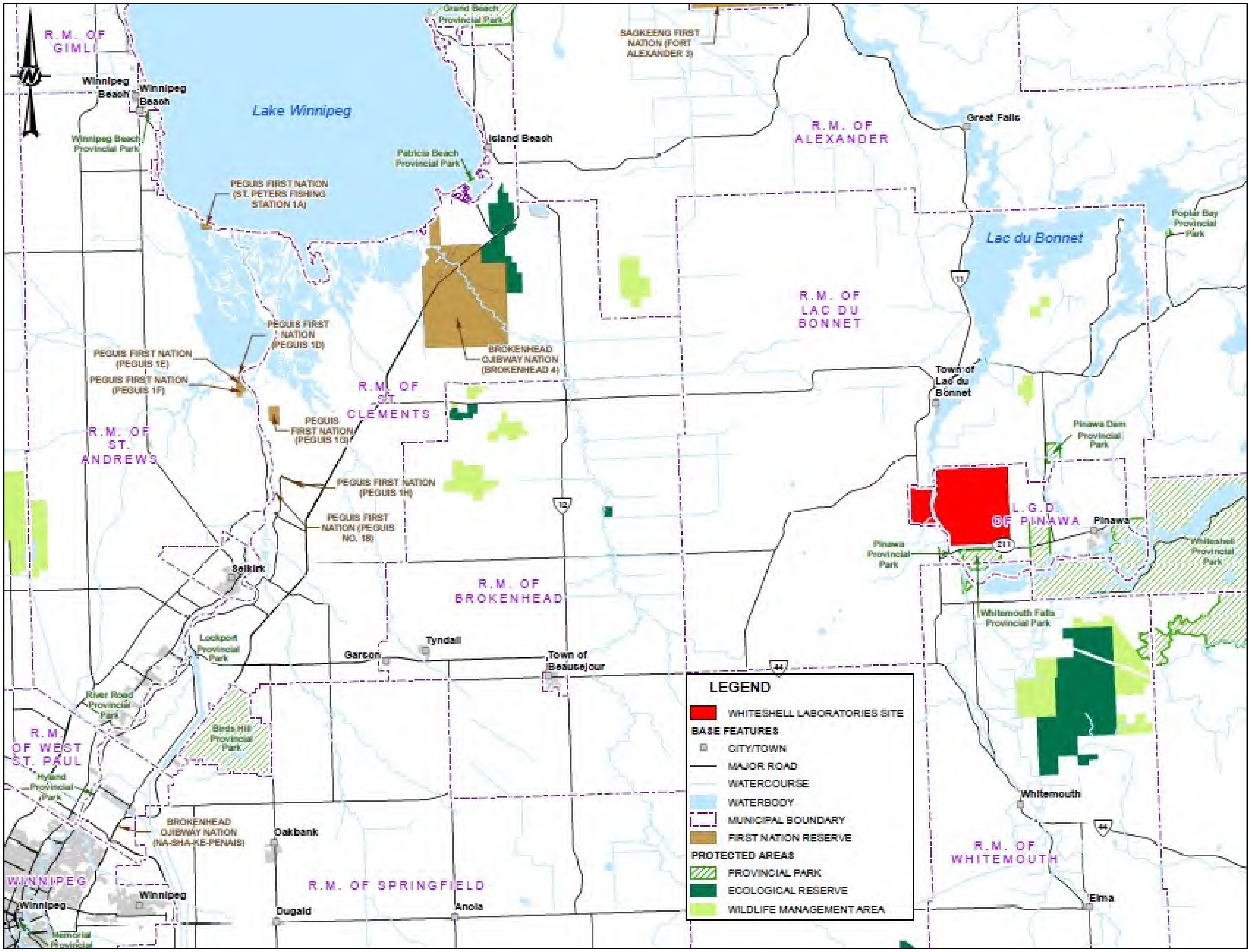
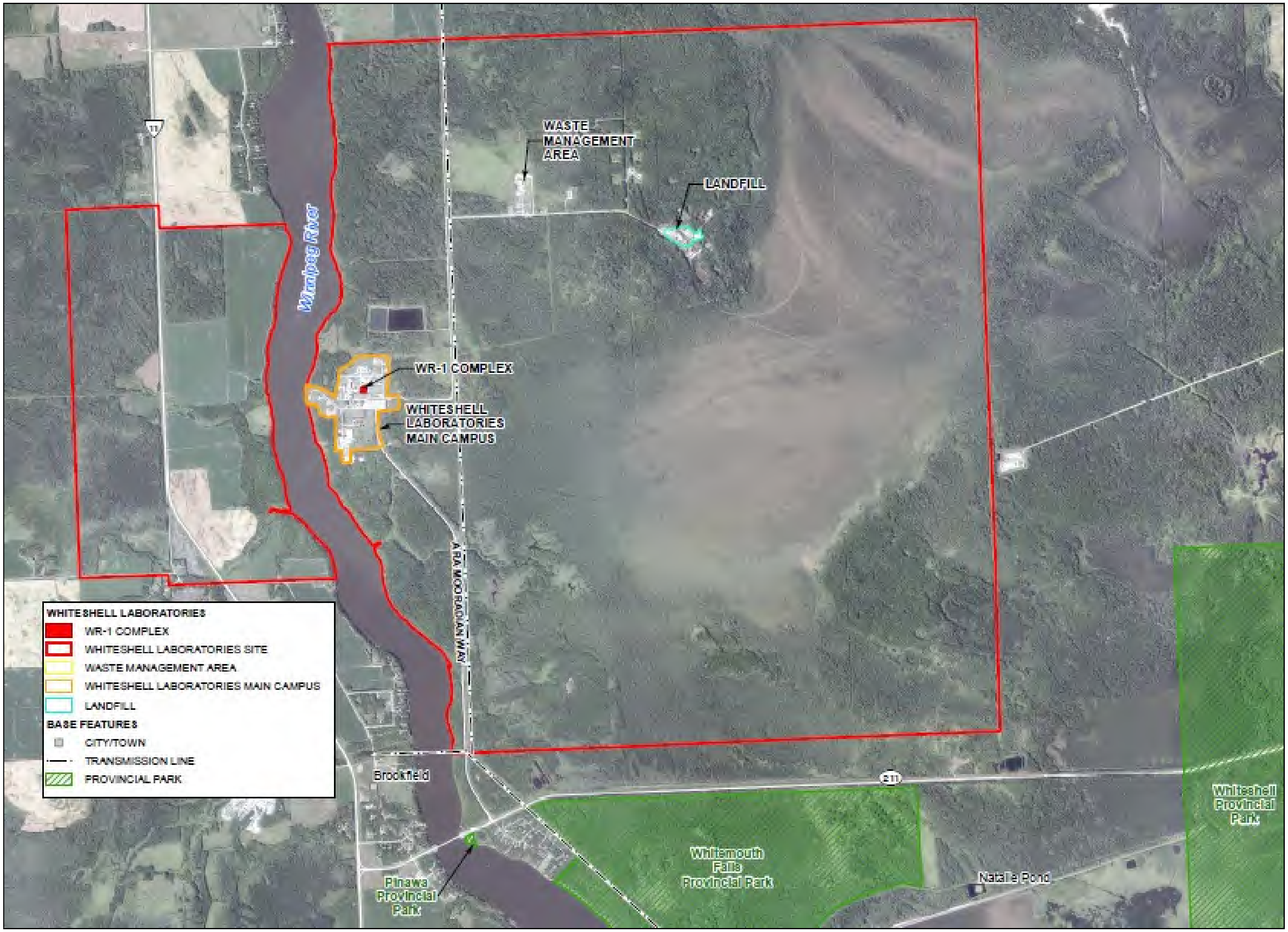


Figure 1.2: Aerial view of the WL site, including WMA, Inactive Landfill, Lagoon, and Main Campus relative to the Winnipeg River (figure adapted from WR-1 EIS figure 1.0-2) [40]



The following is a description of the buildings and infrastructure that were originally located on the WL site along with their purpose [41]:

- **Active Liquid Waste Treatment Center (ALWTC), Building (B) 200**: Historically used for receiving low-level liquid waste effluent (transferred from WR-1, Research laboratories in B300, and laundry / decontamination via underground piping), as well as processing and solidification of medium-level liquid waste (concentrating waste steam originating from the Shielded Facility (SF) building), which was eventually transported to and stored in the Waste Management Area (WMA).
- **Concrete Canister Storage Facility (CCSF)**: Used as part of the Concrete Canister Fuel Storage Program in order to demonstrate dry storage as a feasible alternative to water pool storage for irradiated reactor fuel, and eventually to store remaining used fuel from the WR-1.
- **Decontamination Centre, B411**: Used to provide decontamination services for equipment and tools, including laundry services for radioactively contaminated clothing.
- **Neutron Generator Facility, B300**: Originally located in the Research and Development Complex, this facility was used in the development of methods for the assay of fissile and fertile materials in reactor fuels and components, and eventually fast neutron activation analysis.
- **Sewage Lagoon**[1]: The Lagoon is comprised of a primary settling pond and a secondary pond (connected via a culvert), an outlet and a sewage lift station (B907), constructed of low permeability clay embankments placed on a prepared clay surface. The Lagoon was historically used to receive liquid wastes from lavatories, showers and non-active drains. It is located just north of the main laboratory site.
- **Shielded Facility (SF), B300**: Also located in the Research and Development Complex and comprised of the Hot Cells facility, the SF was used to provide shielded, remote handling facilities in support of the CANDU Reactor Safety research programs and other activities involving radioactive materials. The Immobilized Fuel Test Facilities were used for experiments involving radioactive materials, in support of the Canadian Nuclear Fuel Waste Management and CANDU Reactor Safety research programs.
- **Van de Graff Accelerator Facility, B300 (four rooms)**: This facility housed the accelerator, a target room and a control room. The Van de Graff Accelerator operated from 1970 to 1997.
- **Waste Management Area (WMA)**: Used for storage of low level radioactive wastes (LLW) and intermediate radioactive wastes (ILW), irradiated fuel waste, high level wastes (HLW), and other hazardous chemicals, the WMA includes a variety of buildings, unlined earth trenches, in-ground concrete bunkers and other storage bunkers, concrete stand pipes, and amine storage tanks (see figure 3.3 in section 3.2.4).

[1] Referred to henceforth as the Lagoon.

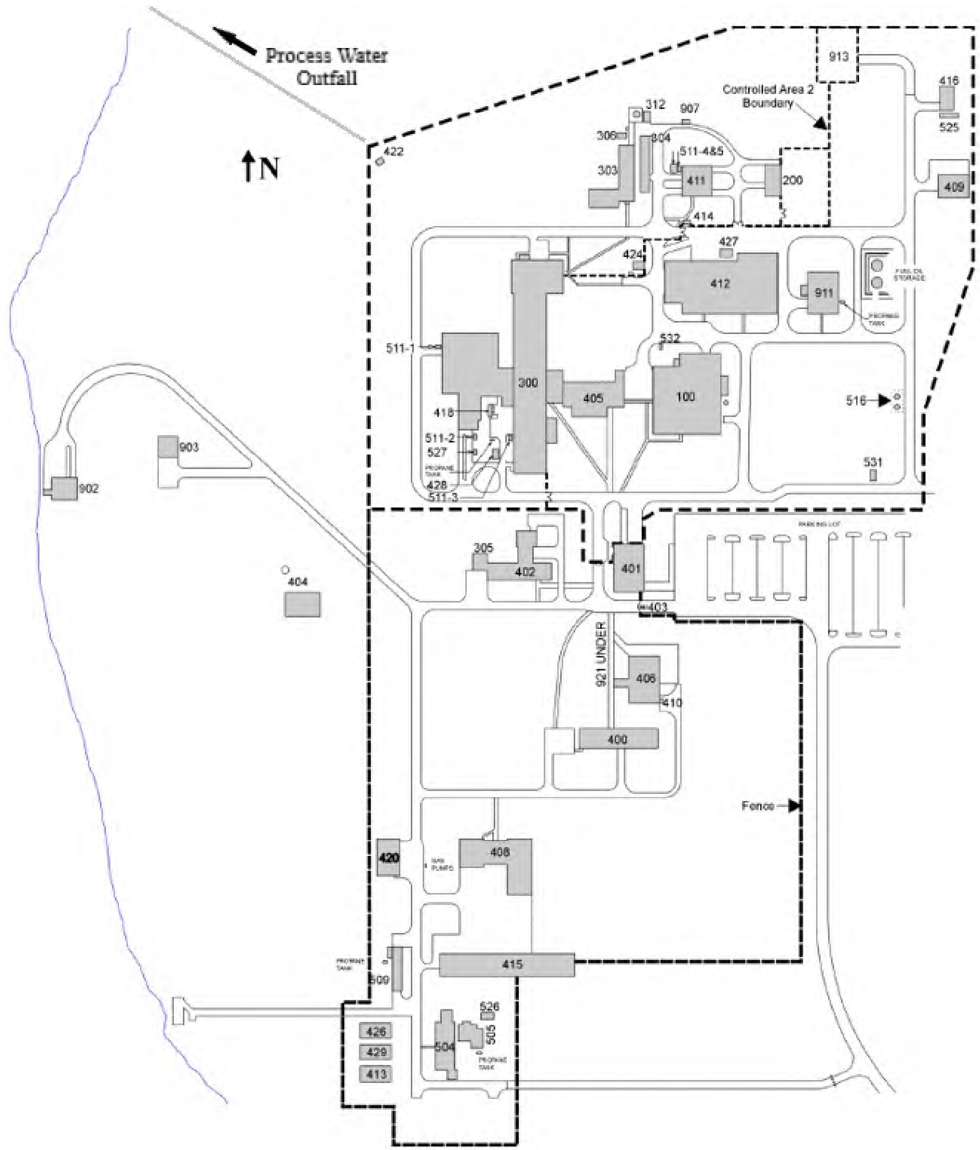
- **Whiteshell Reactor #1 (WR-1), B100**: Used from 1965 to 1985 to demonstrate the organic-cooled reactor concept, using heavy water as the moderator. The facility was also used for engineering tests on fuels, fuel channels and reactor coolants. After shutdown in 1985, the reactor was defueled and placed in a safe, secure, shutdown state. The irradiated fuel from WR-1 is currently stored in the CCSF.

The WL site has one main continuous liquid effluent discharge point into the Winnipeg River, the Process Water Outfall[2], located about 8 meters offshore on east side of the river.

See figure 1.3 for the original WL site layout and location of the Process Outfall. Detail on the progress of the decommissioning activities related to the buildings and infrastructure at the WL site can be found in section 1.2.3.

[2] Referred to henceforth as the Process Outfall.

Figure 1.3: Original WL site layout (Provided by CNL)



100	Reactor Operations
200	Active Liquid Treatment Center
300	Research and Development
303	Gas Dynamics Research Laboratories
304	Gas Dynamics Research Laboratories
305	Accelerator Application Research Facility
306	Gas Dynamics Equipment Storage
307	Diffusion Flame Facility
312	Steam Generator Storage
400	Engineering and Administration
401	Security and Reception
402	Health and Safety
403	Vehicle Gate House
404	Meteorological Tower
405	Technical Information Center
406	Cafeteria
408	Material handling
409	Active Area Stores
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412	Machine Shop and Maintenance
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907	Sewage Lift Station and Lagoons
911	Power House
913	Main Substation
921	Pedestrian Links Between Buildings

1.2.2 Project Overview

As described in CMD 19-H4, following AECL's 1997 decision to discontinue operations and close the WL site, an initial strategy for decommissioning was developed [41]. The proposed strategy included the following stages:

- ***Decontamination and clean up*:** Bringing nuclear and radioisotope buildings and facilities into a safe, secure, interim end state and completely decommissioning the Van de Graaf Accelerator and Neutron Generator.
- ***Storage-with-Surveillance:*** Conducting monitoring and surveillance of remaining buildings and facilities, placing most waste management facilities in the WMA into a passive control state, as well as establishing interim processing, handling and storage facilities (required for monitoring, surveillance and decommissioning project activities).
- ***Final decommissioning*:** Completely decommissioning the WL site to the final end state. During this stage, infrastructure refurbishment and rebuilding were expected to be required, in order to maintain the facilities under monitoring and surveillance.

This strategy explained that a safety case for the *in situ* disposal of 21 LLW trenches in the WMA and river sediments downstream of the Process Outfall would be provided to, and assessed by the CNSC at a future date [34][41]. These activities were also expected to be followed by a 200 year period of institutional control, during which performance of any *in situ* disposal components would be monitored and controlled by CNL, with regulatory oversight by the CNSC [41 to 42].

In April of 2002, AECL submitted an application to the CNSC to replace their existing NRTEOL with a six–year decommissioning licence, in order to begin implementing their proposed decommissioning strategy. In a two-part public hearing, held on September 12th and November 14th of the same year, the Commission considered submissions from intervenors, CNSC staff and AECL, including the *Whiteshell Laboratories Decommissioning Project Comprehensive Study Report* [41] which was produced in accordance with the EA requirements under the *Canadian Environmental Assessment Act, 1992* (CEAA 1992) (see section 2.2 for more information on this EA). The Commission accepted CNSC staff recommendations and concluded that the approved activities to be carried out under the initial licence would result in the safe shutdown of facilities and gathering of information necessary for the planning, preparation and assessment of future decommissioning activities. In 2003, the Commission granted a decommissioning licence (NRTEDL) that was valid until December 31, 2008 [43].

In April of 2008, AECL submitted an application to renew this decommissioning licence for a 10 year licence period, in order to complete ongoing decommissioning activities, based on an accelerated schedule. Although the original decommissioning plan had not been fundamentally altered, deferment periods[3] had been eliminated wherever possible, allowing AECL to reduce the number of years for storage-with-surveillance activities [44]. In a public hearing held on November 5th of the same year, the Commission renewed the WL site NRTEDL from January 1, 2009 until December 31, 2018 [45].

[3] A period of monitoring and surveillance when no significant decommissioning work is in progress.

Following the restructuring of AECL in 2014, several administrative changes were made to the NRTEDL. In November 2014, the licence was transferred to CNL from AECL. In January 2016, the address of the facility was changed, and a new licence in the updated licence format and a Licence Condition Handbook (LCH) were issued to CNL. No changes to authorized activities were introduced in the updated licence or LCH [46].

On May 16, 2016, the CNSC received a Project Description from CNL proposing an alternative strategy (*in situ*) to decommissioning the WR-1 reactor, to the existing decommissioning strategy of dismantlement. The CNSC determined that the proposed project to *in situ* decommission the WR-1 reactor would require a federal EA, pursuant to *Canadian Environmental Assessment Act, 2012* (CEAA 2012). The official public record of this EA process can found on the Canadian Environmental Assessment Registry website (reference no: 80124). The regulatory review process for the proposed *in situ* strategy under the CEAA 2012 and the NSCA are still underway. The proposed *in situ* strategy for the WR-1 project is thus out of scope from this licence renewal.

Given that more time is needed by CNL to address public, Indigenous and federal comments in the ongoing EA for the proposed *in situ* WR-1 reactor and the need to continue approved decommissioning activities for the site, on March 13, 2018 CNL submitted a request for a one year licence renewal. This request included no changes to the existing activities or licence conditions, and was approved by the Commission on August 1, 2018. The licence was extended until December 31, 2019 [47].

According to the accelerated project plan, CNL plans to have the entire WL site decommissioned to its final end-state within the requested 10 year licence period. Furthermore, in addition to the ongoing EA and associated documents related to the proposed *in situ* strategy for the WR-1, CNL intend to develop and present a safety case to CNSC staff, in order to gain authorization for *in situ* disposal of 21 underground LLW trenches. The concept for *in situ* disposal of these trenches was included under the decommissioning licence in 2003 by the Commission, but the safety case must still be approved. This is expected to be completed and submitted to the CNSC over the next licencing period [34].

1.2.3 Decommissioning Progress

Since the granting of the initial decommissioning licence in 2003, many planned activities have been completed. Table 1.1 provides a summary of decommissioning activities to date [1][14][34][35][44].

Table 1.1: Decommissioning activities completed to date

Facility	Activities and components completed	Completed
Active Liquid Waste Treatment Center (B200)	• Cementation of Active Liquid Wastes from historical fuel reprocessing experiments completed • Building shut down, operationally cleaned up and final decommissioning commenced	Previous licence period
Concrete Canister Storage Facility (CCFS)	• No activities - continued operations, in support of decommissioning	-

Facility	Activities and components completed	Completed
Decontamination Center (B411)	• Relocation and reconfiguration of laundry and decontamination services • Building decommissioned and demolished • Building debris packaged and transported off site	Previous licence period
Neutron Generator	• Dismantled and removed	Prior to 2005
Sewage Lagoon	• No activities. Continued operations, in support of decommissioning	-
Shielded Facilities (SF) (B300) and other Main Campus nuclear facilities	• Decommissioning and demolition of hot cell 12 (hot cells 6-11 share ventilation with cells 1-5) and storage blocks dismantled and sealed • Decommissioning and demolition of SF warm cells 14 to 18	Between 2005 and 2007
Shielded Facilities (SF) (B300) and other Main Campus nuclear facilities	• Decommissioning and demolition of radioisotope laboratories (including main radioisotope Research and Development complex) • Thermal Hydraulics Test Facility shut down and clean up commenced	Previous Licence period
Van de Graff Accelerator	• Dismantled and removed	Prior to 2005
Waste Management Area	• Shielded Modular Above-Ground Storage (SMAGs) building constructed and brought to operational status, in order to enable future decommissioning plans • Contaminated Soil Storage Facility constructed	Previous Licence period
Waste Management Area	• Remaining Experimental Cesium Pond soil waste excavated, packaged and transported offsite	Between 2017 and 2018
WR-1 Building (B100)	• Remaining unirradiated WR-1 fuel material removed from the WL site • Planning and design activities for later activities	Previous Licence period
Other site activities	• Central oil-fired heating system shut down and transition of building heating to electric/propane; related fuel storage tanks also removed • Final decommissioning of SLOWPOKE Demonstration Reactor completed - all major components were removed • Shutdown and demolishment of various non-nuclear buildings	Previous Licence period

CNSC staff regularly report on the performance of licensees to the Commission. In 2012, an update was provided on the status of the decommissioning progress [48] at the WL site, as well as in 2014 [49] and 2016 [50]. In 2018, the WL site was included in the 2017 *CNL Progress Update for CNL's Prototype Waste Facilities, Whiteshell Laboratories and Port Hope Area Initiative* (CMD 18-M30) [51]. As noted in these updates, CNL has planned, implemented and completed decommissioning activities in accordance with CNSC approved decommissioning plans, and CNSC staff have been satisfied with the overall performance.

The planned activities for the requested 10 year licence period are outlined in table 1.2.

Table 1.2: Remaining facilities to be decommissioned and related activities

Facility to be decommissioned	Proposed activities and components
Active Liquid Waste Treatment Center (B200)	• Decommissioning of remaining ALWTC equipment (in progress), and demolition of the building
Concrete Canister Storage Facility (CCFS)	• Complete defueling and decommissioning/demolition of the CCSF and the Demonstration Canister Storage Site and remediation of the area • Retrieval of fuel baskets from canisters, transfer to a certified shipping container for transport to CRL for storage • Decontamination of empty canisters with radioactive contamination as needed, and demolishment
Sewage Lagoon	• Options for decommissioning the Lagoon are currently being evaluated, and an Environmental and Human Health Risk Assessment is underway
Shielded Facilities (B300) and other Main Campus nuclear facilities	• Decommissioning of remaining Hot Cells and associated active exhaust ducting, active drain systems, and radioisotope laboratories (maintained to support future decommissioning activities) • Decommissioning of remaining facilities and systems in B300 and demolition of buildings, once operations have ceased
Waste Management Area	• Deactivation, demolishment and/or remediation of all buildings, structures, and grounds within the WL site WMA (with the exception of 21 LLW trenches – See figure 1.4) • Retrieval, characterization and re-packaging of LLW, ILW, and HLW from underground trenches and waste bunkers (as necessary), for shipment to a suitable licensed storage/disposal facility
WR-1 Building (B100)	• Complete remediation and removal of the building • All activated and contaminated components removed, packaged and dispositioned at off-site facilities • Facility structure decontaminated and demolished
Other site activities	• Decommissioning and demolition of all remaining non-nuclear buildings and support infrastructure (e.g., administrative offices, non-active laboratories, workshops, storage buildings, vehicle garages, shipping and receiving areas)

2.0 REGULATORY OVERSIGHT

The CNSC regulates nuclear facilities and activities in Canada to protect the environment and the health and safety of persons in a manner that is consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations. The CNSC assesses the environmental effects of nuclear facilities and activities at every phase of their lifecycle. This section of the EPR Report discusses the CNSC's regulatory oversight of environmental protection (EP) measures at the WL site.

To meet CNSC's regulatory requirements, CNL is responsible for implementing and maintaining EP measures that identify, control and (where necessary) monitor all releases of radiological and hazardous substances and effects on human health and the environment, from the WL site. These EP measures must comply with, or have implementation plans in place to comply with, the regulatory requirements included in the WL decommissioning licence. The regulatory requirements for the WL site can be found throughout the Regulatory Oversight section.

2.1 Environmental Protection Reviews and Assessments

Under the NSCA, an assessment of the environment is part of the ongoing lifecycle EP framework, whereby EPR Reports such as this one, are produced. No decision is made on the EPR itself, as the information is intended to inform and support the regulatory decision being sought from the Commission by the licensing matter explained in the body of the staff CMD 19-H4.

Depending on the scope and impact of project activities, legislation such as the CEAA 2012 and the former CEAA 1992 may require the completion of an EA [52]. The purpose of an EA is to identify the possible environmental effects of a proposed project, and determine whether these effects can be adequately mitigated to protect the environment and heath of persons. A positive EA decision, by the commission, concluding no significant adverse effects is required before a licence can be granted.

The following section provides information on the Comprehensive Study EA [53] completed under the former CEAA 1992, as well as information regarding elements of the EA FUP. The EA FUP verifies the accuracy of the predictions of the EA and the effectiveness of the mitigation measures. The CNSC ensures that EA FUPs within the CNSC's mandate are incorporated into the licensing process.

2.1.1 Comprehensive Study EA under CEAA 1992

Under the former CEAA 1992 [52], an EA was conducted for the currently licensed decommissioning activities at the WL site. In 1999, AECL began to prepare plans for decommissioning of the facilities located on the WL site, and as described in section 1.2, later applied to the CNSC for a decommissioning licence. Under CEAA 1992, the CNSC determined that a Comprehensive Study EA was required. This EA was carried out by the CNSC and the Department of Fisheries and Oceans Canada (DFO), who were designated as Responsible Authorities (RAs) under this former Act.

A document outlining the scope of the project and assessment was issued by the CNSC in December 1999, following consultation with the public and other federal and provincial government departments. In 2001, the *Whiteshell Laboratories Decommissioning Project Comprehensive Study Report* (CSR) [41] was produced by AECL, in accordance with the requirements of the EA process.

Following CNSC and DFO staff findings that all of the CEAA 1992 requirements had been adequately fulfilled, in 2002 the Minister of the Environment agreed that the project was not likely to cause significant adverse environmental effects, taking into account the implementation of mitigation measures [554]. CNSC rendered a licensing decision in December 2002, and the decommissioning licence was granted [43].

The EA process identified the need for an EA FUP [4] designed to validate the predicted environmental effects and effectiveness of the mitigation measures. Further details of this are provided in section 2.1.2.

2.1.2 EA Follow-Up Program

In May 2002, CNL submitted a draft EA FUP for the WL site, to the CNSC and DFO. Following incorporation of feedback from both RAs, the program was finalized in June 2002. AECL has submitted Annual Progress Reports on the EA FUP since the 2002 approval of the EA FUP, and CNL continues to meet this commitment.

The objectives of the EA FUP are as follows [4]:

- verify the accuracy of the EA
- determine the effectiveness of any mitigation measures that have been implemented
- optimize the monitoring and surveillance program at the WL site
- confirm that appropriate mitigation measures are implemented
- develop appropriate responses to unforeseen events
- identify effects of the project that may not have been predicted

Achievement of these objectives continues to be accomplished using monitoring, surveillance and inspection activities, which are supported by planning, data collection, analysis, evaluation and reporting. The program is structured around nine themes of work, referred to as Work Packages. These Work Packages are shown in table 2.1, along with the associated Work Tasks and overall status.

Table 2.1: Environmental assessment Follow-Up Program elements and status [4][25][55]

#	Work package	Component	Description	Completed activities and status
1	Routine environmental monitoring program (EMP)	Environmental	Establishment of an EMP in order to confirm the CSR EA conclusions, as well as ensure remediation measures are effective throughout all phases.	Monitoring has continued over the entirety of the project life-cycle, and these activities are ongoing. As decommissioning activities continue, this program adapts as needed.
2	Air and meteorology	Environmental	Collection of monitoring data, in order to establish a site baseline, as well as ongoing collection and monitoring of data (during building demolition), in order to ensure effectiveness of mitigation measures, and that environmental effects remain insignificant.	Monitoring stations related to air and meteorology were established, collection of baseline data has been completed, and various buildings have been demolished. The collection of data and monitoring continues.
3	Fitness for service (FFS) of WMA Facilities	Interim Storage and End state Support	An initial assessment of the fitness-for–service of structures where storage would continue during decommissioning activities, including validation of facility integrity and geological/ hydrogeological conditions around facilities.	Various activities have been completed, including: confirmation of structural integrity of buildings, evaluation of potential impact of containment transport from individual storage facilities / areas, establishment of remediation criteria related to containment transport impacts, relative to waste removal to final disposal. CNL continues to evaluate potential impacts of containment transport from storage facilities and areas, as well as remediation requirements and timeframes, where appropriate.
4	Confirmation of hydrogeological conditions at the WMA	Interim Storage and End state Support	Enhanced hydrogeological monitoring in order to evaluate fitness-for–service of interim storage structures, as well as collect detailed information needed in order to develop safety case for *in situ* disposal of LLW trenches.	Detailed planning for enhanced monitoring system completed. Although many activities have been completed, installation and refurbishment of monitoring wells, evaluation and reporting on interim storage environment, as well as monitoring and data collection for the safety analysis to support LLW *in situ* end state are all ongoing.

5	Interim remediation of WMA Facilities	Interim Storage and End state Support	Interim remediation plans for structures and areas of the site where facility life-cycle would not be adequate to manage the wastes.	The following activities are and have been ongoing: recovery of, processing, packaging and provision of enhanced interim storage of irradiated fuel (from standpipes), and other wastes; retrieval of LLW from trenches not suitable for *in situ* disposal (irradiator reactor components in trench #6, soil and waste contaminated by WR-1 waste water in trench #10, arsenic from trench #1 and others).
6	Inactive Landfill Enhanced Monitoring	Interim Storage and End state Support	Enhanced monitoring in order to confirm the integrity of hydrogeological environment, control groundwater impacts and collect data in preparation for site closure.	Detailed planning for enhanced monitoring system completed, along with installation and refurbishment of monitoring wells. Evaluation of interim storage environment, monitoring and data collection, as well as preparation of a closure plan will continue over the decommissioning period.
7	Sewage Lagoons Enhanced Monitoring	Interim Storage and End state Support	Enhanced monitoring in order to confirm compliance of discharges, assess impacts to groundwater and the Winnipeg river, as well as development of a closure plan.	Detailed planning for enhanced monitoring system completed, along with installation and refurbishment of monitoring wells. Monitoring and collection of data, compliance evaluation, assessment of groundwater impacts, as well as preparation of a closure plan are all ongoing.
8	River Sediments Enhanced Monitoring	Interim Storage and End state Support	Enhanced monitoring of river sediments in order to ensure the CSR assessment remains valid, as decommissioning activities continue.	Identification of depositional areas above the hydroelectric dam sites for core sampling completed, agreement signed with DFO and CNSC for target sampling locations, as well as collection and analyzation of Caesium-137, following which a baseline was established. Re-sampling will continue at 20, 40 and 60 year marks (years 2026, 2046 and 2066, respectively), in order to validate CSR conclusions.
9	Establish and maintain project communications mechanisms	Public communication	Interactive public communication activities in order to continue communications with stakeholders, including municipal governments, Indigenous people, other interested parties and members of the public in the WL site region.	Communication contact list was assembled and verified, input was solicited from stakeholders in the contact list, in order to establish formal and informal communication measures and communication processes, based on this feedback. Communications will be ongoing for the remainder of project activities.

CNSC staff continue to review the follow-up activities, in order to ensure that the EA FUP objectives are being met. To date, CNL has continued to implement follow-up activities as required. EA FUP elements associated with the monitoring of emissions and effluents or the receiving environment are incorporated within the environmental management program, as needed.

2.2 Detailed Decommissioning Plan

Decommissioning activities for research and test facilities such as those at the WL site are regulated by the CNSC. The following sub-section provides high level information with respect to the Detailed Decommissioning Plan.

Decommissioning plans document the decommissioning strategy and end-state objectives; the major decontamination, disassembly and remediation steps; the approximate quantities and types of waste generated; an overview of the principal hazards and protection strategies; and an estimate of cost. As a full lifecycle regulator, the CNSC will continue to monitor and remain aware of the end state of the WL site. As decommissioning activities are completed, they are expected to result in a decrease in both radiological and hazardous releases to the environment, as the WL site reaches its eventual end state.

The decommissioning strategy for the WL site is documented in the *Whiteshell Laboratories Detailed Decommissioning Plan: Volume 1 – Program Overview* [3] (along with 11 subsequent volumes).

CNL is planning, implementing and completing decommissioning activities, in accordance with detailed decommissioning plans. Revisions to the program overview are currently underway, and subsequent volumes are developed when so required by CNL. Through analysis of these plans, staff can provide a high level assessment of how the project/environmental interactions will change over time.

Progress on activities at the WL site can be found in section 1.2.2 of this report, and in further detail in the Waste Management SCA of the CMD 19-H4.

2.3 Regulatory Framework

The EP program at the WL site was designed and implemented in accordance with REGDOC 2.9.1-2013, and includes derived release limits (DRLs) (N288.1-08) and public dose modelling. The licensee has also re-evaluated their EP program against the latest version of REGDOC 2.9.1-2017 and the associated CSA standards. Specific implementation dates are shown in table 2.2 below.

Table 2.2: Status of WL site Environmental Protection Measures with respect to implementation of regulatory documents and standards

Regulatory document or standard	Status
CNSC Regulatory Document REGDOC 2.9.1 *Environmental Protection: Policies, Programs and Procedures* (2013) [56]	Implemented
CSA N288.1-08, G*uidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [57]	Implemented
CSA N294-09 (reaffirmed 2014), *Decommissioning of Facilities Containing Nuclear Substances* [58]	Implemented.
CSA N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* [59]	Scheduled: January 1, 2020
CSA N288.5-11, *Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills* [60]	Scheduled: January 1, 2020
CSA N288.6-12, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [61]	Scheduled: January 1, 2020
CSA N288.7-15, *Groundwater protection programs at class I nuclear facilities and uranium mines and mills* [62]	Scheduled January 1, 2020
CSA N288.8-17, *Establishing and implementing action levels to control releases to the environment from nuclear facilities* [63]	Scheduled: January 1, 2020
CNSC Regulatory Document REGDOC 2.9.1, *Environmental Principles, Assessments and Protection Measures, version 1.1* (2017) [64]	Scheduled: January 1, 2020

CNSC staff confirm that CNL has either implemented programs in accordance with the relevant EP regulatory documents or standards, or has implementation plans in place [34]. CNL has committed to a schedule such that their programs will be designed and implemented, in accordance with REGDOC-2.9.1-2017 [64] and the full range of associated CSA standards within the initial year of relicensing (i.e., January 1, 2020).

In addition to requiring the evaluation of programs against regulatory documents and standards and the submission of these programs to the CNSC, licensees are also required to regularly report on the results of these programs. Reporting requirements are specified within the *Radiation Protection Regulations* [65] (public dose), the licensees accepted programs or as specified within the LCH.

CNL is required to submit Annual Compliance Monitoring Reports, including an environmental monitoring report that details the results of the environmental protection measures related to the decommissioning of the WL site. These annual reports and any associated special studies are reviewed by CNSC staff for compliance and verification as well as trending. The 2018 annual report summary is available on CNL's website [66].

As noted in section 1.2.3 of this EPR Report, CNSC staff provided updates to the Commission on the status of the decommissioning progress at the WL site, which included reports on the performance of activities conducted at CNL sites, in 2012 [48], 2014 [49], 2016 [50] and in 2018 [51]. Furthermore, Regulatory Oversight Reports (ROR) are the CNSC's standard mechanism for updating the Commission on the operation and regulatory performance of licensed facilities. A ROR addressing CNL operated facilities in Canada, including the WL site, will be reported to the Commission in November of 2019.

2.3.1 Environmental Protection Measures

To meet CNSC's regulatory requirements under REGDOC-2.9.1 [56][64], CNL is responsible for implementing and maintaining EP measures that identify, control and monitor releases of radioactive and hazardous substances and effects on human health and the environment, from the WL site. EP measures are an important component of the overall requirement for licensees to make adequate provision for protection of the environment.

This and the following sub-sections provide a brief summary of the WL site EP framework and the status of each specific EP measure, relative to the latest regulatory document or CSA standard. Section 3.0 of this EPR Report summarizes the results of these programs/measures against relevant regulatory limits, environmental quality objectives/guidelines and discusses any trends of interest.

CNL was required to update the Environmental Protection Program (EnvP) during the previous licence period, in order to conform to REGDOC-2.9.1-2013 [56]. The program includes the following elements:

- Environmental Management System (EMS)
- Effluent Emissions Control and Monitoring:
    - derivation of Derived Release Limits (DRLs) in accordance with CSA N288.1-08
    - Effluent Verification Monitoring Program (EVMP)
- Receiving Environment Monitoring Program:
    - Environmental Monitoring Program (EMP)
    - Groundwater Monitoring Program (GWMP)
- EA FUP (section 2.2)

Further details on these programs can be found in the following sub-sections.

2.3.2 Environmental Management System

An EMS refers to the management of an organization's environmental policies, programs and procedures in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection. The EMS serves as a management tool for integrating all of a licensees EP measures in a documented, managed and auditable process by:

- identifying and managing non-compliances and corrective actions within the activities, through internal and external inspections and audits
- summarizing and reporting the performance of these activities both internally (licensee management) and externally (Commission and public)
- training of personnel involved in these activities
- ensuring the availability of resources (i.e., qualified personnel, organizational infrastructure, technology and financial resources)
- defining and delegating roles, responsibilities and authorities essential to effective management

CNL has established and implemented an EMS for the WL site in accordance with REGOC-2.9.1-2013 [56]. The WL site has an EMS that has been registered to CAN/ISO 14001-2004 *Environmental Management Systems – Requirements with Guidance for Use* [67] since 2010. In 2018, the WL site EMS was recertified to ISO 14001-2015 [68]. CNSC staff have concluded that CNL has developed and implemented an EMS program at the WL site in compliance with CNSC regulatory requirements.

2.3.3 Environmental Risk Assessment

An environmental risk assessment (ERA) of nuclear facilities is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment on human and other biological receptors, including the magnitude and extent of the potential effects associated with a facility. The ERA serves as the basis for the development of site-specific effluent and EMPs. These programs in turn inform and refine future revisions of the ERA.

As required by REGDOC-2.9.1-2013 [56], the 2001 CSR was used to inform the WL site EP measures for the previous licencing period. For the proposed licence period, CNL will be updating their EP measures in order to meet the requirements of REGDOC-2.9.1-2017 [64], which requires the establishment and maintenance of a site wide ERA, in accordance with CSA N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [61].

ERAs for the Lagoon and WMA are currently underway [35] in order to support future CNL decision-making related to site activities, and will be provided within the upcoming licence period. These will be followed by a site-wide ERA, prior to the January 2020 implementation date as outlined in table 2.2. The outcomes of these ERAs will help inform the updating of EP measures as needed and will be reported on through the Regulatory Oversight Report for CNL sites.

2.3.4 Effluent and Emissions Control and Monitoring

Controls on environmental releases are established in order to provide protection to the environment, as well as respect the principles of sustainable development and pollution prevention. The effluent and emissions prevention and control measures are established on the basis of industry best practice, the application of principles of optimization (e.g., in design) and as low as reasonably achievable (ALARA) principles, respect of legislated limits and results of an ERA (or in this case, the CSR produced under CEAA 1992 [41]).

The WL LCH contains site-specific DRLs [69] and Action Levels (ALs) [70], in order to control radiological effluents and emissions. The DRLs have been calculated using CSA N288.1-08, a radionuclide transport and exposure model that can be used to back-calculate release rates based on limiting exposure to a specified member of the public (representative person) to a dose less than the 1 mSv per year, the regulatory dose limit (as prescribed within the *Radiation Protection Regulations* [65]). The ALs in place at the WL site are set at a fraction of the DRL, in order to serve as an early warning of potential loss of control.

The most recent DRLs were provided for the WL site in 2016 [69], developed in accordance with CSA N288.1-08. In January 2020, CNL plans to transition to new ALs, with the implementation of CSA N288.8-17, scheduled for January 2020. These new ALs will be derived from actual operating expectations and performance, in accordance with CSA N288.8. This will likely result in significantly lower ALs than those currently in use.

CNL has established an Effluent Verification Monitoring Plan [71] at the WL site, which is in compliance with REGDOC-2.9.1-2013 [56]. CNL has indicated that it will be revised to address the additional requirements and guidance associated with REGDOC 2.9.1-2017 [64] and CSA Standard N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills* [60].

Based on review and assessment of the EVMP results presented in CNL's reports, CNSC staff conclude that the EVMP currently in place for the WL site continues to protect the public and the environment.

2.3.5 Environmental Monitoring Program

CNSC requires licensees to design and implement an EMP specific to the monitoring and assessment requirements associated with their facility, and the environment within which the facility is situated. The program is required to:

- measure contaminants in surrounding environmental media of the facility or site
- determine the effects if any on the of the site or facility operation on people and the environment
- serve as a secondary support to the EVMP to demonstrate the effectiveness of emission controls and the adequacy of effluent monitoring

More specifically, the program must obtain the environmental data necessary for the calculation of public dose, in order to demonstrate compliance with the public dose limit (1 mSv per year). The program design must also address the potential environmental interactions identified at the site (as identified in the CSR produced under CEAA 1992 [41]). The major focus at the WL site is on radiation and radionuclides, though hazardous substances are included within monitoring activities associated with the sewage lagoons and site groundwater. Section 3.0 of this EPR Report provides a summary of the results of site monitoring activities and an evaluation of the current state of the environment at the WL site, including dose to the public.

CNSC staff confirm that for the previous licence period, CNL conducted their EMP as per their current licensing basis, and were in compliance with REGDOC-2.9.1-2013 [56].

2.4 Greenhouse Gas Emissions

A core element of the CNSC requirement for an EMS is the identification of all regulatory requirements applicable to the facility whether under the NSCA or other federal or provincial legislation. The EMS must ensure that programs are in place to respect these requirements.

While there are a range of broadly applicable federal environmental regulations (e.g., petroleum products storage tanks, environmental emergency regulations), the management of GHG emissions has been identified as a national priority.

Under the federal *Canadian Environmental Protection Act, 1999* (CEPA, 1999) [72], CNL is required to monitor and report on GHG emissions [73]. Since 2013, nuclear facilities that emit more than the 50,000 tons of CO_2 equivalent (CO_2e) emission reporting threshold on an annual basis must report their GHG emissions. The WL site has been well below all GHG emission thresholds since 2013; however, CNL continues to report GHG emissions from the site in their Annual Compliance Monitoring Report. Information on GHG emissions at the WL site can be found in section 3.1.1.2.

The CNSC maintains a collaborative working relationship with Environment and Climate Change Canada through a formal Memorandum of Understanding. This ensures a coordinated regulatory approach is achieved with respect to meeting all federal requirements associated with environmental protection.

3.0 STATUS OF THE ENVIRONMENT

The following sections of this EPR Report include summaries of project-environment interactions that were assessed by CNSC staff and deemed to be of specific public, Indigenous and/or regulatory interest including atmospheric, aquatic, terrestrial and hydrogeological environments and human health, for the licence application by CNL to renew the WL site licence.

It should be noted that environmental components are regularly reviewed through annual reporting requirements and CNSC compliance verification activities, as detailed in other areas of this report. These are reported to the Commission in the environmental protection safety and control areas of licensing Commission Member Documents and RORs.

This section provides a summary of the status of the environment around the WL site. It first includes a description of the radiological and hazardous releases to the environment (section 3.2), followed by an assessment of any potential effects to human health and the environment, as a result of exposure to these contaminants (section 3.3). Further, sub-sections of section 3.3 provide general descriptions of the environment itself, at and around the WL site.

3.1 Releases to the Environment

3.1.1 Airborne Releases

3.1.1.1 Radiological Emissions

As part of the WL site EVMP, releases to the atmosphere are continuously monitored throughout the year. The main sources of radiological emissions at the site are from the WR-1 Building (B100) stack, the ALWTC (B200) roof vent, and the Hot Cells Facility and Immobilized Fuel Facility (B300) roof vent. For each of these facilities, radiological emissions are measured for gross alpha and gross beta. Additionally, tritium releases from the reactor building as a result of continuous airflow purging of the moderator system are also routinely collected and analyzed.

Table 3.1 provides annual release of radionuclides to the atmosphere for the licence period of 2009 to 2018, compared against DRLs developed by CNL and accepted by CNSC to ensure releases to the environment will not exceed the annual regulatory public dose limit of 1 mSv per year, which is recognized to be protective of human health. As shown in table 3.1, the radiological emissions from the WL site remain at a very small fraction of the DRLs.

Table 3.1: Annual radionuclide airborne releases from the WL site compared with applicable release limits (2009 – 2018) [5 to 14]

Emission	Tritium (Bq/yr)	Gross beta particulates (Caesium-137) (Bq/yr)	Gross alpha particulates (Pu-239) (Bq/yr)
DRL *(2009-2015)**	3.97E+16	6.19E+11	3.95E+16
2009	2.08E+10	6.24E+05	1.09E+05
2010	2.86E+10	7.80E+05	1.04E+05
2011	3.12E+10	3.38E+05	1.14E+05
2012	1.87E+11	4.06E+05	1.04E+05
2013	3.48E+10	3.95E+05	8.84E+04
2014	3.48E+10	3.95E+05	8.84E+04
2015	9.88E+10	2.29E+05	9.88E+04
DRL *(2016-2018)*	8.58E+15	3.60E+11	9.00E+10
2016	3.24E+10	2.12E+05	9.46E+04
2017	5.04E+10	2.24E+05	9.36E+04
2018	1.30E+10	1.70E+05	9.36E+04

*As described in section 2.3.4, DRLs ensure emissions do not exceed the public dose limit of 1 mSv per year.

3.1.1.2 Hazardous Emissions

The main sources of non-radiological emissions at the WL site are from the use of Number 2 fuel oil for heating, diesel fuel for site generators, and dust generation from sandblasting, excavation projects and vehicle traffic on site. It should be noted that in 2013, Number 2 fuel oil was replaced with propane. These sources release small quantities of carbon monoxide, nitrogen oxides, sulphur dioxide, hydrocarbons, and particulate matter. These substances are monitored for trending and continuous improvement purposes and are reportable to the National Pollutant Release Inventory (NPRI) if reporting thresholds are exceeded [74]. Table 3.2 provides the total annual hazardous emissions from the WL site and the NPRI reporting thresholds.

Table 3.2: Total annual hazardous emissions from the WL site (2009 to 2018) [15 to 24]

Parameter (Mg/year)	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	NPRI reporting threshold (Mg/year) [75]
Nitrogen oxides (NOx as NO_2)	9.06	7.86	7.24	6.20	3.65	1.03	1.04	0.91	0.75	0.54	20
Sulphur dioxide (SO_2)	2.67	2.32	2.14	1.66	0.89	0.02	0.03	0.02	0.02	0.01	20
Carbon monoxide (CO)	1.89	1.64	1.51	1.30	0.88	0.47	0.46	0.40	0.35	0.23	20
Total particulate matter ($PM_{10\ \&\ 2.5}$)	0.75	0.65	0.6	39.69*	42.51*	19.57	16.36	15.02	13.65	14.56	20
PM_{10}	0.38	0.33	0.30	10.26*	10.92*	5.01*	4.20*	3.85*	3.50*	3.72*	0.5
$PM_{2.5}$	0.09	0.08	0.07	1.11*	1.14*	0.53*	0.54*	0.41*	0.38*	0.39*	0.3
Volatile organic compounds	0.08	0.07	0.06	0.11	0.08	0.08	0.08	0.07	0.06	0.04	10

* As TPM, PM10 and PM2.5 were over the threshold, these were reported to NPRI. Increases in these parameters are a result of increased road dust from gravel roads and periods of dry weather.

GHG emissions from the WL site consist primarily of carbon dioxide, methane and nitrous oxides as a result of burning propane, use of diesel generators, on-site transportation, on-site landfill, and open-pit wood burning. They are measured in CO_2e tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP). Eliminating the use of Number 2 fuel for heating in 2013 reduced the average GHG emissions by 43%.

Hazardous emissions to air are reduced as decommissioning activities continue and demolished buildings no longer require heating (table 3.3). This decline is expected to continue with ongoing decommissioning activities. During the previous licence period, GHG releases remained below the reporting requirement of 10,000 CO_2e tonnes/a [76].

Table 3.3: Total estimated annual greenhouse gas emissions from the WL site (2009-2018) [15 to 24]

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Greenhouse Gas (CO_2e tonnes/a)*	8,596	7,463	8,056	6,310	4,260	1,940	1,957	1,883	1,873	1,678

* CO_2e tonnes: A unit of measure used to compare between GHGs with different GWPs. For example, the GWP for methane is 25. This means that emissions of one metric ton of methane are equivalent to emissions of 25 metric tons of CO_2. In 2013, the GWP for methane and nitrous oxide were changed from 21 to 25 and 310 to 298 respectively under the *CEPA, 1999* Notice with Respect to Reporting of GHGs for 2013.

3.1.1.3 Conclusions

Based on CNSC staff's review of the results of CNL's EVMP, CNSC staff conclude that CNL's reported releases of nuclear substances to the atmospheric environment from the WL site have remained below CNSC approved DRLs for air emissions during the current licensing period. Additionally, CNL continues to monitor and report on hazardous substances released to the atmosphere, including the monitoring of GHG emissions. CNL continues to provide adequate protection of people and the environment from atmospheric releases.

3.1.2 Waterborne Releases

As part of the WL site EVMP, releases of radiological and hazardous contaminants to surface water are monitored on a weekly basis throughout the year. The main sources of effluent releases at the WL site are from the Process Outfall and the Lagoon. The Outfall effluent is composed of stormwater runoff from paved roadways around buildings, cooling water used in process and experimental facilities, and holding tank discharges including those from the ALWTC. The discharge locations are shown in figure 3.1.

Figure 3.1: WL site and discharge locations Process Outfall and, Lagoon (modified from figure 11-1 [14])

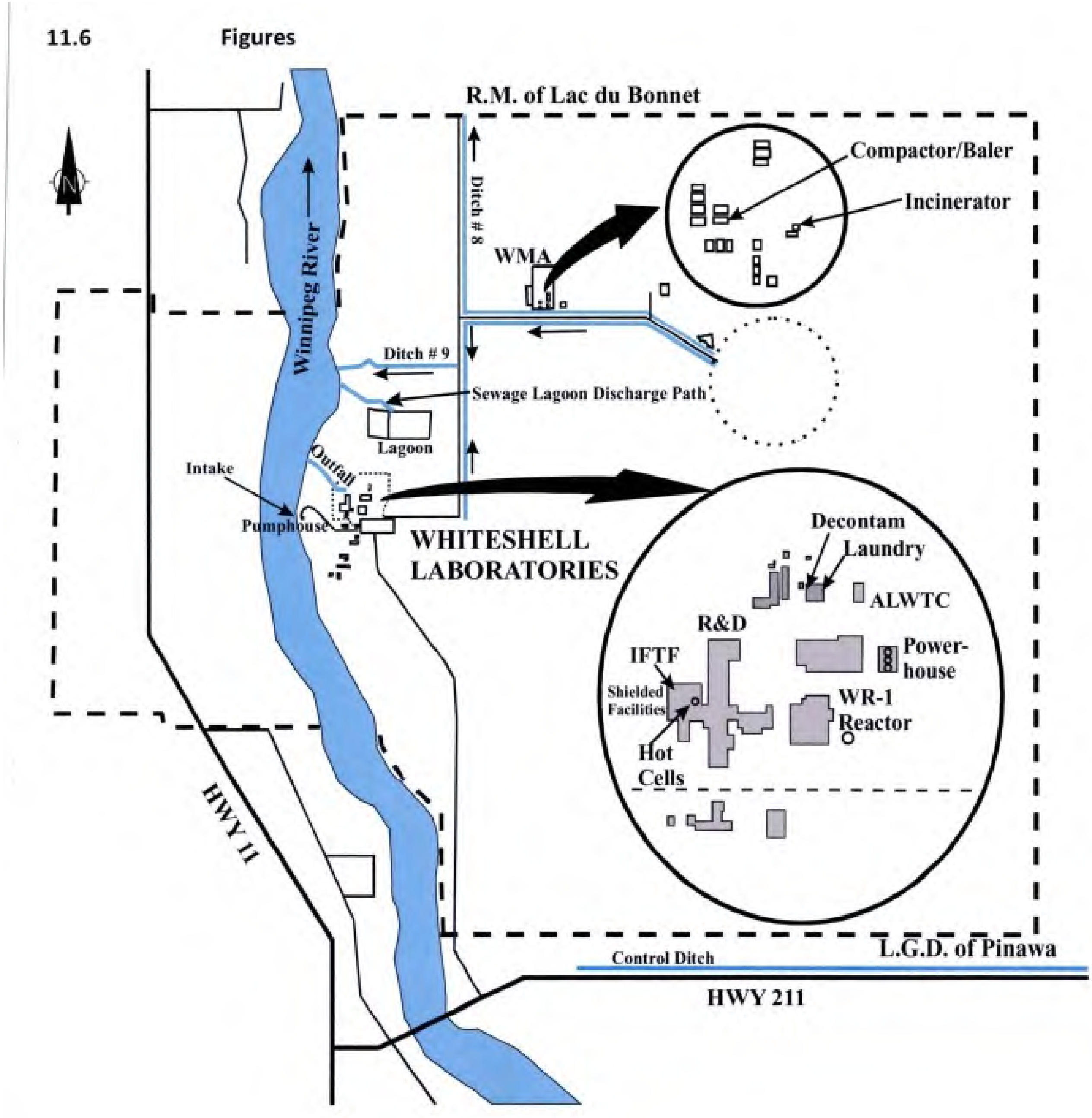


Figure 11-1
Effluent Monitoring Locations

The Lagoon collects and treats prior to discharge, sanitary and wastewater from most buildings on the site, as well as from the laundry facility.

3.1.2.1 Radiological Effluent

Radiological effluent releases are measured for gross alpha and beta, total uranium, plutonium-239/240, americium-241, strontium-90 and caesium-137. Table 3.4 provides the total annual releases of radionuclides to the Winnipeg River for the licence period 2009-2018. The total annual releases are compared against DRLs developed by CNL and accepted by CNSC to ensure releases to the environment will not exceed the annual regulatory public dose limit of 1 mSv per year. As shown in table 3.4, the total annual releases of radionuclides from the WL site remain at a very small fraction of the DRLs.

Table 3.4: Total annual waterborne releases of radionuclides from the Process Outfall and Lagoon at the WL site (2009 – 2018) [15 to 24]

Effluent	Gross Alpha (Bq/yr)	Strontium-90 (Bq/yr)	Caesium-137 (Bq/yr)
DRL *(2009-2015)*	3.36E+12[1]	1.75E+13	2.89E+12
2009	9.84E+07	1.44E+08	1.56E+08
2010	1.13E+08	1.56E+08	1.32E+08
2011	9.60E+07	1.20E+08	9.60E+07
2012	1.08E+08	1.19E+08	9.12E+07
2013	1.14E+08	6.96E+07	6.36E+07
2014	3.48E+07	4.68E+07	4.32E+07
2015	4.08E+07	3.96E+07	1.68E+07
DRL *(2016-2018)*	1.33E+10[2]	1.56E+11	1.39E+11
2016	4.68E+07	6.00E+07	1.44E+07
2017	3.84E+07	6.72E+07	1.92E+07
2018	3.96E+06	3.20E+07	1.51E+07

[1] DRL for gross alpha is that for Am-241, which was identified as the radionuclide with the most restrictive DRL.
[2] DRL for gross alpha is that for Pu-239/Pu-240, which is identified as the radionuclide with the most restrictive DRL.

3.1.2.2 Hazardous Effluent

As with radiological contaminants, the main sources of hazardous substances from liquid effluent at the WL site are from the Process Outfall and the Lagoon. Table 3.5 provides annual monthly average concentrations of hazardous contaminants released from the Process Outfall into the Winnipeg River for the licence period 2009-2018. With the decrease in site activities and completion of decommissioning work, discharges at the Process Outfall have consistently decreased since 2009. CNSC staff conduct routine compliance verification of the Process Outfall releases by comparing against CNL non-radioactive effluent limits, also provided in table 3.5 [77]. As shown in table 3.5, the hazardous effluent releases from the Process Outfall remain well below the effluent limits.

The Lagoon is a second contributor of hazardous substances to the Winnipeg River, discharging approximately 25 times less water than the Process Outfall in 2017. Table 3.6 provides annual monthly average concentrations of hazardous contaminants released from the Lagoon into the Winnipeg River for the licence period 2009-2018. CNSC staff conduct compliance verification of the lagoon effluent by comparing against CNL's non-radioactive effluent limits, which include those required under the Federal Wastewater System Effluent Regulations (FWSERs). As shown in table 3.6, the hazardous effluent from the Lagoon remain below the effluent limits [77].

Table 3.5: Annual monthly average concentrations of hazardous releases from the WL site Process Outfall (2009 – 2018) [15 to 24][77]

Parameter	(Unit)	Effluent limit[1,2]	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
pH		6-9	7.54	7.60	7.10	7.40	7.47	7.57	7.54	7.50	7.81	7.76
Phosphorus	µg/L	1000	43	29	28	29	66	119	120	40	35	30
TSS	mg/L	25	2.5	2.6	2.5	6.1	3.8	2.1	7.6	2.4	2.97	1.5
Chromium	µg/L	500	1.9	1.0	1.4	0.9	0.7	1	2.4	0.1	0	0.1
Copper	µg/L	500	17	21	18	17	12	9	10	6	6	5
Iron	mg/L	1	0.38	0.34	0.29	0.33	0.26	0.29	0.36	0.32	0.26	0.19
Lead	µg/L	100	0	1.5	1.7	1.1	0.3	0.5	2.3	0.4	0.3	0.2
Nickel	µg/L	500	1.7	1.6	2.6	2.7	1.9	1.3	2.7	0.9	2	0.6
Zinc	µg/L	500	10	11	10	13	13	25	4	3	1	1
Mercury	µg/L	1[3]	0.047	0.015	0.01	0.009	0.008	0.019	0.012	0.001	0	0.005
Phenolics	µg/L	20	2.2	1.9	0.6	0.3	0.7	0.8	1.1	1.7	4	0.1
Oil & grease	mg/L	15	1.7	1.7	1.4	1.3	1.6	1.5	2.4	0.8	0.2	0.1
Total yearly discharge of effluent	m^3	-	1,780,000	1,740,000	1,550,000	1,760,000	1,460,000	1,380,000	1,330,000	1,410,000	1,130,000	1,160,000

[1] CNL, Procedure - WL Non-Radioactive Effluent Limits, WL-509244-PRO-002 Revision 0, 2015.
[2] Effluent limits apply to the monthly average release concentrations.
[3] Daily Internal Control Level.

Table 3.6: Total annual monthly average hazardous releases for the WL site Lagoon (2009 – 2018) [15 to 24][77]

Parameter	(Unit)	Effluent limit[1,2]	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
COBD	mg/L	25	-	-	0	1.47	8.08	6.67	0.211	0	9	14.2
Un-ionized ammonia	µg/L as N	1250	-	-	1.7	3.0	30	120	120	9.9	35	9.7
Total residual chlorine	µg/L	20	-	-	34	20	9	34	23	35	24	18
Fecal coliform	MPNU/100mL	400	7.3	3.5	33.8	12.6	7.7	4.2	1.3	5	6.2	5
pH	pH	6 to 9	6.85	7.87	7.34	7.61	8.31	7.96	8.41	7.01	7.81	8.68
Phosphorus	µg/L	1000	123	147	176	267	324	273	171	83	69	131
TSS	mg/L	25	2.4	4.8	4.7	11.74	5.9	9.2	3.89	1.92	4.807	3.8
Chromium	µg/L	500	1.0	0.7	3.1	4.4	0.3	0.6	0.5	0	0	0
Copper	µg/L	500	7	9.5	3.5	1.8	1.5	1.1	1.0	1.6	1.4	1.5
Iron	mg/L	1	0.06	0.165	0.175	0.234	0.233	0.243	0.216	0.245	0.283	0.370
Lead	µg/L	100	1	0.9	0.2	0.2	0	0	0	0	0.0005	0
Nickel	µg/L	500	1.9	0.5	1.4	2.1	1.4	0	4	5	1.9	1.5
Zinc	µg/L	500	4.6	5.5	14	4.5	2.5	1.1	0.5	0.3	0	0
Mercury	µg/L	1[2]	0.025	0.015	0.005	0.146	0.0117	0.077	0.003	0.0006	0	0
Phenolics	µg/L	20	1.3	1.9	1	0.3	1.4	0.7	1.5	1.7	5.5	0
Oil & grease	mg/L	15	1.7	1.1	1.56	1.31	1.76	2.53	0.45	0.78	1.6	0
Total yearly discharge of effluent	m^3		124,000	132,000	104,000	119,000	103,000	83,500	52,600	74,600	47,200	12,200

[1] CNL, Procedure - WL Non-Radioactive Effluent Limits, WL-509244-PRO-002 Revision 0, 2015.
[2] Effluent limits apply to the monthly average release concentrations, with the exception of COBD, TSS, total residual chlorine, and un-ionized ammonia, which apply to annual average release concentrations as per Section 6(2) of the FWTSRs.
[3] Daily Internal Control Level.

3.1.3 Conclusions

CNSC staff have assessed radiological and hazardous releases to the environment from the WL site during the licensing period. Radiological releases to the atmosphere and to the Winnipeg River were below their respective DRLs. With the exception of chlorine, hazardous releases to the Winnipeg River were below release limits. Chlorine is discussed in section 3.2.2.1.

3.2 Environmental Effects Assessment – Licensing Activities

As noted in section 2.2 of this report, a CSR was produced for the WL site in 2001 [41]. This CSR, along with the support of Annual Safety Reports submitted by the licensee, were reviewed and assessed, and inform this section of the EPR Report.

The following sub-sections discuss the impacts of decommissioning activities at the WL site and provide CNSC staff's conclusions on whether CNL will continue to make adequate provision for the protection of the environment and human health.

Each sub-section also presents an overview and assessment of the predicted effects, using the results of both environmental monitoring and modelling as documented in the CSR and annual reports, in order to determine whether the environment and human health are, and will continue to be, protected as decommissioning continues.

The assessment of predicted effects of the project was carried out in a step-wise manner as follows:

- identifying potential environmental and health effects
- determining whether the environment and health of persons are protected

A review was conducted for all components related to the project, but only a selection of topics are presented in detail in this section.

3.2.1 Atmospheric Environment

An assessment of the atmospheric environment at the WL site consists of characterizing both the meteorological conditions around the WL site, as well as assessing the ambient air quality. Meteorological conditions such as wind speed, wind direction and precipitation are monitored in order to assess the extent of the atmospheric dispersion of contaminants released to the atmosphere, the rates of contaminant deposition, and to determine predominant wind directions which are used to identify critical receptor locations from the air pathway. Based on extensive meteorological data collected, the predominant wind directions are both to and from the north northwest and from the northwest with average annual wind speeds of approximately10 km/h [78].

Ambient air monitoring is used to confirm that ambient air quality as a result of atmospheric releases from the facility due to decommissioning and demolition activities remain at levels protective of human health and the environment. As part of the EMP, CNL conducts monitoring of ambient gamma radiation, as well as ambient dust during demolition activities.

3.2.1.1 Ambient Gamma Dose Monitoring

As part of the EA FUP, ambient gamma dose monitoring is conducted at the WL site, in order to ensure gamma levels within the controlled area fence, site perimeter, and in the town of Pinawa are within regional background levels. Table 3.7 provides the 5-year average total gamma dose rate levels. Over this period, gamma dose rates have remained within the expected regional background.

Table 3.7: Total gamma dose rates from the WL site [15 to 33]

Location	5-year average (mSv/a)
Average background dose in Winnipeg [79]	4.1
Controlled area fence	0.54
Facility perimeter	0.53
Pinawa area	
Town yard	0.53
Pinawa golf course	0.50
Hospital	0.43

3.2.1.2 Airborne Dust Monitoring

CNL initiates dust control measures during building demolition activities. These measures include the use of containment and suppression techniques, such as wetting, as well as restricting activities during high wind conditions. During demolition activities, CNL also conducts ambient monitoring for total suspended particulates (TSP) to ensure that the release of fine dust is minimized and controlled to levels below Canada's National Ambient Air Quality Objectives (NAAQO) [80].

The TSP concentrations during all 2017 demolition activities ranged between 0.7 – 831 $\mu g/m^3$, with the average daily TSP concentrations at 150 $\mu g/m^3$, compared to the tolerable daily NAAQO of 400 $\mu g/m^3$. Although there were occasional exceedances of the NAAQO, these were attributed primarily to elevated background concentrations caused by forest fires and the use of gas generators, and any residual risk to people or the environment from demolition activities is unlikely.

3.2.1.3 Conclusion

Based on CNSC staff's review of the CSR, the annual EMP results and EA FUP results for the licensing period of 2009-2018, CNSC staff conclude that ambient air quality remains at levels protective of human health and the environment.

3.2.2 Aquatic Environment

An assessment of the aquatic environment at the WL site consists of characterizing water conditions, sediment quality and the health of aquatic ecosystems (including the consideration of species at risk) around the WL site. This includes assessing the possibility of exposure of aquatic species to contaminated sediments in the Winnipeg River, which supports a diverse fish community with spawning, rearing and foraging habitats. Walleye, northern pike, lake whitefish, white sucker and shorthead redhorse are routinely captured upstream and downstream of the WL site, where various forage fish species can also be found.

CNL monitors radionuclide concentrations in water and sediments of the Winnipeg River as well as in fish tissue to evaluate any potential impacts that decommissioning and demolition activities may have on the environment and the public. Since releases of hazardous substances from the Process Outfall and the Lagoon are low (section 3.1.2), monitoring of hazardous substances in surface water and fish in Winnipeg River is not part of the EMP (see section 3.3.2.1).

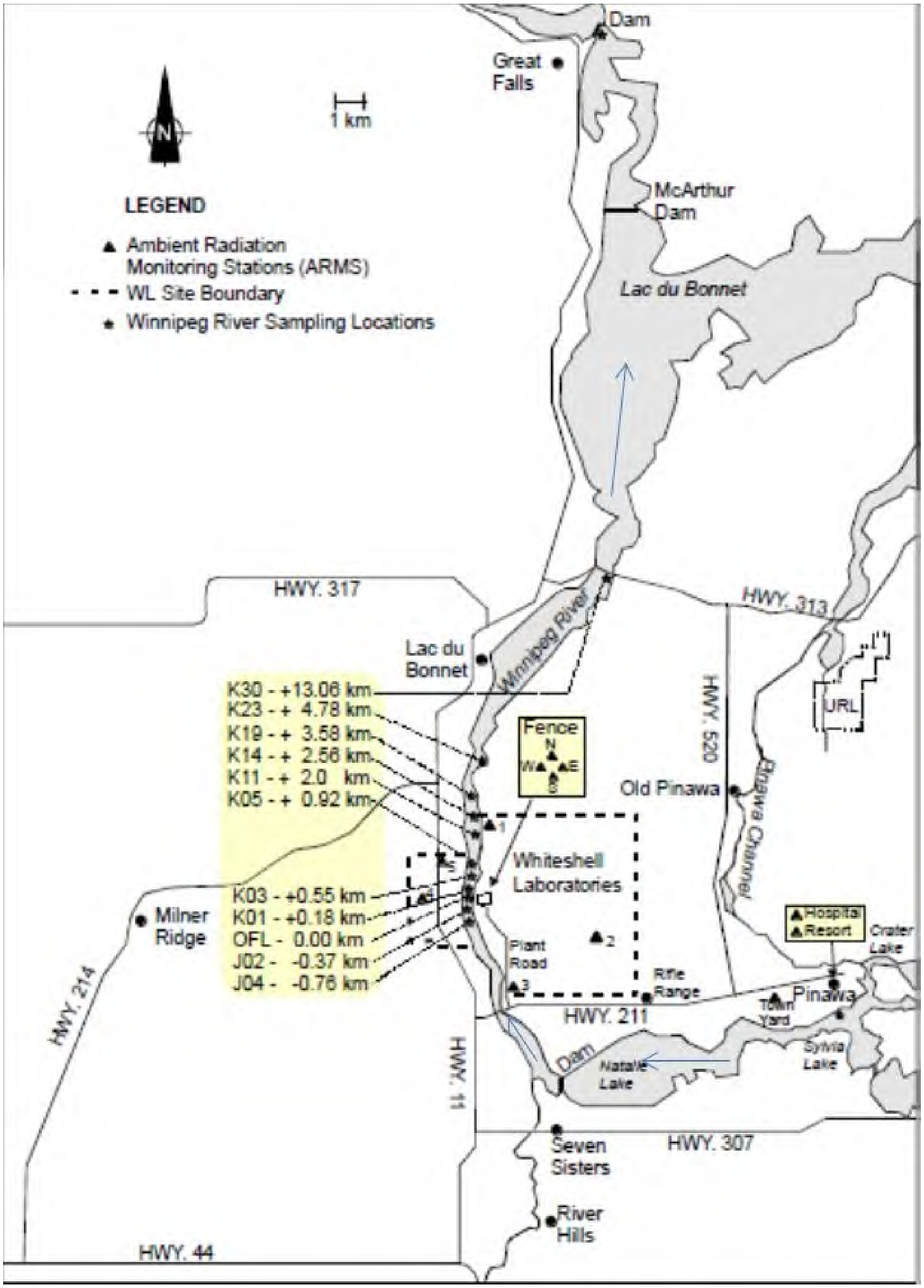
3.2.2.1 Water quality in the Winnipeg River

Radiological Substances

As part of their EMP, CNSC requires CNL to collect monthly composite samples of Winnipeg River water from four locations: near Pinawa, which is approximately 17 km upstream of the Process Outfall; 2 km downstream at the WL site property boundary; 10 km downstream at the Lac du Bonnet water intake; and 28 km downstream at the Great Falls generating station (figure 3.2).

The upstream monitoring station is a reference location because it is not exposed to releases from the WL site. Levels of radiological substance at this upstream site near Pinawa are thus considered ambient levels. These ambient levels are used for comparison with radiological levels in the Winnipeg River, downstream of the site, in order to determine if the WL site discharge increases levels of radiological substances. Water samples are analysed for tritium, strontium-90, gross beta, caesium-137 and potassium-40 [23], which were identified in the 2001 CSR. Sample locations are shown in figure 3.2.

Figure 3.2: Sediment and water monitoring locations on the Winnipeg River upstream and downstream of the WL site[4] [23]



[4] Water quality locations are identified as black circles and sediment sampling locations are highlighted in yellow and blue arrows indicate direction of the Winnipeg River flow.

Temporal trends in radiological substances concentrations are shown in table 3.8. Two kilometers downstream from the Process Outfall, gross beta, potassium-40 and strontium-90 are higher than upstream. Activity concentrations of these radionuclides return to levels measured upstream at 10 and 28 km downstream of the Process Outfall. It should be noted that gross beta activity concentrations have decreased since 2009 (table 3.8), likely because of reduction in operations. Caesium-137 (table 3.8), tritium and gross alpha (for which data are not shown because concentrations downstream were similar to upstream) activity concentrations in the Winnipeg River downstream of the Process Outfall remain similar to ambient levels upstream. This confirms that the WL site operations are not an important source of alpha emitting radionuclides, caesium-137 or tritium. The assessment of environmental risk from these surface water concentrations are discussed in section 3.2.2.3.

Table 3.8: Temporal trends in mean activity concentrations (mBq/L*) in Winnipeg River upstream and downstream of the WL site (2009 – 2017) [23]

Location ID	Site	Distance	2009	2010	2011	2012	2013	2014	2015	2016	2017
Caesium-137											
Pinawa	upstream		4	3	4	4	6	4	5	4	4
K11	downstream	2 km	5	11	5	5	6	5	5	5	4
Lac du Bonnet	downstream	10 km	3	3	4	4	5	4	3	2	3
Great Falls	downstream	28 km	3	4	4	4	5	3	2	2	2
Strontium-90											
Pinawa	upstream		6	7	7	7	7	9	7	6	7
K11	downstream	2 km	11	16	11	11	7	9	7	7	13
Lac du Bonnet	downstream	10 km	8	9	7	7	8	10	6	6	8
Great Falls	downstream	28 km	9	8	8	9	8	7	7	6	8
Potassium-40											
Pinawa	upstream		62	36	53	53	60	59	78	62	86
K11	downstream	2 km	82	120	82	68	72	76	113	80	95
Lac du Bonnet	downstream	10 km	41	41	46	53	51	69	67	59	49
Great Falls	downstream	28 km	45	56	52	54	84	56	61	54	50
Gross beta											
Pinawa	upstream		78	75	77	77	74	62	87	66	85
K11	downstream	2 km	142	130	142	134	86	86	105	101	107
Lac du Bonnet	downstream	10 km	78	75	85	78	80	81	80	69	65
Great Falls	downstream	28 km	91	81	84	93	73	83	72	72	64

*For illustrative purposes, mBq/L was used instead of Bq/L, in order to fit the table into this report.

Hazardous Substances

As presented in section 3.1.2 above, CNSC requires CNL to measure hazardous substances in the Process Outfall and the Lagoon. However, CNSC does not require CNL to measure hazardous substances in the Winnipeg River, because hazardous substances concentrations in the liquid effluent are generally below the Canadian Council of Ministers of the Environment (CCME) water quality guideline for the protection of aquatic life. Comparisons of liquid effluent concentrations to the CCME water quality guideline are presented in the following section, in order to explain why hazardous substances are not monitored in the Winnipeg River.

The Process Outfall discharges continuously to the Winnipeg River and is the main effluent in terms of volume (table 3.5). Levels of hazardous substances (pH, chromium, nickel, and phenolics) in effluent are currently below the CCME water quality guideline for the protection of aquatic life [81]. Other substances such as copper and mercury have been consistently above the CCME water quality guideline in the effluent. Copper levels were approximately 10 times the CCME guideline from 2009 to 2012. Since then, these levels have decreased, but remain slightly above the guideline. Also, mercury was consistently higher than the CCME water quality guideline prior to 2017 (table 3.5), but has since been below 0.1 µg/L. Below this level, bioaccumulation of mercury in fish is low and not of concern [82].

On occasion, zinc, iron, lead and phosphorus have been above the CCME water quality guideline. From 2009 to 2014, zinc was found to be slightly above the CCME water quality guideline, but has since decreased below the guideline. On occasion, iron and phosphorus have been above the CCME water quality guideline. These rare exceedances of iron are not of environmental concern because it is an essential element to aquatic life. With regards to phosphorus exceedances in 2014 and 2015, it is not expected to contribute significantly to eutrophication of the Winnipeg River.

The Lagoon water is discharged occasionally to the Winnipeg River, but frequency and volumes have decreased over the years (table 3.6). The Winnipeg River discharges a million times more water than the Lagoon. Levels of hazardous substances (pH, total suspended solids, chromium, iron, lead, nickel and, phenolics) in the Lagoon effluent have been consistently below the CCME water quality guideline for the protection of aquatic life [81]. Other substances are consistently or on occasion above the CCME water quality guideline in the Lagoon effluent.

For instance, mercury has been consistently above the CCME water quality guideline but decreased to below detection limits in 2017 and 2018. Similarly, phosphorus has consistently decreased in the effluent to levels seen in aquatic environment with average productivity. Copper was above the CCME guideline from 2009 to 2013 and zinc was above the CCME water quality guideline in 2011, but both have since decreased to below their respective CCME water quality guideline. Finally, iron was above the CCME water quality guideline in 2018, but is not of environmental concern because it is an essential element to aquatic life.

Total residual chlorine was often above the CNL effluent limit (table 3.6). CNSC staff does not have concerns with these frequent exceedances because the water flow rate of the Winnipeg River is a millions times higher than what the Lagoon discharges annually, which provides ample potential for dilution of chlorine [83] in the Winnipeg River. Total residual chlorine is therefore not a concern to the health of the Winnipeg River ecosystem.

In contrast to the Winnipeg River, CNSC requires CNL to monitor hazardous substances in the north and west ditches (ditch 8 and ditch 9, respectively), similar to the Process Outfall and the

Lagoon. These are intermittent streams during rain events. Ditch 9 flows to the Winnipeg River, whereas ditch 8 flows to the north. Tables 3.9 and 3.10 provide annual average concentrations of hazardous substances in surface water of the ditches from 2009 to 2018. Hazardous substances concentrations are compared against the CCME guideline for the protection of the aquatic life. As shown in these tables, the concentrations in ditches 8 and 9 were similar to those measured in a nearby unaffected creek. On occasion, copper and mercury were above the CCME water quality guideline and ambient levels measured in a nearby unaffected creek.

Table 3.9: Total annual average hazardous substances concentration for WL site Ditch 8 (northbound) (2009 – 2018) [15 to 24] compared against *Federal Water Quality* (CCME) Guidelines [81] *

Parameter	(Unit)	CCME Guideline	Background*	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
pH		6 to 9	6.98-7.81	7.36	7.56	7.51	7.55	7.41	7.24	7.46	7.50	7.88	7.81
Phosphorus	µg/L	100	71-192	85	120	89	70	81	168	116	49	71	45
Conductivity	µs/cm	N/A	197-736	577	484	434	560	374	348	554	571	445	690
TSS	mg/L	25	1-14	2.6	8.0	18.5	4.6	2.5	1.5	2.4	2.3	2.7	1.7
Chromium	µg/L	9	0.3-1.3	2.9	1.8	1.9	0.3	0.3	0.8	1.2	0.4	0	0
Copper	µg/L	2	0.5-2.5	5	11	3	4	2	2	3	2	3	1.5
Iron	mg/L	0.30	0.26-1.02	0.22	0.47	0.67	0.22	0.17	0.26	0.19	0.21	0.19	0.08
Lead	µg/L	1	0.5-3.6	0	1.0	1.0	0.03	0	0.4	0.9	0.2	0	0
Nickel	µg/L	25	1.6-3.2	4.8	5.7	4	5	0.3	2	4	5	4	2.6
Zinc	µg/L	7	3-12	10	8	8	11	5	7	4	4	2	1.4
Mercury	µg/L	0.000026	0.008-0.052	0.220	0.016	0.007	0.009	0.006	0.165	0.006	0.006	0	0.002
Phenolics	µg/L	4	0.6-7.4	1.4	1.7	0.9	0.7	2	1.6	0.6	2.2	7	0.2
Oil & grease	mg/L	N/A	0.8-1.5	1.1	0.9	1.5	1.6	1.7	1.9	1.4	0.9	0.4	0.1

* Values in red are above CCME guidelines for protection of aquatic life and natural background concentrations measured in an unaffected ditch, which are discussed in more detail in section 3.2.2.

Table 3.10: Total annual average hazardous substances concentrations for WL site Ditch 9 (Westbound) (2009 – 2018) [15 to 24] Compared against *Federal Water Quality* (CCME) Guidelines [81] *

Parameter	(Unit)	CCME Guideline	Background*	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
pH		6 to 9	6.98-7.81	7.01	7.26	7.28	7.37	7.06	6.93	7.14	7.05	7.67	7.81
Phosphorus	µg/L	100	71-192	82	98	76	63	73	181	136	53	45	45
conductivity	µs/cm	N/A	197-736	144	142	182	405	205	195	216	193	214	690
TSS	mg/L	25	1-14	8.7	14	18	8	5	5	2	2	2	2
Chromium	µg/L	9	0.3-1.3	3.5	2.0	1.4	0.7	3.0	0.6	1.8	0.3	0	0
Copper	µg/L	2	0.5-2.5	18	9	3	3	1	2	3	1	1	1.5
Iron	mg/L	0.300	0.26-1.02	0.75	0.86	0.79	0.47	0.35	0.52	0.45	0.58	0.33	0.08
Lead	µg/L	1	0.5-3.6	0	2	2	0.4	0	0.1	0.9	0	0	0
Nickel	µg/L	25	1.6-3.2	5.2	2.9	3.8	3.4	0.2	1.8	2.7	3.0	2.2	2.6
Zinc	µg/L	7	3-12	11	8	10	12	8	10	5	6	2.2	1.4
Mercury	µg/L	0.000026	0.008-0.052	0.068	0.011	0.007	0.007	0.008	0.034	0.008	0.009	0	0.002
Phenolics	µg/L	4	0.6-7.4	1.7	2.4	0.9	0.7	1.8	2.3	0.9	2.1	1.6	0.2
Oil & grease	mg/L	N/A	0.8-1.5	1.0	1.0	1.2	2.0	1.4	0.9	1.6	1.1	0.4	0.1

* Values in red are above CCME guidelines for protection of aquatic life and natural background concentrations measured in an unaffected ditch, which are discussed in more detail in section 3.2.2.

As explained above, CNL is not required to measure hazardous substances in water of the Winnipeg River. However, the province of Manitoba does monitor water quality for hazardous substances at the Powerview Dam, 30 km downstream of the WL site. Table 3.11 indicates that the maximum concentrations of metals are all below the CCME water quality guideline for the protection of the environment, except for aluminum.

For aluminum, naturally present amounts of aluminum in North American rivers range from 12 µg/L to 2250 µg/L [84]. Recent American studies [84 to 85] on aluminum toxicity suggest that a water quality guideline of 100 µg/L is very protective of the environment. In rivers with high organic matter like the Winnipeg River, CNSC staff concur with the American studies [85] that a safe level of aluminum is around 300 µg/L [85]. In 2017, aluminum levels in the WL site water intake was at 150 µg/L, similar to the effluent concentrations [86], which indicates that the WL site does not contribute to an increase in aluminum levels in the Winnipeg River. It is CNSC staff's conclusion that there is no risk to aquatic ecosystems from current levels of aluminum in the Winnipeg River. Although far from the site, provincial monitoring indicates the risk to aquatic organisms living in the water column of the Winnipeg River is negligible.

Table 3.11 Average (maximum) concentrations of metals from 2009 to 2018 at the Powerview Dam on Winnipeg River, 30 km downstream of the WL site [15 to 24]

Metal	Al	As	Cd	Cu	Cr	Mo	Ni	Se	U	Zn
Value (µg/L)	163 (239)	0.8 (1.7)	0.007 (0.008)	1.2 (1.3)	0.1 (0.1)	0.2 (0.2)	0.8 (1.0)	0.1 (0.2)	0.1 (0.2)	0.2 (0.3)
CCME Guideline [81]	100	5	0.09	2	1	73	25	1	15	7

Overall, most hazardous substances in wastewater from the Process Outfall and the Lagoon, as well as surface water in ditches 8 and 9, were below the CCME water quality guideline for the protection of aquatic life. Despite the occasional levels of aluminum above the CCME water quality guideline, considering that the annual water flow of the Winnipeg River is 100,000 and 1,000,000 times the annual Process Outfall and lagoon discharge, levels of hazardous substances are expected to be well below the CCME water quality guideline for the protection of aquatic life. CNSC staff therefore conclude that the Winnipeg River is adequately protected from releases of hazardous substances. For this reason, CNL is not required to monitor hazardous substances in the Winnipeg River.

As for ditch 8, for which runoff water drains to the north only during rain events, levels of hazardous substances were all below CCME guidelines in 2018 (table 3.9). While there were some exceedances of the CCME guidelines prior to 2018, these exceedances are not of concern because ditches are not aquatic habitats since water only flows during rain events.

3.2.2.2 Sediment quality in the Winnipeg River

As radiological and hazardous substances have accumulated in sediments downstream of the WL site since 1964, CNSC requires CNL to monitor radiological substances in the sediments of the Winnipeg River to assess environmental risk associated with historical releases. This section discusses potential risk of radiological and hazardous substances in sediments.

Radiological Substances

Winnipeg River sediments are collected on an annual basis [87] from 11 locations ranging from 0.8 km upstream to 13.1 km downstream of the WL site Process Outfall, as shown in figure 3.2. Results from the latest 2017 sampling campaign are detailed in table 3.12.

Gross alpha is similar between upstream and downstream sediments as it was the case in surface water. However, gross beta activity is higher at the Process Outfall, as well as 0.5 and 13 km downstream, compared to upstream samples. Gross beta activity was also higher in surface water 2 km downstream of the Process Outfall.

Caesium-137, is also higher at the Process Outfall, as well as 0.8, 3 and 13 kilometers downstream, in comparison to upstream (table 3.12) [23]. This is in contrast with surface water where caesium-137 concentrations downstream were similar to upstream of the Process Outfall from 2009 to 2017. This higher concentration of caesium-137 in sediments is the result of historical higher releases of caesium-137, prior to 2009 [15][88].

Caesium-137 is a mobile element, and the sediment monitoring data suggest that some caesium-137 is recirculated downstream in the Winnipeg River. Since caesium-137 is a beta-emitter, it also explains the similar gross beta pattern in sediments. Strontium-90, which was elevated in surface water 2 km downstream of the Process Outfall (table 3.8), was below the detection limit of 0.0001 Bq/Kg (data are not shown because concentrations are below detection limits). Potassium-40 appears slightly higher a kilometer downstream of the Process Outfall, similar to surface water concentrations. The risk to aquatic biota from radiological substances concentration in sediment is not of concern, as is further discussed in section 3.2.2.3, Dose Assessment to Non-Human Biota.

Table 3.12: Radionuclide activities in sediment (Bq/Kg dry weight) upstream and downstream of the WL site [23]

Location (see figure 3.2)	Distance (Km)	Gross alpha	Gross beta	Potassium-40	Caesium-137
J04	-0.76*	396	655	606	10
J06	-0.37*	348	616	550	10
Process Outfall	0	350	817	580	183
K01	0.15	291	562	645	9
K03	0.52	407	864	588	49
K05	0.79	365	662	580	179
K14	2.56	386	600	580	15
K30	13.06	346	725	614	24

*A (-) indicates a upstream measurement.

Hazardous Substances

In support of the CSR in 2001, CNSC staff requested that CNL sample sediments twice within the center of the plume, in a background area and downstream of the operations. Metal concentrations were enriched in sediment exposed to discharge from the Process Outfall, compared to background sediments (table 3.13). Despite this enrichment, none of the metal concentrations were above sediment quality guidelines [85]. Next sediment monitoring for hazardous substances is expected in 2021.

Note that the sediment quality guideline for cadmium is below measurable levels and levels in the outfall area were similar to background. Hence, cadmium is not a concern at the site.

Table 3.13: Hazardous substance concentrations (mg/kg) in the Winnipeg River sediments directly in the Process Outfall and downstream of the WL site in 2001

Substance	Background[1]	Plume[1]	Downstream[1]	ISQG[2]	PEL[3]	LEL[4]
Cadmium	1.3	1.3	1.6	0.6	3.5	-
Chromium	4.9	6	11	37	90	37
Copper	2.4	5.8	8	36	200	12
Molybdenum	2.8	4.6	2.3	-	-	8
Nickel	4.7	7.8	12.3	-	-	21
Zinc	10.8	15.7	28	120	320	-

1 Concentrations [88]
2 Interim sediment quality guideline [89]
3 Probable effects level [89]
4 Lowest effect levels [90]

3.2.2.3 Aquatic ecosystem health in the Winnipeg River

Consideration of Species at Risk

The Winnipeg River supports a diverse fish community with spawning, rearing and foraging habitats. CNL has identified fish and fish habitat in and around the WL site [40].

Fish species occurring in the Winnipeg River and within the vicinity of the WL site are forage fish including minnows, suckers, sculpins and darters. Predatory fish species reported in the area include Walleye, Northern Pike and Smallmouth Bass. Walleye, northern pike, lake whitefish, white sucker and shorthead redhorse, are routinely captured upstream and downstream of the WL site, during annual environmental monitoring [2][40].

The carmine shiner is the only fish species listed on schedule 1 of the *Species at Risk Act* (SARA) living in the Winnipeg River and in the vicinity of the WL site [91]. The known distribution of the carmine shiner is limited to the Winnipeg River, at the base of Whitemouth Falls (located approximately 7 km upstream of the WL site), and its tributaries [92]. DFO has published an Action Plan for the Carmine Shiner in Canada in order to help this species recover, as part of their SARA Action Plan Series [93].

Radiological Levels in Fish Tissue

As part of their EMP, CNL caught three species of fish (white sucker, walleye and northern Pike) in the Winnipeg River at a location upstream and four species (white sucker, walleye and northern pike and whitefish) downstream during the fall period on an annual basis. In 2017, three individual fish were caught per species and per location. The flesh was analysed for gross beta activity and scanned by gamma spectroscopy, which provided values for caesium-137 and potassium-40. The downstream locations and the upstream Sylvia Lake location are identified in figure 3.2.

A five year average of caesium-137, potassium-40, and gross beta activity in fish flesh is provided in table 3.14 for the years 2012 to 2017. This table indicates that caesium-137 is enriched in all fish species downstream of the WL site, compared to fish caught upstream in Sylvia Lake. This result supports the observed accumulation of caesium-137 in sediments (see section 3.2.2.2). Caesium-137 has accumulated in sediments as a result of historical releases prior to 2009 [15][88]. The contribution of caesium-137 to dose to these fish and the implication on their health is discussed in the next section.

Table 3.14 Five year average of radionuclide activities in fish flesh (2012 – 2017) (Bq/Kg fresh weight) for three species upstream and downstream of WL site [23]

	Upstream	2 km downstream	5 km downstream
White sucker			
Caesium-137	0.77	0.48	1.70
Potassium-40	137	135	121
Gross Beta	142	135	135
Walleye			
Caesium-137	0.61	0.87	0.81
Potassium-40	130	125	138
Gross Beta	132	141	143
Pike			
Caesium-137	0.40	0.54	0.44
Potassium-40	126	115	133
Gross Beta	136	130	137
Whitefish			
Caesium-137	0.33	0.44	0.48
Potassium-40	141	133	141
Gross Beta	148	137	141

Dose Assessment to Non-Human Biota

In 1973, benthic invertebrate community monitoring upstream and downstream of the WL site indicated that organisms dwelling in the Winnipeg River sediment were not affected by releases from the site [94]. In 2001, CNL calculated radiological doses to organisms dwelling in the Winnipeg River sediment. Maximum predicted dose was 0.76 µGy/hr, which is lower than the 10 µGy/hr benchmark [95]. CNSC staff reviewed CNL dose calculations and concluded that organisms living in the Winnipeg River sediments directly downstream of the Process Outfall and Lagoon were not affected by radiological exposure at that time [88].

For this EPR Report, CNSC staff modelled radiological dose to aquatic biota using the ERICA tool [95]. In their assessment, CNSC staff considered maximum activities of tritium, strontium-90 and most importantly, caesium-137 in water and sediments. Maximum modelled dose to organisms dwelling into sediments was 1.4 µGy/h, which is lower than the 10 µGy/hr benchmark, demonstrating no adverse effects on biota. The modelled dose to benthic and pelagic fish was below the dose predicted to organisms inhabiting sediments. Caesium-137 accumulation in fish tissue is therefore not of concern.

CNSC staff confirm that aquatic organisms living in the Winnipeg River downstream of the WL site, including species at risk, remain protected from historical and current radiological exposure.

3.2.2.4 Conclusion

Based on annual monitoring of fish, water and sediment, CNSC staff confirm that aquatic organisms living in the Winnipeg River downstream of the WL site remain protected. CNL continues to provide adequate protection of the environment from releases to surface water.

3.2.3 Terrestrial Environment

An assessment of potential effects on terrestrial biota at the WL site consists of characterizing local terrestrial habitat and terrestrial species and consideration of terrestrial species at risk. This includes assessing the possibility of exposure to radioactivity in native vegetation and wildlife, radiological and hazardous soil quality along with physical stressors that may be disruptive to both human and ecological receptors.

In the immediate vicinity of the WL site, there are approximately 10 to 20 m of surficial overburden soils overlying the Precambrian bedrock. These overburden soils include glacial, glaciofluvial and alluvial deposits. At the WMA, where extensive test hole drilling has taken place prior to and since site development, the overburden soils were found to comprise 0.5 m of organic-rich soil horizon overlying 1.5 m of silt, 2.5 m of clay, 5 m of clayey till, and 3 to 5 m of stratified sand.

The terrestrial habitat in and around the WL site consists of wetland areas to the east, and forest species and abandoned farm fields vegetated with grasses and shrubs to the west.

Over 50 species of mammals can be expected to be found around the WL site, along with a large variety of bird species and amphibians. A wide diversity of amphibians are also present in the vicinity of the WL site,

CNL monitors radionuclide concentrations in soils around the WMA, in order to evaluate any potential impacts that decommissioning and demolition activities may have on terrestrial biota, including vegetation and wildlife.

3.2.3.1 Soil Quality at the Perimeter of WMA

In general, the surficial soil distribution in the low-lying areas to the northwest and west, as well as away from major streams, comprise peats in areas of poor drainage. Improved drainage conditions in these areas leads to the development of humic gleysols and brunisols, while underlying outwash sands and gravels lead to the development of brunisols. Soil development near the Winnipeg River includes peaty humic gleysols on lacustrine silts and clays, but the inherently more effective surface drainage at these locations generally retards peat development. Precambrian bedrock outcrops generally have only partial lichen and moss cover, although peat soil is common in depressions.

Radiological Substances

The WL site EMP includes measurements of radioactivity in soils. Table 3.15 provides a summary of the radioactivity found in the surface soils collected in 2017 at the perimeter locations of Standpipe Rows E, F, and G in the WMA (refer to figure 1.4 for Standpipe locations).

Table 3.15: Radioactivity in surface soil near Standpipe Rows of WL WMA, 2017 [23, table B-13]

Location	Gross beta (Bq/g)	Gross alpha (Bq/g)	Potassium-40 (Bq/g)	Strontium-90 (Bq/g)	Caesium-137 (Bq/g)
Location E (1 m East of WMA Fence at Standpipe Row E)					
Perimeter (7m south)	1.00	0.70	0.54	0.10	0.01
Perimeter (8m south)	1.90	0.80	0.71	0.31	0.09
Perimeter (9m south)	1.99	1.00	0.66	0.12	0.06
Perimeter (9m west)	2.45	1.20	0.68	0.12	0.12
Location F (1 m East of WMA Fence at Standpipe Row F)					
Perimeter (9m west)	1.47	0.90	0.62	0.05	0.01
Location G (1 m East of WMA Fence at Standpipe Row G)					
Perimeter (9m north)	1.70	0.70	0.73	0.09	0.06
Perimeter (9m west)	0.95	0.64	0.54	0.04	0.01
NSRDR clearance level	NA	1.0	10	1.0	0.1

The alpha activity detected in the 2017 soil samples is most likely from naturally occurring alpha emitters such as uranium and thorium present in the soil. Two samples were at or slightly above the *Nuclear Substance and Radiation Devices Regulation (NSRDR) Clearance Level* [96] of 1.0 Bq/g (not including Potassium-40). The strontium-90 levels at the perimeter locations were below the NSRDR Clearance Level of 1.0 Bq/g. Caesium-137 activity at the perimeter locations were similar to the normal background levels for this radionuclide (0.02 to 0.11 Bq/g for this part of Manitoba) and at the NSRDR Clearance Level of 0.1 Bq/g. Therefore, there is negligible risk to members of the public.

Core samples were collected from the perimeter of the standpipe area in 2005 and additional work was conducted in 2011 and 2012. Radioactivity of groundwater (from routine environmental monitoring), and the soil samples from this study indicate there is no significant radioactive migration from the waste management facilities. Refinement and supplementary monitoring of the groundwater continues to support this finding.

Hazardous Substances

In 2008, AECL documented the nine sampling campaigns conducted at the Inactive Landfill and Lagoon in order to obtain the baseline conditions for these areas, and to identify the need for remediation that may be required. Soil samples were collected at locations where there was potential for radiological and hazardous contamination.

Most of the soil samples collected at the landfill and Lagoon areas demonstrated background levels of metals. Some concentrations of nickel, boron, cadmium, molybdenum, beryllium, aluminum, cobalt, chromium, copper and iron were above the background and/or above the most restrictive CCME Soil Quality Guidelines for agricultural land use [97]. It was concluded that the hazardous levels are such that there is no serious detriment to the local environment other than the fact that the land is probably not suitable for use as farmland. However, these levels in general meet the guidance criteria for residential/parkland, commercial and industrial land use.

3.2.3.2 Terrestrial Habitat and Terrestrial Biota

Black spruce is the common plant species in the easterly portions of the WL site, however jack pine is also present in this area, along a ridge of well drained sandy soil. The forest species to the west of the site consist of ash and poplar growing in poorly drained clay plains. Blueberries are common along the sides of the plant road south of the site.

Mammalian species that are common and widespread in the area include the snowshoe hare, American red squirrel, meadow vole, red fox and white-tailed deer. Not only is the white-tailed deer present on WL site, they have also established a wintering area. The white-tailed deer is considered to be an important species for the traditional communities and game species in the area. Recently, moose have also been sighted on the south-east portion of the WL property.

A bat survey conducted in 2015 at the WL site indicated that bats were not roosting within buildings at the site, but rather can be found roosting in the forested areas of the site.

A large variety of bird species can be expected to occur in the vicinity of the WL site. Bird migratory staging areas are present on and near the site, and the Winnipeg River is an important migratory corridor for many bird species including: common loon, red-necked grebe, horned grebe, double-crested cormorant, American white pelican, Bonaparte's gull, common tern, Caspian tern, lesser scaup, greater scaup and bald eagle.

Despite the generally harsh winter conditions of the WL site, about 10 species of amphibians can be found, the majority of which are frogs. These include the spring peeper, grey tree frog, striped chorus frog, wood frog and northern leopard frog, which are common and widespread, as well as the green frog and the mink frog, which are less common and widespread. Only four reptile species can be found on site; two turtle and two snake species, both of which are common and widespread. The common garter snake is widely distributed and prevalent in the region, but little is known about the exact status of the redbelly snake found in the area. All the reptile species hibernate to survive the harsh winters and hibernacula are a potentially important ecological feature in the region. None are known to exist on the WL site. In spring, the reptiles become active and enter their breeding cycle, which may involve special areas for egg-laying; none are known to be located in the WL controlled area.

Consideration of Terrestrial Species at Risk

Table 3.16 lists a number of threatened and endangered species under the federal *SARA*, and Manitoba's *Endangered Species and Ecosystems Act* (ESEA) that are likely to be present in the vicinity of the site, or the Winnipeg River. The possible presence of these species on the site was also indicated by the Manitoba Conversation Data Centre.

Table 3.16: Status for terrestrial Species at Risk (ESEA and SARA)

Species	Status	
	ESEA [98]	SARA [99]
Birds		
Bank swallow	Not Listed	Threatened
Barn swallow	Not Listed	Threatened
Bobolink	Not Listed	Threatened
Canada warbler	Threatened	Threatened
Chimney swift	Threatened	Threatened
Common nighthawk	Threatened	Threatened
Eastern wood pewee	Not Listed	Special Concern
Golden-winged warbler	Threatened	Threatened
Horned grebe	Not Listed	Special Concern
Least bittern	Endangered	Threatened
Loggerhead shrike	Endangered	Endangered
Olive-sided flycatcher	Threatened	Threatened
Peregrine falcon	Endangered	Special Concern
Piping plover	Endangered	Endangered
Red-headed woodpecker	Threatened	Threatened
Short Eared owl	Threatened	Special Concern
Trumpeter swan	Endangered	Not Listed
Whip-poor-will	Threatened	Threatened
Yellow rail	Not Listed	Special Concern
Mammals		
Grey fox	Not Listed	Threatened
Little brown myotis	Endangered	Endangered
Northern myotis	Endangered	Endangered
Reptiles		
Snapping turtle	Not Listed	Special Concern
Insects		
Monarch	Not Listed	Special Concern
Yellow banded bumble bee	Not Listed	Special concern
Plants		
Gattinger's agalinis	Endangered	Endangered
Rough agalinis	Endangered	Endangered
Western silvery aster	Threatened	Threatened
Ironweed	Endangered	Not listed

CNL have recently placed netting on buildings in the WMA, in order to discourage nesting of barn swallows and bats. New structures have also been constructed on site, in order to support the nesting of these species in alternative locations, as well as to prevent future nesting in buildings that are undergoing demolition. CNL plans to monitor these structures.

Species at risk can be difficult to include in dose and risk calculations due to incomplete knowledge of their exposure factors. While not all species at risk are specifically assessed, an effort was made to by CNL ensure that the species selected have similar feeding habits, so that surrogate species can be used to infer dose and risk for the species at risk either present or potentially present on the WL site.

Physical Stressors

Physical stressors, such as noise and vibration, are relevant to both human and ecological receptors, and are generated during decommissioning and demolition activities. As part of the CSR, impacts of noise and vibration from decommissioning activities were assessed. It was identified that any noise generated would be short-term and sporadic, confined during daytime activities, and that affected wildlife, such as deer and moose, could temporarily relocate to other suitable habitats. Additionally, dense tree coverage across the site provides a natural noise barrier between site activities and potential noise receptors around the WL site. CNSC staff reviewed CNL's assessment and concluded that no residual effects, including habitat loss, from noise and vibration would be expected.

During the current licensing period, decommissioning and demolition activities were not continuous but performed intermittently. Due to the above factors, CNSC staff conclude that are likely no residual effects from physical stressors including noise and vibration to the terrestrial environment.

Assessment of Potential Effects on Terrestrial Biota

The WL site EMP includes measurements of radioactivity in vegetation and in wildlife. Trends of concentrations for caesium-137, strontium-90, potassium-40, gross beta and gross alpha activities in vegetation and wildlife samples are presented in tables 3.17 and 3.18, respectively, along with the Ambient Radiation Monitoring Stations (ARMS) where they were taken.

Table 3.17: Radioactivity in vegetation [23]

Radioactivity (Bq/kg fresh weight)						
Parameter	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
WL perimeter, 3.2 km N (ARMS #1)						
Caesium-137	< 11	< 4	< 14	< 12	< 7	< 5
Strontium-90	5.2	1.3	2.5	2.1	3.0	2.4
Potassium-40	399	308	524	785	648	350
Gross Beta	502	347	547	668	594	429
Gross Alpha	31	20	110	55	45	95
WL perimeter, 3.4 km SSE (ARMS #3)						
Caesium-137	< 11	< 5	< 6	< 9	<4	< 3
Strontium-90	2.8	2.0	5.5	2.3	3.2	13.2
Potassium-40	211	206	395	789	899	301
Gross Beta	299	319	547	686	734	375
Gross Alpha	18	27	41	87	27	51
WL perimeter, 2.2 km W (ARMS #4)						
Caesium-137	< 7	< 6	< 7	< 8	< 4	< 5
Strontium-90	4.1	1.0	1.9	2.6	1.7	1.9
Potassium-40	322	554	593	671	584	464
Gross Beta	438	333	411	589	500	488
Gross Alpha	4	25	61	32	49	28
WL perimeter, 2.4 km NW (ARMS #5)						
Caesium-137	< 9	< 3	< 7	< 5	< 9	< 5
Strontium-90	4.6	0.5	1.1	1.3	0.6	< 0.8
Potassium-40	314	213	423	736	1140	400
Gross Beta	486	274	701	613	972	383
Gross Alpha	60	25	26	34	46	42
West of WMA and north of Canister Area (WMA #1)						
Caesium-137	< 8	< 3	< 6	< 6	< 5	< 4
Strontium-90	5.3	1	2.1	2.4	11.5	1.8
Potassium-40	328	551	306	481	912	370
Gross Beta	447	374	334	481	795	379
Gross Alpha	68	40	27	98	41	43
East of WMA near incinerator (WMA #7)						
Caesium-137	-	-	< 4	< 11	< 4	< 4
Strontium-90	-	-	7.4	9.6	6.4	2.7
Potassium-40	-	-	581	502	640	312
Gross Beta	-	-	465	493	662	342
Gross Alpha	-	-	37	28	23	33

Table 3.18: Radioactivity in wildlife (collected and analyzed road kills) [23 to 24]

Year	Gross beta	Potassium-40	Caesium-137
Grouse			
1998*	67	89	2.6
1998*	91	135	0.9
2003	72	112	0.8
2005	20	28	0.2
2006	172	214	3.9
2015	83	151	< 0.3
2016	177	130	1.0
Average	97	123	1.4
Method detection limit	2	6	0.3
Deer			
2011	129	135	0.7
2013	92	63	0.2
2014	119	98	7
2016	120	101	1.5
2018*	130	101	18
2018*	131	100	1.0
Average	115	99	2.4
Method detection limit	2	6	0.3

*Data occurs twice, due to two road kills in 1998 (grouse) and 2018 (deer).

These data indicate that in many instances the total radioactivity measured in vegetation and wildlife samples is due to natural radionuclides (for example Potassium-40). Caesium-137 levels in wildlife samples were below the detection limits, which ranged between 3 and 14 Bq/kg over the 2009-2018 licence period. They were also generally below the background level of 4 Bq/kg in all vegetation samples. Levels of strontium-90 and alpha activity in vegetation were detectable and in general within the range of previous years. The caesium-137 activity in the flesh of grouse and deer was relatively low (for example, the background level of caesium-137 in deer flesh is 2 Bq/kg) [23]. CNSC staff used the RESRAD model to estimate potential doses to the vegetation and wildlife based on the maximum measured radioactivity in the samples collected at the WL site. These estimates were several orders of magnitude below the most conservative radiation dose screening criteria for terrestrial biota.

3.2.3.3 Conclusion

Based on CNSC staff's review of the results of the EMP at the WL site and assessment of potential radiological dose to terrestrial receptors, CNSC staff confirm that terrestrial biota and soil quality remain protected from radiological exposures and no significant adverse effects are likely as a result of radioactive releases from the WL site. The hazardous contamination of soil within the WL site is mostly localized to the WMA, Inactive Landfill and Lagoon areas and is not expected to result in significant adverse effects to terrestrial biota since metal concentrations in general do not exceed the respective CCME soil environmental quality guidelines.

3.2.4 Hydrogeological Environment

An assessment of the hydrogeological environment at the WL site consists of identifying potential sources of groundwater contamination on the site, determining the extent of contamination, if any, which could lead to a pathway for exposure to human and/or non-human receptors, and determining the significance of any exposure from this pathway. Additionally, the hydrogeological assessment confirms whether control measures in place continue to remain effective in protecting the environment.

Potential sources of radiological and hazardous groundwater contamination include contamination of groundwater from the WMA, Inactive Landfill and Lagoon, as well as from two groundwater and surface water drainage ditches around the site.

Groundwater from the WL site flows from east to west towards the Winnipeg River. The surficial overburden soils on the WL site consist of layers of silt, clay, clay till, and basal sand overlaying Precambrian bedrock. The water table is located within the silt layer (0 to 3 m below ground surface) and fluctuates seasonally as a result of snow melt, precipitation and evapotranspiration. Figure 1.2 in section 1.2 provides an aerial view of the WMA, Inactive Landfill, Lagoon, and Main Campus relative to the Winnipeg River.

The north and west drainage ditches (ditch 8 and ditch 9) are also used to collect and divert shallow groundwater around the WMA. Water from the recharge area east of the WMA is diverted around the WMA towards the west and discharges into the Winnipeg River, while water north of the WMA is diverted through the second ditch towards the north site boundary. The presence of the ditches does promote some lateral flow in the silt, clay, and clay till units. This water is sampled as part of the WL site EMP, and monitoring results show levels to be at background.

3.2.4.1 Groundwater Quality

Groundwater is monitored for radiological and hazardous substances around the WMA, the Lagoon, and the Inactive Landfill to assess the extent and significance of any contamination around these structures and ensure that any contamination is localized. Groundwater is not used as a source of potable water on the WL site.

Radiological Contaminants in Groundwater

Radiological contaminants are monitored in groundwater as part of the WL site EMP and include gross beta, gross alpha, and tritium.

Waste Management Area

Groundwater quality is monitored from 70 groundwater monitoring wells around the WMA (see figure 3.3). Around the WMA, groundwater monitoring wells within the clay, clay-till, and basal sand layers and bedrock are sampled and analyzed. Table 3.19 provides a summary of the radiological groundwater quality monitoring results from all wells in and surrounding the WMA. The *Guidelines for Canadian Drinking Water Quality* [100] are also provided, for comparison only. As stated previously, groundwater on the WL site is not used as a source of drinking water.

Table 3.19: Average radionuclide concentrations in groundwater around the WMA (2013-2017) [15 to 33]

Surficial layer	Gross beta (Bq/L)	Gross alpha (Bq/L)	Tritium (Bq/L)
Drinking Water Guidelines [100]	1	0.5	7000
Clay	0.35 – 1.21	0.54 – 1.05	7.2 – 12.4
Clay till	0.36 – 0.86	0.35 – 0.77	9.0 – 13.4
Basal sand aquifer	0.16 – 0.65	0.1 – 0.2	3.4 – 5.2
Bedrock	0.15 – 0.82	0.17 – 0.55	3.4 – 4.4

A number of below-grade ILW bunkers are known to have groundwater inflow. Groundwater in the vicinity of these structures is monitored for caesium-137, strontium-90 and tritium as indicators of potential contaminant migration. Monitoring results over the past licensing period have shown elevated concentrations of tritium adjacent to a number of the ILW bunkers; however, these results have also shown that this contamination is localized within the clay and clay till layers. Given the low hydraulic conductivity, migration is limited. CNL will continue monitoring to confirm the extent of tritium migration. Slightly elevated concentrations of strontium-90 have also been measured in the groundwater adjacent to the ILW Bunker 1, but concentrations remain orders of magnitude below those measured in water samples within the bunker itself, demonstrating that migration is limited. In all cases groundwater contamination around the ILW bunkers remains localized, and the bunkers and surrounding clay layer are serving as an effective means of containment.

Within the WMA, water from the Soil Storage Compound and SMAGS waste facilities is collected by sumps. Monitoring results during the licensing period confirm that no leaks have been detected and that these structures are operating as designed.

Figure 3.3: WL site WMA Wells [23, figure A.2]

Note: Map not to scale.

Groundwater monitored from other structures around the WMA site, including the CCSF provide no evidence that indicate there has been any contamination of groundwater as a result of operations.

Lagoon

The Lagoon is located in the area adjacent to the Winnipeg River. Groundwater is sampled from 10 wells located in the water table and basal sand aquifer around the Lagoon during the spring. There is no impact from this groundwater to the Winnipeg River. Monitoring results of radiological contaminants in groundwater around the Lagoon are summarized in table 3.20.

Table 3.20: Average radionuclide concentrations in groundwater around the Lagoon (2013-2017) [15 to 33]

Surficial layer	Gross beta (Bq/L)	Gross alpha (Bq/L)	Tritium (Bq/L)
Drinking Water Guidelines [100]	1	0.5	7000
Water table	0.14 – 0.93	0.24 – 0.53	3.4 – 4.1
Basal sand aquifer	0.79 – 2.4	1.0 – 3.3	3.3 – 4.1

Inactive Landfill

The Inactive Landfill is located in the upland recharge area to the east of the WMA. Groundwater samples are collected from 13 wells located in the water table and basal sand aquifer around the Landfill area during the spring. Groundwater quality results have shown that contaminant levels are consistent with regional background concentrations. There is no impact from this groundwater to the Winnipeg River. Table 3.21 provides a summary of the groundwater quality monitoring results around the Inactive Landfill.

Table 3.21: Average radionuclide concentrations in groundwater around the Inactive Landfill (2013-2017) [15 to 33]

Surficial Layer	Gross beta (Bq/L)	Gross alpha (Bq/L)	Tritium (Bq/L)
Drinking Water Guidelines [100]	1	0.5	7000
Water table	0.1 – 0.44	0.08 – 0.19	4.2 – 8.4
Basal Sand Aquifer	0.16 – 0.71	0.07 – 0.78	3.3 – 4.0

WL Site Main Campus

Currently there are 29 groundwater monitoring wells around the WL Main Campus. In 2018 groundwater quality monitoring was initiated, and will be reported on in future annual reports. CNCS staff will assess these results as they become available.

Hazardous Contaminants in Groundwater

Hazardous substance parameters are also measured in groundwater wells around the WMA, Lagoon, and inactive landfill. Samples are analyzed for a range of metals, volatile organic compounds and hydrocarbons, which may be present in groundwater originating from stored waste on site. These include chromium, copper, iron, lead, zinc, arsenic, uranium, mercury, nitrate, nitrite, ammonia, chloride, volatile organic compounds (such as benzene, toluene, ethylbenzene, xylene, and acetone) and HB40 (organic coolant oil used during the operation of the WR-1 reactor). Results from groundwater well sampling around the WMA, Lagoon, and Inactive Landfill show that with the exception of uranium, iron and sulphate, concentrations of contaminants are within federal and provincial water quality guidelines and are consistent with previous groundwater assessments. In Manitoba, background concentrations of uranium, iron and sulphate are naturally high, and the results have shown these levels to be within expected regional background [97][101 to 102]. Considering that groundwater on site is not used as a source of drinking water, there is no expected impact from hazardous contaminants in groundwater to people or the environment.

Table 3.22 provides a summary of uranium concentrations in groundwater around the WMA, Lagoon and Inactive Landfill. The drinking water quality guideline for uranium is provided for comparison only. As stated previously, groundwater on the WL site is not used as a source of drinking water. Water from the Winnipeg River, may be a source of drinking water, and an assessment of surface water quality in the Winnipeg River (table 3.11), shows concentrations of uranium to be at 0.0002 mg/L, which is below the drinking water quality guideline of 0.02 mg/L.

Table 3.22: Average uranium concentrations in groundwater around the WMA, Lagoon, and Inactive Landfill (2013-2017) [15 to 33]

Surficial layer	WMA (mg/L)	Lagoon (mg/L)	Inactive landfill (mg/L)	*Uranium Drinking Water Guideline* (mg/L) [100]
Water table	-	0.012 – 0.013	0.001 – 0.002	0.02
Clay	0.032 – 0.040	-	-	
Clay Till	0.02 – 0.022	-	-	
Basal Sand Aquifer	0.0003 – 0.0004	0.056 – 0.090	0.0022 – 0.0036	
Bedrock	0.0008 – 0.0036	-	-	

3.2.4.2 Conclusion

CNSC staff have reviewed and assessed the hydrogeological environment around the WL site. Groundwater quality monitoring results around the WMA, Lagoon, and Inactive Landfill confirm that with the exception of localized contamination within the WMA, concentrations of radiological and hazardous contaminants in groundwater are below provincial and federal guidelines or within background.

Annual groundwater monitoring data indicate that there are elevated tritium concentrations at certain locations on the WL site, specifically around the WMA. However, tritium in groundwater does not extend beyond the WMA as contaminant migration is reduced by the clay and clay till layers. CNSC staff will continue to review CNL's groundwater monitoring results around the WL site, including areas around the WMA, Lagoon and Inactive Landfill.

As onsite groundwater is not used as a source of drinking water, there is no direct human health risk from this pathway. Based on a review of the most recent annual reports and the results from CNL's GWMP and annual environmental monitoring data, CNSC staff conclude that there are no adverse effects on the groundwater from the WL site and CNL continues to provide adequate protection of the hydrogeological environment.

3.2.5 Human Environment

An assessment of the human environment at the WL site consists of identifying critical groups located in proximity to the WL site, and whether the aforementioned environmental pathways will have an impact on these human receptors. Critical groups included residents of farms that are located in proximity to the WL site, as well as individuals engaging in harvesting of country foods (particularly local Indigenous communities, which continue to use the WL for traditional activities – see section 7.0). It is also acknowledged that humans perform other recreational activities in proximity to the WL site (swimming, fishing, hiking, camping and others), including hunting and trapping, however these activities are not considered representative of critical population groups [40].

Radiological and hazardous substance releases to the environment are monitored by CNL's EVMP and further assessed through the EMP. For radiological dose assessment, results of these monitoring and control activities are used to determine doses to members of the public and to ensure that doses remain below the regulatory limit.

For hazardous substance exposures, an approach encompassing a semi-quantitative pathways analysis was used to determine if members of the public would likely be exposed through air, water or the food chain.

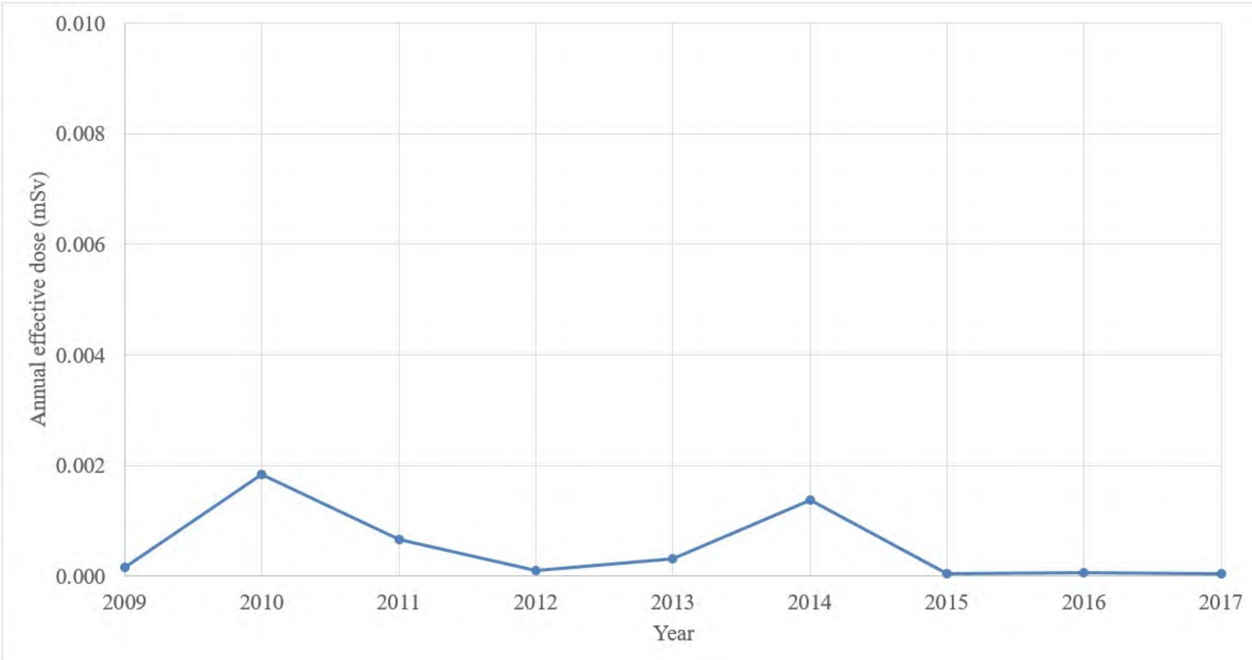
3.2.5.1 Public Exposure - Radiological

The CNSC's *Radiation Protection Regulations* [65] prescribe radiation dose limits to protect the public from exposure to radiation as a result of licensed activities. The annual effective dose limit for a member of the public is 1 mSv per year.

The annual doses to persons residing in the vicinity of the WL site are due to releases of radiological substances to the Winnipeg River, as well as from airborne emissions from various facilities on the site. The members of the public with the highest calculated exposure are residents located at a farm 3 km north of Building 200. These residents are assumed to reside year-round at the farm, to consume a significant fraction of fruits and vegetables grown at the farm, and are assumed to obtain all of their drinking water from the Winnipeg River, downstream of the WL site. Liquid effluents contribute almost entirely to the annual dose to these residents. They mainly originate from the Process Outfall, which consists of stormwater runoff from roadways and around buildings on the site, cooling water used in process and experimental faculties, water from holding tank discharges, as well as the active liquid waste treatment system tanks at Buildings 100 and 300. The remainder of liquid effluents originates from the sewage Lagoon, which collects sanitary and wastewater from most buildings on the site as well as from the laundry facility.

The annual doses to residents in vicinity of the WL site have been calculated based on environmental monitoring data as well as from measurements of airborne effluents. The dose to these farm residents in 2017, based on environmental monitoring, was 0.05 µSv (5×10^{-5} mSv) per year. The trend from 2009 to 2017 is shown in figure 3.4. During that period, the annual dose to the public did not exceed 0.002 mSv. The annual dose limit for members of the public, as stipulated in the *Radiation Protection Regulations* is 1 mSv. The annual dose from background radiation in the Winnipeg area is 4.1 mSv. This includes exposures from cosmic radiation, natural radioactivity in the ground and in food, as well as from radon.

Figure 3.4: Maximum calculated annual effective dose for a member of the public due to site releases of nuclear substances: 2009 to 2017 [15 to 23][25 to 33]*



* Annual effective dose over the previous licence period has remained consistently well below the annual public dose limit of 1 mSv per year. The variance shown in figure 3.4 is not considered by CNSC staff to be significant, and presents no concern with respect to risk to members of the public.

The 2017 dose to the public from the WL site remained well below the regulatory limit of 1mSv per year. Over the licensing period, CNL continued to ensure protection of members of the public in accordance with the *Radiation Protection Regulations* [65].

3.2.5.2 Public Exposure – Hazardous Substances

Effects on public health were assessed to determine if there was potential for exposure of members of the public to contaminants through several routes of exposure such as air, water or the food chain. This assessment included an evaluation of air quality, drinking water quality (surface water and groundwater), water quality of the Winnipeg River for recreational activities, and exposure to contaminants. The assessment did not include exposure to hazardous substances through consumption of food in the vicinity of the WL site, although the potential for exposure through this pathway is expected to be limited.

As onsite groundwater is not a source of drinking water, there is no direct exposure of humans from this pathway.

Measurements of hazardous substances contaminants in WL site effluents from the Lagoon and Process Outfall discharging to the Winnipeg River also indicated that concentrations of these substances did not exceed the monthly guideline limits. Monitoring of water quality of the Winnipeg River 40 km downstream from the WL site for hazardous substance parameters also indicated that, with the exception of aluminium, levels of metals are well below the Canadian drinking water quality guidelines (table 3.23). However, aluminum is an abundant element in the Earth’s crust (about 8 %) and elevated levels of this element in natural waters is not uncommon

[103][104]. Varying amounts of aluminum in North American rivers has been reported in the literature [105]. It is also unclear what, if any, aluminum contribution to the Winnipeg River has been made through operations at the WL site. Overall, it can be surmised that risk to human health via the drinking water ingestion pathway would be negligible.

Table 3.23: Average (and maximum) concentrations of metals from 2008 to 2018 measured at the water sampling station near the Powerview Dam on Winnipeg River, downstream of the WL site, from Manitoba Department of Sustainable Development [106]

Metal	Al	As	Cd	Cu	Cr	Mo	Ni	Se	U	Zn
Value (µg/L)	163 (239)	0.8 (1.7)	0.007 (0.008)	1.2 (1.3)	0.1 (0.1)	0.2 (0.2)	0.8 (1.0)	0.1(0 .2)	0.1 (0.2)	0.2 (0.3)
Canadian Drinking Water Quality Guideline (µg/L) [107]	100	10	5	1000	5	-	-	5	20	5000
WHO *Drinking Water Quality Guideline* (µg/L) [108]	900	10	3	2000	50	70	70	40	30	3000

Monitoring of hazardous substances atmospheric emissions from the WL site included contaminants such as nitrogen oxides, sulphur dioxide, carbon monoxide, particular matter (PM $_{10}$ and $PM_{2.5}$), and volatile organic compounds. Results of this monitoring suggest that risk to human health via the inhalation route of exposure would be negligible.

Characterization of hazardous substances contaminants in soil media and food near the site is not available. However, based on data reported for atmospheric emissions, which is the dominant source of deposition onto soil and food resources, exposure of humans to these contaminants via the ingestion pathway is likely to be limited.

Given that decommissioning activities are not expected to result in increased emissions of hazardous substances to air and surface water, it can be inferred that overall risk to human health is characterized as low.

3.2.5.3 Conclusion

Results of environmental monitoring indicated that dose to members of the public are well below the regulatory dose limit of 1 mSv per year. CNL ascertained to annual dose using the results of the effluent and EMPs at the WL site. These are described in section 3 of this report. The dose to residents living year-round on a farm near the WL site was calculated to be 0.05 µSv in 2017. A 10-year trend of the annual effective dose to exposed members of the public showed a downward trend. An evaluation of the routes of exposure to human receptors from groundwater, surface water, airborne emission, soil and food suggested that overall risk to health of members of the public from radiation was low.

Given that the decommissioning activities at WL are not expected to increase emission of radiological and hazardous substances to air and surface water, it can be inferred that the overall risk to human health is characterized as low.

4.0 CNSC INDEPENDENT ENVIRONMENTAL MONITORING PROGRAM

The CNSC has implemented its IEMP to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to the CNSC's ongoing compliance verification program. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological and hazardous contaminant substances in those samples. CNSC staff collect the samples and send them to the CNSC's laboratory for testing and analysis.

4.1 IEMP at the Whiteshell Laboratories Site

The IEMP was completed in 2017 around the WL site. The 2017 IEMP sampling plan for the WL site focused on radioactive contaminants. A site-specific sampling plan was developed based on the CNL's approved EMP and the CNSC's regulatory experience with the site. In 2017, CNSC staff collected air, soil, sediment, vegetation, food and water samples in publicly accessible areas outside the WL site perimeter.

CNSC staff sampled the following in the vicinity of the WL site:

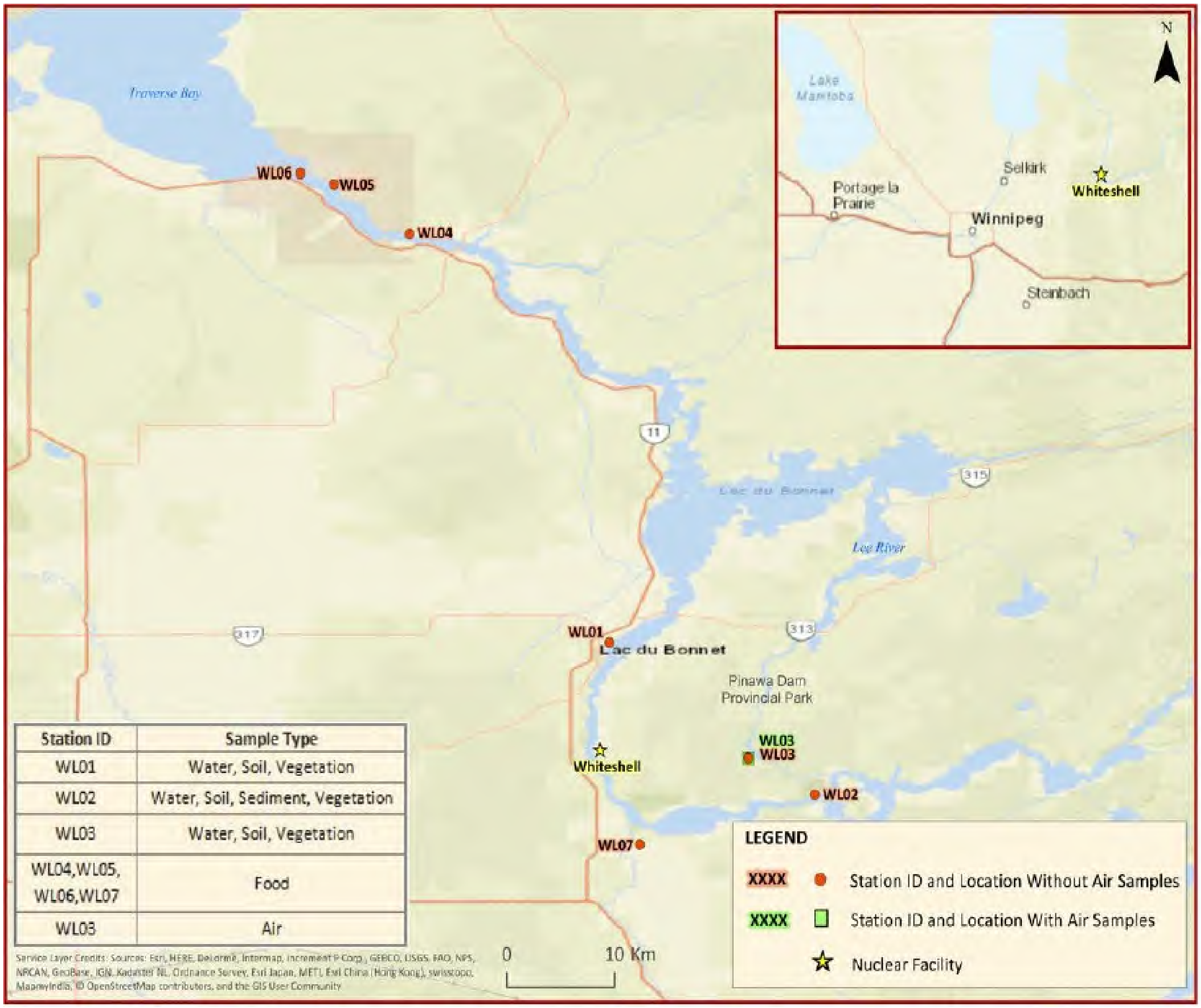
- air (1 location)
- water (3 locations)
- soil and sediment (4 locations)
- grass and wild vegetation (3 locations)
- food (6 locations)

Samples collected were analyzed by qualified laboratory specialists in the CNSC's laboratory in Ottawa, using appropriate protocols. CNSC staff measured the following:

- radioactive particulates, including caesium-137, cobalt-60, organically bound tritium, tritiated water, gross alpha and gross beta

Figure 4.1 provides an overview of the WL site and sample locations for the 2017 IEMP sampling campaign, and the IEMP results are published on the CNSC's website [36].

Figure 4.1: Location overview of the sample locations [36]



4.2 Sampling with Sagkeeng Anicinabe

It is a priority for the CNSC that IEMP sampling reflects Indigenous traditional land use, values and knowledge where possible. In addition to planned IEMP sampling activities, three fish were sampled on this trip, in collaboration with the Sagkeeng Anicinabe (Sagkeeng).

In May 2017, Sagkeeng and CNSC staff met to discuss the proposed *in situ* decommissioning of the WR-1 and IEMP. During that meeting Sagkeeng requested that fish from the Winnipeg River be sampled. Together, CNSC staff and Sagkeeng caught a northern pike sample, downstream from the WL site. Sampling results were provided to Sagkeeng in April 2018 and CNSC staff have made themselves available to discuss the results with the community. CNSC staff will continue to work with Indigenous communities in future sampling campaigns and will take into account any available IK studies to ensure meaningful results are obtained.

4.3 Summary of Results

The levels of radioactivity in all of the aforementioned samples were below available guidelines and CNSC screening levels, details of which can be found in the IEMP Technical Information Fact Sheet [109]. These screening levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv per year, which represents one tenth of the CNSC's public dose limit of 1 mSv per year. No health or environmental impacts are expected at these levels.

The IEMP results for 2017 indicate that the public and the environment in the vicinity of WL site are protected and that there are no expected health impacts. These results are consistent with the results submitted by CNL, demonstrating that the licensee's environmental protection program protects the health and safety of people and the environment.

5.0 HEALTH STUDIES

The following section draws from the results of regional health studies to provide further independent verification that the health of people living near the WL site is protected. The health of populations around the WL site are monitored by various organizations and institutions in Manitoba and disease rates are compared to other populations to detect any potential health outcomes that may be of concern. CNSC staff keep abreast of any new publications related to the health of populations living near nuclear facilities.

There are several health studies and reports that assessed the health of populations living the near WL site. The CNSC continues to carefully monitor and conduct health studies to ensure the protection of human health. Additional information on health studies related to nuclear facilities is available on the CNSC webpage on Health Studies [110].

The following sections provide a list of health studies carried out in the region.

5.1 Population and Community Health Studies and Reports

5.1.1 Interlake-Eastern Regional Health Authority (2014)

The Interlake-Eastern Regional Health Authority (RHA) and Community Health Assessment (2014) examines factors that affect the health of people living in areas serviced by the Interlake-Eastern Regional RHA and health outcomes within the populations, including those near the WL site [111]. Cardiovascular diseases (i.e., heart disease and stroke) are the leading cause of death in the region, followed by cancer. The region's cancer incidence rates are similar to the whole of Manitoba. The prevalence of related key risk factors was also assessed. The percentage of regional residents who currently smoke (23%) was slightly higher than that of Manitoba (20%). Similarly, the proportion of residents who are overweight or obese (62.3%) was slightly higher than the Manitoba average (56.4%).

This community health assessment also provides data on First Nations living in the region. The majority of the data are for First Nations living on reserve, which represents 80% of the First Nations population in the region. The Interlake-Eastern RHA summarizes data from CancerCare Manitoba 2013-2014 [112], and the First Nations Regional Health Survey 2008–2010 [113], which are also further described below. The cancer incidence rate for First Nations living on reserve within the Interlake-Eastern RHA was 629.6 cases per 100,000 people which was statistically significantly higher than the Manitoba average of 471.2 cases per 100,000 people and the regional average of 471.8 cases per 100,000 people. Furthermore, cancer survival rates were statistically significantly lower for First Nations living on reserve in the region compared to the provincial average.

First Nations in the region were well below the regional average for breast cancer, cervical, and colorectal cancer screening. Cancer screening increases the likelihood of early detection and treatment, and can improve cancer survival. The daily smoking rate for First Nations adults on reserve in the region (48.1%) was higher than the rate of First Nations living off reserve (16.4%), Manitoba (19.6%) and Canada (19.0%). Tobacco smoking is the main cause of cancer, especially lung cancer.

5.1.2 Manitoba Health (2016–2017)

The Manitoba Health, Seniors and Active Living's Annual Statistics Report describes Manitoba's population, health utilization and health status using key health indicators [114]. In Manitoba, the five most common causes of death include: heart disease (27.7%), cancer (27.1%), respiratory disease (8.6%), mental/behavioural issues (7.9%), and injuries (7.5%). The population within the Interlake-Eastern RHA have a slightly higher premature death rate compared to the Manitoba average, but also have higher rates of heart attacks, which may account for this increase [114]. However, there is no information provided on whether these differences are statistically significant.

5.1.3 CancerCare Manitoba Reports (2013–2014), (2015)

CancerCare Manitoba released a Community Health Assessment Report (2013–14) that examines cancer risk factors (such as smoking and limited physical activity), wait times for screening and treatment, and incidence, mortality and survival rates. Risk factors for cancer such as obesity, smoking and alcohol consumption, show considerable variation by region and are frequently higher in the North. In Manitoba, 23.4 % of the population are obese (this does not include individuals who are overweight), and 19.6 % are smokers [112].

The 2015 Annual Statistics Report, based on data from the Manitoba Cancer Registry, found lung cancer to be the most commonly diagnosed cancer site in Manitoba, followed by breast cancer. This is consistent with the leading cancer sites for Canada in 2015 [114]; however, the cancer mortality rate in Manitoba is slightly lower than the national rate [116].

5.1.4 Cancer Incidence in First Nations living in Manitoba

In Manitoba, First Nations people constitute almost 10% of the population. A study by Decker et al. (2016) looked at the prevalence of breast cancer and colorectal cancer incidence in First Nations in Manitoba compared to the provincial rate from 1984–2008 [117]. Historically, First Nations in Manitoba have had lower rates of cancer and chronic diseases than other Manitoba residents. However, the rate of cancer incidence and cancer mortality appears to be increasing due to changes in behavioural, environmental, other social factors and lower rates of participation in early cancer screening activities. Further, as life expectancy increases and people live into old age, we see an increase in cancer incidence and mortality rates.

Although overall breast cancer incidence remains lower for First Nations women compared to the provincial rate, the rate among First Nations women increased more rapidly from 1984–2008.

Likewise, the breast cancer mortality rate increased among First Nations women, whereas the provincial mortality rate decreased [117]. Similar increases in breast cancer incidence and mortality among Indigenous peoples has been observed elsewhere, in Greenland, New Zealand, United States and elsewhere in Canada. One of the factors that may influence this increase is breast cancer screening among First Nations women. Demers et al. (2015) assessed breast cancer screening rates among First Nations women compared to all other Manitoba women [117]. First Nations women had lower rates of mammography (a method to screen for breast cancer) compared to all other Manitoba women [118].

The incidence of colorectal cancer among First Nations people has also increased, and in 1999–2003, it surpassed the rate for all Manitobans. Although colorectal cancer mortality rate for all Manitobans declined over time, the colorectal cancer mortality rate for First Nations people increased by a factor of eight. Similarly, another study by Decker et al. (2015), found that First Nations living in Manitoba were less likely to have colorectal cancer screening [119].

5.1.5 First Nations Regional Health Survey (2008–2010)

The First Nations Regional Health Survey (RHS) Phase 2 (2008-2010): Manitoba Regional Report [120] was designed, developed, and delivered by Indigenous peoples across Canada. The self-report survey was supported by the Manitoba Chiefs-in Assembly. The report presents a snapshot of a variety of health indicators, including self-assessment of health, access to care, and socio-economic factors in First Nations people of Manitoba for 2008–2010, as well as providing data on involvement in traditional activities on lands, and related culturally based indicators.

For health outcomes the two most prevalent chronic diseases amongst Manitoba First Nation adults are hypertension (high blood pressure) and diabetes, with the vast majority being type 2 diabetes. In terms of health risk factors, approximately 50% of young adults (18–34) and adults (35–54) are daily smokers with lower rates for those age 55 and older. Access to health care is also a major issue; 55.8% of adults indicate that they have less access to health services compared to the general Canadian population, mainly due to long wait times and lack of health care providers [120].

5.2 Summary of Health Studies

Reviewing and conducting health studies and reports is an important component of ensuring that the people living near nuclear facilities are protected. The population and community health studies and reports indicate that common causes of death among the Manitoba populations (provincial, Interlake-Eastern RHA, and First Nations) include heart disease and cancer. This is similar to other provinces in Canada where heart disease and cancers are the two leading causes of death, aside from Nunavut, where heart disease and respiratory diseases are the leading causes of death [121].

The above health studies are descriptive studies which compare the occurrence of health outcomes within a population at a certain time in a given geographical area to the “expected” occurrence of the disease in a stable reference population (such as the general population of the province or Canada). Descriptive studies have some limitations, such as: 1) the results are averaged over a group and do not look at the individual level, and 2) individual exposures are not known, and they cannot be used to determine the cause of a health outcome, however they are used to generate hypotheses regarding potential risk factors for health outcomes. For further information regarding advantages and disadvantages of health study designs please see INFO-0812 [122].

These health studies and reports provide a snapshot of the health of people living near the WL site. CNL currently meets CNSC's regulatory requirements. Based on exposure and health data, CNSC staff have not observed and do not expect to observe any adverse health outcomes due to the presence of the WL site.

6.0 OTHER REGIONAL MONITORING PROGRAMS

There are several regional monitoring programs carried out by other levels of government, which the CNSC has reviewed to confirm that the environment and the health of persons around the WL site are protected. A summary of the findings of these programs are provided below.

The Radiation Protection Bureau of Health Canada manages the Canadian Radiological Monitoring Network (CRMN) [123]. The CRMN routinely collects drinking water, precipitation, atmospheric water vapour, air particulate, and external gamma dose for radioactivity analysis at 26 monitoring locations. The closest CRMN monitoring location to the WL site is in Winnipeg. The results at the Winnipeg station for 2017 and 2018 are consistent with data from previous years and are well below the acceptable public dose limit.

In addition, Health Canada has complemented its CRMN network with a Fixed Point Surveillance (FPS) system [124]. The FPS functions as a real-time radiation detection system designed to monitor public dose from radioactive materials in the air, including atmospheric releases associated with nuclear facilities and activities both nationally and internationally. Monitoring stations continuously measure gamma radioactivity levels from ground-deposited (ground-shine) and airborne contaminants.

Health Canada measures the radiation dose rate as Air KERMA (Kinetic Energy Released in unit MAss of Material) reported as nanoGray per hour (nGy/h) of absorbed dose. These measurements are conducted every 15 minutes at 79 sites of its FPS network across the country. Air KERMA is also measured for three radioactive noble gases associated with nuclear fission which may escape into the atmosphere during normal operation of nuclear facilities. These three noble gases are Argon-41, Xenon-133 and Xenon-135. CNSC staff converted the absorbed dose rate to an effective dose, reported in mSv per year, which allows for comparison to annual background dose estimates and the regulatory public dose limit.

The 2017 and 2018 total external gamma doses reported for the FPS network near Winnipeg are similar to the Canadian average for natural background from gamma (the range is 0.007 – 0.027 mSv per year). These results indicate that total external gamma dose at these stations is not significantly influenced by activities at the WL site. Further evidence of this is provided by the extremely low activity levels reported for the noble gases, as outlined in table 6.1. All of the results are significantly below the public dose limit of 1 mSv.

Table 6.1: Annual external gamma doses (mSv per year[1]) for 2017 and 2018 at the Fixed Point Surveillance network monitoring stations associated with the WL site.

Monitoring stations near Whiteshell	External gamma dose				
	Year	All gamma sources	Monitored noble gases (Fission products)		
			Argon-41	Xenon-133	Xenon-135
Winnipeg	2017	0.011	*	*	*
Winnipeg	2018	0.011	*	*	*

*No data is reported when results were below the minimum detectable dose
[1] Assumptions: adult located at monitoring station for 24 hours a day, 365 days per year. Air KERMA in nanoGray corrected. Total Dose: 0.69 mSv for every Gray of absorbed dose measured: Argon-41: 0.74; Xenon-133: 0.75; Xenon-135: 0.67.

7.0 INDIGENOUS KNOWLEDGE STUDIES

The CNSC acknowledges the importance of working with and integrating IK into staff assessments and regulatory activities, when provided to the CNSC by Indigenous communities. One way in which the CNSC integrates IK is through collaboration and understanding of IK studies pertaining to CNSC regulated facilities and activities. These studies provide community-specific knowledge of the land, waters, and resources where CNSC-regulated facilities are located and of the potential or existing interactions of those facilities with Indigenous communities' historic and current land use, values, rights and interests. The studies and IK contained within them, represent the distinct Indigenous perspective on their specific interests, exercise of their rights, and potential impacts on the same.

In January 2019, CNSC staff received an IK study from the Manitoba Metis Federation (the MMF, which is the democratically elected, self government representative of the Manitoba Metis Community) [37][38] pertaining to the proposed *in situ* decommissioning activities for the WR-1 reactor at the WL site, located within their traditional territories. This study was supported by the CNSC's Participant Funding Program (PFP), as part of the WR-1 EA and licensing review process (which is separate from this licence renewal process), and conducted in order to provide CNSC staff and CNL with Indigenous-specific knowledge and perspectives of the proposed decommissioning activities for the WR-1 reactor. This study also assessed the potential impacts of the newly proposed *In Situ* Decommissioning of the WR-1 Project to Manitoba Metis Community's historic connection to, contemporary use of, and occupancy of this portion of their traditional territory.

CNSC staff are currently reviewing the MMF's study in detail and are working with the MMF on how to best incorporate and reflect the information into CNSC's regulatory review processes and activities pertaining to the WL site, including the ongoing review of the proposed *In Situ* Decommissioning of the WR-1 Project that is the subject of a separate EA and licensing review process. For the purposes of the WL site licence renewal and this EPR, the information provided in the study has not been incorporated into the Environmental Effects Assessment section of this report (section 3.2). CNSC staff require more time to adequately consult and collaborate with the MMF, in order to ensure the contents of their study is appropriately and respectfully integrated into CNSC regulatory processes and assessments, and that potential impacts on rights and concerns identified in the studies are adequately addressed, mitigated and resolved.

CNSC staff recognize that MMF has unique values and interests. Their IK study provides a distinct set of data and perspectives that help the CNSC better understand how the MMF view the proposed WR-1 decommissioning activities and the WL site's interaction with their traditional territory, along with key VCs that are considered vital to their citizens, in exercising their Indigenous rights. The relevant VCs and baseline conditions detailed in the study has been summarized at a high level in this EPR Report, in order to acknowledge all information available to CNSC staff, which will be fulsomely examined and incorporated in collaboration with MMF moving forward.

The CNSC endeavours to collaborate with Indigenous communities in order to ensure IK is appropriately protected, managed and reflected in resulting documentation, where appropriate. The following section discussing the MMF study has been reviewed by the MMF, in advance of publishing this EPR Report. MMF has given CNSC staff permission to include this content and have collaborated in compiling the respective portions of Section 7.

Notwithstanding this collaborative approach, it is important to read their report in its entirety for the full context of the information provided below, including the distinct Indigenous-perspectives captured in each study, and acknowledge that this section reflects a high-level summary of the information.

In addition, CNSC staff received in January 2019 an IK study from Sagkeeng pertaining to the proposed *in situ* decommissioning activities for the WR-1 reactor at the WL site, located within their traditional territory. This study was also supported by the CNSC's Participant Funding Program (PFP), as part of the WR-1 EA and licensing review process (which is separate from this licence renewal process), and conducted in order to provide CNSC staff and CNL with Indigenous-specific knowledge and perspectives of the proposed *In Situ* Decommissioning of the WR-1 Project. This study also assessed the potential impacts of the newly proposed *In Situ* Decommissioning of the WR-1 Project to Sagkeeng's historic connection to, contemporary use of, and occupancy of this portion of their traditional territory.

Sagkeeng has clarified with CNSC staff that the scope of their study is specific to the *In Situ* Decommissioning of the WR-1 Project and does not include inputs from Sagkeeng members on the management of the whole WL site or anything beyond WR-1. This was a project-specific Land Use and Occupancy Study and its results cannot be automatically interpolated to extend and encompass other issues relating to the WL site, or Sagkeeng territory. Therefore, CNSC staff have not included a summary of the Sagkeeng study in this EPR Report, which is specific to the WL site licence renewal process.

The concerns raised in Sagkeeng's study are primarily focused on the proposed *In Situ* Decommissioning of the WR-1 Project and not specific to the renewal of the WL site. CNSC staff are committed to working with Sagkeeng leadership and community members to help address the concerns raised in their study, with relation to the proposed *In Situ* Decommissioning of the WR-1 Project. CNSC staff will continue to work to meaningfully incorporate the values and information provided by Sagkeeng into CNSC's regulatory processes and activities, including the EA and licensing process for the proposed *In Situ* Decommissioning of the WR-1 Project and to fulfill its obligations related to the duty to consult and accommodate, where appropriate, and uphold the honour of the Crown in relation to the proposed activities.

7.1 Manitoba Metis Federation

In 2018, the MMF undertook a Traditional Knowledge, Occupancy and Land Use Study, in collaboration with Shared Value Solutions (SVS), related to the proposed *In Situ* Decommissioning of the WR-1 Project [37]. The study had three stated main goals:

1. Provide evidentiary data of how Metis harvesters who participated in the study are using the lands and waters around the WR-1 Reactor site;
2. Provide information on consumption frequency and quantity as it relates to harvested country foods relied on by Metis harvesters within a 50 km area around the WR-1 Reactor site;
3. Provide this information in a format that is consistent with the current MMF Metis Land Use and Occupancy data so that the study can build upon this existing information.

Although the focus of the study was primarily on the *In Situ* Decommissioning of the WR-1 Project, the scope of this study is relevant to the WL site under consideration for licence renewal as it highlights various concerns of MMF community members (also known as MMF Citizens) and includes evidence about MMF Citizens past and present use of the WL site and surrounding area to exercise their Metis specific rights, practices and traditions. However, it is important to note that the study is specific to the proposed decommissioning activities for the WR-1 project and the building in which it resides[5], not the WL site as a whole.

7.1.1 Study Scope and Valued Ecosystem Components

The information in the study is based on interviews with 10 citizens and harvesters from the Manitoba Metis Community, conducted between November 19 and 23, 2018. Participants were selected through self-identification on a consumption survey mailed to Metis citizens that attended a MMF information and engagement meeting held in Lac Du Bonnet, MB, as well as through phone contact with MMF Citizens holding Metis harvesting cards.

The data collected for this study was obtained using a map biography process, involving the marking of locations of features identified during interview discussion on digital maps using the ESRI Arc Geographic Information System program. At the same time, interview participants provided descriptions associated with the data points. This information was augmented by oral interviews, where participants shared traditional knowledge of the land through direct recollections, family stories, perceptions of the areas in question, and future hopes for the study areas.

The data provided in these interviews are discussed and analyzed as site-specific use values, geographically located within a particular proximity to the proposed *In Situ* Decommissioning of the WR-1 Project according to two scales (as described in table 7.1). Furthermore, table 7.2 contains the details of the number of site-specific use values, according to location type including observed changes to the environment.

[5]Referred to in this section, for purposes of this study, as the WR-1 facility.

Table 7.1: Manitoba Metis Federation Study Areas [37]

Study area	Description
100 m Study Area	This area includes the Winnipeg River, between Seven Sisters to the mouth of Lake Winnipeg, as well as Lac du Bonnet and the Lee River. In addition to these water bodies, a 100 m buffer on either side of these bodies are included in this Study Area.
25 km Study Area	This area represents a 25 km buffer around the WR-1 site.

Table 7.2: Manitoba Metis Federation locations of Land Use and Occupancy [37]

Location types	100 m Study area	25 km Study Area (including 100 m Study Area)
Access routes	12	23
Fishing locations	38	44
Trapping / snaring locations	-	3
Gathering locations	-	18
Commercial guiding or other commercial land use	-	3
Changes to environment	15	32
Hunting locations	2	8
Demographic locations	2	41
Locations of cultural significance	2	11
Other land use (Ice-fishing huts)	2	2
Total	**75**	**192**

In addition to the 192 sites of land use and occupancy (LUO) identified within the 25 km study area, an additional 232 locations of LUO were identified by participants, for a total of 424 Metis LUO locations. Each of these identified Metis LUO locations represents evidence of the exercise of Metis specific s. 35 rights, practices, or traditions in the study area. The temporal scope of this use is according to "current use", which is defined as within the lifetime of the interview participant. These results cannot be considered a comprehensive representation of all Manitoba Metis Community LUO in the study areas, but rather provide a reasonable representation of the information that is available from a small sample of the Manitoba Metis Community, based on the limited interviews undertaken and study scope.

In addition to the detailed description of these LUO locations identified in this study, MMF produced a *Review of Draft Valued Components (VCs) and Related Measurement Endpoints and Indicators for the Project Environmental Impact Statement (EIS)* [38]. Table 7.3 contains all of the VCs identified in both documents. The VCs identified by the MMF specifically relate to environmental components that, if affected by the *In Situ* Decommissioning of the WR-1 Project activities, could potentially have corresponding impacts on s. 35 Metis rights. Many of the specific biota VC species were identified based upon MMF Citizens providing evidence in the interviews and study of direct consumption and reliance on these species for substance purposes.

In addition, the *Review of Draft Valued Components (VCs) and Related Measurement Endpoints and Indicators for the Project Environmental Impact Statement (EIS)* highlighted that a distinctions-based approach, which considers the Manitoba Metis Community's VCs as distinct from other Indigenous and non-Indigenous VCs, would more accurately and meaningfully identify, measure, and consider impacts on MMF Citizens. CNSC will be working with the MMF through the WR-1 EA and licensing process to ensure the different impacts, uses, and considerations for each VC are considered through a Metis-specific lens as the CNSC acknowledges the distinct knowledge, perspective, and experience of MMF Citizens.

Table 7.3: Valued components identified by the Manitoba Metis Federation [37][38]

Category	Valued components
Air	Air Quality
Water	Surface water and groundwater quality (drinking water)
Sediment	Sediment quality
Soil	Soil quality and quantity
Biota	Fish: walleye / pickerel, lake sturgeon, carmine shiner, lake whitefish, smallmouth bass, jackfish / northern pike, suckers, goldeye, mooneye, perch, and catfish Aquatic Invertebrates: benthic invertebrates
	Birds: geese, ducks, ruffed grouse, spruce grouse, partridge, horned grebe, trumpeter swan, mallard, barn swallow, and golden-winged warbler, American robin, loggerhead shrike Mammals: moose, white-tailed deer, marten, rabbit, squirrel, weasel, mink, meadow vole, common shrew, snowshoe hare, white-tailed deer, red fox, northern myotis and little brown myotis Invertebrates: earthworm Reptiles: snapping turtle
	Plants: wild rice, berries (blueberries, pin cherries, cranberries, Saskatoon berries, chokecherries, gooseberries, strawberries, raspberries and wild plums); Labrador tea, fiddleheads and hawthorn nuts; other aquatic and terrestrial plants, including grasses and shrubs, including flowers; trees including poplar, spruce, jackpine, birch; flowers
Ecosystem	Various areas that serve as habitat, including: marsh habitat, for wild rice, as well as jackfish and water fowl; fish habitat for sturgeon and jackfish, in order to ensure self-sustaining and ecologically effective fish populations; plant and berry, bird, mammal and reptile habitat, more generally
Human	Socioeconomic: government finances, business opportunities, community well-being, infrastructure and services, employment and income
	Human Health: public health and safety, worker health
	Traditional land and resource use: hunting, fishing, trapping, plant and berry gathering, as well as outdoor recreation and tourism, capacity for continued land tenure and use, tubing on the water, access to boat launches, land and water trails, gathering of firewood
	Cultural and Archaeological Sites: protection and preservation of cultural and archaeological sites; gathering places, picnic areas, swimming areas
	Sense of well-being: connection to the land, spiritual practices

7.1.2 Reported Impacts to Manitoba Metis Federation Citizens

Overall, the study demonstrated that MMF Citizens rely on and use the land and waters around the WL site for various cultural and traditional activities, and have done so both prior to the construction of the WR-1 and WL site and continue to do so in the present day. MMF Citizens interviewed for the study expressed concerns about degradation of water quality and resources, and the impacts of extreme weather events on the WL site leading to potential impacts to human and environmental health in the 100m and 25km study areas and beyond. Study participants stressed how contamination of the land, waters and species that they value and rely on to maintain their Metis specific traditions, exercise their rights, and feed their families, both in and around the WL site, could have cascading impacts on MMF Citizens (through impacts to aquatic and terrestrial resources, contamination of resources relied on, and their cultural ways of life).

The MMF interviewees expressed a desire to have a better understanding of all activities taking place on the WL site, potential impacts of these activities, and the mitigation measures in place. The study expressly recommended further engagement between CNSC and the MMF to further address these potential impacts and concerns.

The study concluded that many MMF Citizens have concerns based on their harvesting experience about contamination and the quality of water, plants, fish, wild rice, medicines, berries, wildlife and plant species in their traditional territory, including the WL site. MMF Citizens expressed that they would like further information regarding the safety of these resources to help address their perception of potential or real contamination or risk of traditional resources. The study also provided evidence by Metis Citizens that a perception of a contamination risk associated with the WL site could impact their s. 35 harvesting activities in the study area and result in avoidance behaviours that affect Metis Citizens preferred means of exercising their s. 35 rights.

The study also provided evidence of outstanding questions regarding the progress of decommissioning activities at the WL site and overall timelines. Interviewees requested more frequent communication on these topics from CNL and the CNSC, and wish to participate in the planning and oversight of these activities in order to ensure that Metis laws of harvest and harvesting timeframes are adequately considered. Throughout the upcoming WR-1 EA process and the lifecycle regulation of the WL site, the CNSC will continue to work with the MMF to address these concerns and perceptions, including providing regular updates on the WL site and decommissioning activities and assessing potential impacts and VCs identified in their IK study and through consultation.

Given the concerns raised and desire for continued stewardship of Metis traditional territories, interviewees demonstrated an interest in serving as equal partners in problem solving and decision-making regarding land use and decommissioning activities on and around the WL site, to help contribute to the sustainability of their traditional territories, including preservation and accessibility for future generations.

7.1.3 Conclusion

The experiences and values of the Metis Citizens interviewed in the Metis Traditional Knowledge, Occupancy and Land Use Study describe the importance of various sites in proximity to the WL site relating to hunting, trapping and fishing activities, harvesting activities, as well as overall well-being and way of life of the Manitoba Metis Community.

The data collected in this study demonstrates how in and around the WL site has been, and continues to be, used by MMF Citizens for activities that are important to the Manitoba Metis Community's culture, traditions, rights and ongoing livelihood. Furthermore, the detailed accounts reveal evidence of the participants' concern that these cultural practices and exercise of their Metis-specific s. 35 rights have been impacted by activities at the WL site and that there are ongoing concerns regarding potential impacts associated with the decommissioning and other proposed activities.

Through this study MMF has identified a number of VCs of significance to their rights, culture and interests, in and around the WL site. These include resources such as water, medicines and subsistence resources (plants, berries, fish and game), the associated traditional activities, such as harvesting, hunting, and trapping, as well as Metis ways of life, incorporating concepts such as sense of place, identity, connection to the land, psychological well-being, ceremonial practices, and methods of knowledge-sharing.

CNSC staff are committed to working with MMF leadership and Citizens to help address the concerns raised in the study, with relation to the WL site. CNSC staff will continue to work meaningfully with the MMF to incorporate the values and information provided in their IK study into CNSC's regulatory processes and activities, including the EA and licensing process for the proposed *In Situ* Decommissioning of the WR-1 Project and to fulfill its related duty to consult and accommodate, where appropriate, and uphold the honour of the Crown in relation to the proposed activities.

8.0 RECOMMENDATIONS AND CONCLUSIONS

The EPR conducted for the WL Nuclear Research and Test Establishment Decommissioning Licence concludes that CNL has taken adequate provisions for the health of persons and the protection of the environment and will continue to do so in the future.

CNSC staff reviewed CNL's licence application and the documents submitted in support of the application, as well as the CSR, annual reports, and compliance verification activities conducted at the WL site. CNSC staff conclude the licence application and supporting documents submitted in support of the application are satisfactory and meet CNSC's regulatory requirements.

CNSC staff also reviewed the results from other regional monitoring programs conducted by other levels of government, which substantiate CNSC staff's conclusion that the environment and health of persons are protected from operations at the WL site. CNSC staff also conducted IEMP sampling around the WL site in 2017. Both the regional monitoring results and IEMP results confirm that the public and the environment around the WL site are protected and that there are no health impacts as a result of ongoing activities. These results are consistent with the results submitted by CNL, demonstrating that the licensee's environmental programs protect the health of persons and the environment.

CNSC staff acknowledge the concerns raised by MMF in information they have provided to the CNSC, including through their IK study. CNSC staff are committed to working with MMF leadership and citizens to help address the concerns raised. The values and information provided by this IK study will be meaningfully incorporated into CNSC's regulatory work and activities, including, but not limited to the EA for the *In Situ* Decommissioning of the WR-1 Project.

This EPR focused on items of current public and regulatory interest, including physical stressors, releases to air, groundwater and surface water from ongoing operations and activities related to ongoing decommissioning activities. CNSC staff conclude that the potential risk from physical stressors and radiological and hazardous releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible. However, CNSC staff expect that CNL will conduct a site-wide ERA in accordance with REGDOC-2.9.1 and the CSA Standard N288.6-12, *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* during the next licensing period

This EPR conducted for the renewal of the WL NRTEDL concludes that CNL has and will continue to make adequate provision for the protection of the environment and the health of persons. CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health of persons are protected and will continue to be protected over the proposed licence period.

The information provided in this EPR Report supports the recommendation by CNSC staff in CMD 19-H4 to renew CNL's Nuclear Research and Test Establishment Decommissioning Licence for the WL site (NRTEDL-W5-8.05/2019) for a period of ten years.

ACRONYMS

Acronym	Term
AECL	Atomic Energy Canada Limited
AL	Action Level
ALARA	As Low As Reasonably Achievable
ALWTC	Active Liquid Waste Treatment Center
ARMS	Ambient Radiation Monitoring Stations
B	Building
CCME	Canadian Council of Ministers of the Environment
CCSF	Concrete Canister Storage Facility
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act*
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CO2e	CO2 equivalent
CRMN	Canadian Radiological Monitoring Network
CSR	Comprehensive Study Report
DFO	Department of Fisheries and Oceans Canada
DRL	Derived Release Limit
EA	Environmental Assessment
EA FUP	Environmental Assessment Follow-Up Program
EMP	Environmental Monitoring Program
EMS	Environmental Management System
EnvP	Environmental Protection Program
EP	Environmental Protection

EPR	Environmental Protection Review
ERA	Environmental Risk Assessment
ESEA	Endangered Species and Ecosystems Act (Manitoba)
EVMP	Effluent Verification Monitoring Program
FFS	Fitness for Service
FPS	Fixed Point Surveillance
FWSER	Federal Wastewater System Effluent Regulations
Go-Co	Government-owned, Contractor-operated
GHG	Greenhouse Gas
GMP	Groundwater Monitoring Program
GWP	Global Warming Potential
HLW	High Level Waste
IEMP	Independent Environmental Monitoring Program
IK	Indigenous Knowledge
ILW	Intermediate Level Waste
KERMA	Kinetic Energy Released in unit MAss of Material
LCH	Licence Condition Handbook
LLW	Low Level Waste
LUO	Land Use and Occupancy
mSv	Millisievert
MMF	Manitoba Metis Federation
NAAQO	National Ambient Air Quality Objectives
NPRI	National Pollutant Release Inventory
NRTEOL	Nuclear Research and Test Establishment Operating Licence
NRTEDL	Nuclear Research and Test Establishment Decommissioning

	Licence
NSCA	*Nuclear Safety and Control Act*
NSRDR	Nuclear Substance and Radiation Devices Regulation
PFP	Participant Funding Program
PM	Particulate Matter
RA	Responsible Authority
ROR	Regulatory Oversight Report
Sagkeeng	Sagkeeng Anicinabe
SARA	*Species at Risk Act*
SF	Shielded Facility
SVS	Shared Value Solutions
TSP	Total suspended particulates
VCs	Valued Components
WL	Whiteshell Laboratories
WMA	Waste Management Area
WR-1	Whiteshell Reactor #1

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PART TWO

Part two provides all relevant information pertaining directly to the licence, including:

[1] Any proposed changes to the conditions, licensing period, or formatting of an existing licence;

[2] The proposed licence;

[3] The draft licence conditions handbook; and

[4] The current licence.

PROPOSED LICENCE CHANGES

Overview

CNL currently operates Whiteshell Laboratories under the Nuclear Research and Test Establishment Decommissioning Licence, NRTEDL-W5-8.05/2019[1]. The proposed licence incorporates the standard licence conditions and standard format.

Licence Conditions

The proposed licence incorporates the standard licence conditions applicable to the WL site.

Licence Format

The proposed licence uses the standard format.

Licence Period

CNL has requested a renewal of the WL licence for a period of 10 years until December 31, 2029. Based on CNSC staff review of the CNL application, performance history, and supporting information, CNSC staff support CNL's request for a licence period of 10 years. Over the proposed 10 year period, CNSC staff would provide regular reporting on regulatory oversight conducted at the WL site in public Commission proceedings.

PROPOSED LICENCE

The proposed Licence is provided on the following pages of the document.

e-Doc 5768606 (WORD)

e-Doc 59632032 (PDF)

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

PDF Ref: e-Doc 5962032
Word Ref: e-Doc 5768606
File: 2.14

NUCLEAR RESEARCH AND TEST ESTABLISHMENT DECOMMISSIONING LICENCE

WHITESHELL LABORATORIES

I) LICENCE NUMBER: **NRTEDL-W5-8.06/2029**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act*, this licence is issued to

Canadian Nuclear Laboratories Ltd
Laboratoires Nucléaires Canadiens Ltée
286 Plant Road
Chalk River, Ontario
K0J 1J0

III) LICENCE PERIOD: This licence is valid from January 1, 2020 and remains in effect until December 31, 2029 unless otherwise suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

a) operate and decommission the Whiteshell Laboratories (hereinafter “WL”) located in Pinawa, Province of Manitoba as further described in the Whiteshell Laboratories *Licence Conditions Handbook* (LCH) ,

b) produce, possess, process, refine, transfer, use, package, manage, and store the nuclear substances that are required for, associated with or arise from the activities described in a),

c) possess, use, produce and transfer prescribed equipment that is required for, associated with, or arises from the activities described in a),

d) possess, use and transfer prescribed information that is required for, associated with, or arises from the activities described in a),

e) carry out the site preparation, construction or construction modification or undertaking that is required for, associated with or arise from the activities described in a).

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Whiteshell Laboratories Licence Conditions Handbook (LCH) provides compliance verification criteria used to verify compliance with the conditions set out in this licence, including information regarding delegation of authority and applicable versions of documents and a process for version control of codes, standards or other documents that are used as compliance verification criteria.

VI) CONDITIONS:

G GENERAL

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations;

(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence; and

(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

G.4 The licensee shall implement and maintain a public information and disclosure program.

1 MANAGEMENT SYSTEM

1.1 The licensee shall implement and maintain a management system.

2 HUMAN PERFORMANCE MANAGEMENT

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain a training program.

3 OPERATING PERFORMANCE

3.1 The licensee shall implement and maintain an operating program, which includes a set of operating limits.

3.2 The licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission.

4 SAFETY ANALYSIS

4.1 The licensee shall implement and maintain a safety analysis program.

4.2 The licensee shall implement and maintain a nuclear criticality safety program.

5 PHYSICAL DESIGN

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program.

6 FITNESS FOR SERVICE

6.1 The licensee shall implement and maintain a fitness for service program.

7 RADIATION PROTECTION

7.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

8 CONVENTIONAL HEALTH AND SAFETY

8.1 The licensee shall implement and maintain a conventional health and safety program.

9 ENVIRONMENTAL PROTECTION

9.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

10 EMERGENCY MANAGEMENT AND FIRE PROTECTION

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11 WASTE MANAGEMENT

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall implement and maintain a decommissioning plan.

12 SECURITY

12.1 The licensee shall implement and maintain a security program.

13 SAFEGUARDS AND NON-PROLIFERATION

13.1 The licensee shall implement and maintain a safeguards program.

14 PACKAGING AND TRANSPORT

14.1 The licensee shall implement and maintain a packaging and transport program.

SIGNED at OTTAWA, ______________________.

____
Rumina Velshi, President
on behalf of the Canadian Nuclear Safety Commission

DRAFT LICENCE CONDITIONS HANDBOOK

The draft Licence Conditions Handbook is provided on the following pages of the document.

e-Doc 5776240 (WORD)

e-Doc 5961981 (PDF)

Canada's Nuclear Regulator

e-Doc 5776240 (WORD)
e-Doc 5961981 (PDF)
File: 2.14

LICENCE CONDITIONS HANDBOOK

NRTEDL-LCH-08.06/2029

Revision 0

Draft

WHITESHELL LABORATORIES NUCLEAR RESEARCH AND TEST ESTABLISHMENT DECOMMISSIONING LICENCE

NRTEDL-W5-8.06/2029

Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

Canada

Licence Conditions Handbook (NRTEDL-LCH-08.06/2029, Revision 0)

Effective: Month day, year

Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence

NRTEDL-W5-8.06/2029 (Effective: Month day, year)

SIGNED at OTTAWA this____day of Month, 2019

____

Kavita Murthy, Director

Canadian Nuclear Laboratories Regulatory Program Division
Directorate of Nuclear Cycle and Facilities Regulations
CANADIAN NUCLEAR SAFETY COMMISSION

REVISION HISTORY:

Effective Date	Rev. #	e-Doc #	Description	CAF e-Doc #
Month day, year	0	5776240	New document	N/A

TABLE OF CONTENTS

INTRODUCTION

The general purpose of the Licence Conditions Handbook (LCH) is to identify and clarify the relevant parts of the licensing basis for each licence condition. This will help ensure that the licensee performs the licensed activities at the Whiteshell Laboratories (WL) in accordance with the licensing basis for WL and the intent of the WL licence. The LCH should be read in conjunction with the licence.

The LCH typically has three parts under each licence condition: the Preamble, Compliance Verification Criteria (CVC), and Guidance. The Preamble explains, as needed, the regulatory context, background, and/or history related to the licence condition. CVC are criteria used by CNSC staff to verify and oversee compliance with the licence condition. Guidance is non-mandatory information, including direction, on how to comply with the licence condition.

The documents referenced in the LCH by e-Access numbers are not publicly available. The links provided in the LCH are references to the internal CNSC electronic filing system, and those documents cannot be opened from outside of the CNSC network.

Current versions of the licensing basis publications, licensee documents that require notification of change, and guidance documents referenced in the LCH are tracked in the document *Licensing Documents for Whiteshell Laboratories-WL-Specific* (e-Doc 5776580) and -*Company-Wide* (e-Doc 5507946), which are controlled by the Canadian Nuclear Laboratories Regulatory Program Division and are available to the licensee upon request.

Most CNSC documents referenced in the LCH are available through the CNSC public website. Documents listed on the CNSC website may contain prescribed information as defined by the *General Nuclear Safety and Control Regulations*. Information in these documents will be made available only to stakeholders with appropriate security clearance on a valid need to know basis.

The licensee documents referenced in the LCH are not publicly available; they contain proprietary information or prescribed information as defined by the *General Nuclear Safety and Control Regulations*.

Domestic and international standards (in particular consensus standards produced by the CSA Group) are an important component of the CNSC's regulatory framework. Standards support the regulatory requirements established through the *Nuclear Safety and Control Act* (NSCA), its regulations and licences by setting out the necessary elements for acceptable design and performance at a regulated facility or a regulated activity. Standards are one of the tools used by the CNSC to evaluate whether licensees are qualified to carry out licensed activities.

The CNSC offers complimentary access to the CSA Group suite of nuclear standards through the CNSC website. This access platform allows interested stakeholders to view these standards online through any device that can access the Internet.

Up to date lists of the nuclear and support facilities at WL that are subject to CNSC regulatory oversight, and legacy facilities that were placed under care and maintenance or undergoing decommissioning under buildings removal plans, are maintained in the CNL document 900-514300-LST-001, *Site Licences, Certificates, Permits, Facilities and Representatives*.

Appendix A to the LCH provides definitions of terms and a list of acronyms used throughout it.

More information on the LCH is available in the CNSC document titled *How to Write a Licence Conditions Handbook* (LCH) (e-Doc 4967591).

G. GENERAL

Licence Condition G.1: Licensing Basis

The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

- **(i) the regulatory requirements set out in the applicable laws and regulations;**
- **(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence; and**
- **(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;**

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (hereinafter "the Commission").

Preamble:

The licensing basis sets the boundary conditions for acceptable performance at a regulated facility or activity, and thus establishes the basis for the CNSC's compliance program in respect of that regulated facility or activity. The degree to which the regulatory requirements are applied to WL facilities and activities should reflect their importance to health and safety of persons, environment, national security, international obligations to which Canada has agreed, licensee's quality and economic expectations, the complexity of facility or activity, and the possible consequences if accidents occur or the activity is carried out incorrectly.

Where the licence condition requires the licensee to implement and maintain a particular program, the licensee documents that describe and implement the program are part of the licensing basis. Programs required by licence conditions or referred to in the LCH may or may not be health, safety, security, environment, and quality programs as defined in the Canadian Nuclear Laboratories Ltd. (CNL)'s management system.

Compliance Verification Criteria:

Part (i) of the Licensing Basis

Part (i) of the licensing basis refers to applicable laws and regulations. There are many federal and provincial acts and regulations, and international laws, agreements, guidelines, etc., applicable to activities performed at WL.

The laws, regulations and international agreements for which CNSC has a regulatory role are:

- *Nuclear Safety and Control Act* (NSCA) and its regulations;
- *Canadian Environmental Assessment Act*, 2012 (CEAA, 2012) and its regulations;
- *Transportation of Dangerous Goods Act* and its regulations;
- *Canada Labour Code* and *Canada Occupational Health and Safety Regulations*;
- *Nuclear Liability and Compensation Act* and its regulations;
- *Fisheries Act* (CNSC responsibilities are defined in the *Memorandum of Understanding between the CNSC and Fisheries and Oceans Canada*); and
- Canada/IAEA safeguards agreements.

All Memoranda of Understandings between the CNSC and other regulatory agencies or government departments are available on the CNSC Webpage under Acts and Regulations/Domestic Arrangements.

Through its decision of October 22, 2014, the Commission, pursuant to section 7 of the NSCA, exempted CNL from the requirements of sections 15.01 and 15.02 of the CNSC *Class II Nuclear Facilities and Prescribed Equipment Regulations* in relation to the requirement for a certified radiation safety officer (e-Doc 4543516).

Part (ii) of the Licensing Basis

Part (ii) of the licensing basis refers to the conditions and the safety and control measures included in the WL licence and in the documents directly referenced in the licence.

Under the standardized format and content, the WL licence requires the licensee to implement and maintain certain programs. For the purpose of meeting a licence requirement, a program may be a series of documented, coordinated activities, not necessarily a single document.

Part (iii) of the Licensing Basis

Part (iii) of the licensing basis refers to the safety and control measures described in the licence application and the documents needed to support that licence application. The safety and control measures include important aspects of that documentation such as, but not limited to: the facility-specific design basis and operational information documented in the most recent safety analysis and operational limits and conditions documents.

Part (iii) of the licensing basis also includes safety and control measures outlined in CNSC regulatory documents, CSA standards, and other standards, codes and references that are cited in the application or in the licensee's supporting documentation.

Applicable licensee documents are listed in the LCH under the heading "Licensee Documents that Require Notification of Change". Applicable CNSC regulatory documents, CSA standards and other documents are listed in the LCH under the heading "Licensing Basis Publications". The licensee documents listed in the LCH could cite other documents that also contain safety and control measures (i.e., there may be safety and control measures in "nested" references in the application). The licensee documents listed in the LCH and their "nested" references define the licensing basis for the programs required by the WL licence as long as they include safety and control measures.

Regulatory Role of the Licensing Basis

The licensing basis is established when the Commission renders its decision regarding the licence application.

Licence condition G.1 requires the licensee to conduct the licensed activities in accordance with the licensing basis. For activities that are found to be not in accordance with the licensing basis, the licensee shall take action as soon as practicable to return to a state consistent with the licensing basis, taking into account the risk significance of the situation.

The applicability of the licensing basis publications may be graded based on the specific of activity being considered.

CNSC Staff's Approach to Assessing the Licensing Basis for Whiteshell Laboratories

The licence condition G.1 is not intended to unduly inhibit the ongoing management and operation of the facility or the licensee's ability to adapt to changing circumstances and continuously improve, in accordance with its management system. Where the licensing basis refers to specific configurations, methods, solutions, designs, etc., the licensee is free to propose alternate approaches as long as they remain, overall, in accordance with the licensing basis and have a neutral or positive impact on health, safety, the environment, security, and safeguards. However, the licensee shall assess changes to confirm that operations remain in accordance with the licensing basis. The assessment shall be documented and made available to CNSC staff upon request.

For any proposed activity to be carried out on the WL, CNSC staff will review the information submitted by CNL to independently determine if the proposed activity remains within the licensing basis. CNSC staff assess a proposed activity as being within the licensing basis based on the hazard and risk of the change, and its impact on the overall safety of the WL.

CNSC staff will submit to the Commission for consideration any proposed activity which CNSC staff consider to be outside the licensing basis. If the Commission grants approval to such an activity, it will become part of the licensing basis for WL and reflected in updates to LCH as appropriate.

Activities Included in the Whiteshell Laboratories Licensing Basis

Conduct of licensed activities at WL includes:

a) operate and decommission the Whiteshell Laboratories (hereinafter "WL") located in Pinawa, Province of Manitoba as further described in the Whiteshell Laboratories Licence Conditions Handbook (LCH) ,
b) produce, possess, process, refine, transfer, use, package, manage, and store the nuclear substances that are required for, associated with or arise from the activities described in a),
c) possess, use, produce and transfer prescribed equipment that is required for, associated with, or arises from the activities described in a),
d) possess, use and transfer prescribed information that is required for, associated with, or arises from the activities described in a),
e) carry out the site preparation, construction or construction modification or undertaking that is required for, associated with or arise from the activities described in a).

A complete list of all nuclear facilities at WL is found in 900-514300-LST-001, "Site Licences, Certificates, Permits, Facilities and Representatives".

Licence Application Documents and Supporting Documents

Document Number	Document Title	e-Doc
WLD-CNNO-18-0033-L	Application for Renewal of the Nuclear Research and Test Establishment Decommissioning Licence for the Whiteshell Laboratories	5715784
WLD-CNNO-18-0034-L	Application for Renewal of the Nuclear Research and Test Establishment Decommissioning Licence for the Whiteshell Laboratories (Supporting Information for CNSC Staff)	5715800

Guidance:

The CNSC regulatory document REGDOC-3.5.3, *Regulatory Fundamentals*, outlines the CNSC's regulatory philosophy and approach to applying the *Nuclear Safety and Control Act*. It provides information for licensees, applicants and the public, and contains neither guidance nor requirements. In particular, subsection 6.1.1 of the REGDOC-3.5.3 provides information about the licensing basis.

When the licensee becomes aware that a proposed change or activity might be outside the licensing basis, it should first seek direction from CNSC staff regarding the potential acceptability of this change or activity. The licensee should take into account that certain types of proposed changes might require significant lead times before CNSC staff can make recommendations and/or the Commission can properly consider them.

Licence Condition G.2: Notification of Changes

The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

Preamble:

Most changes to the WL and its facilities are captured as changes to corresponding licensee's documents. The LCH identifies licensee documents that require written notification of changes to the CNSC.

Compliance Verification Criteria:

The licensee shall, as a minimum, notify CNSC staff of changes to licensee's documents identified in the LCH. The written notification of change shall include a copy of the revised document and a description of the change.

CNL program requirements documents (PRDs) and program description documents (PDDs) are accompanied by governing document indices (GDIs). The licensee shall provide updated versions of PDDs quarterly and GDIs annually or upon request from CNSC.

Licensee documents listed in the LCH are subdivided into groups having different requirements for notification of change.

Prior Notification Requirement	Definition
Requires prior notification	The licensee shall submit the revised document to the CNSC as far in advance of planned implementation as practicable, but not less than 30 days prior to planned implementation. The licensee shall allow sufficient time for the CNSC to review the change proportionate to its complexity and the importance of the safety and control measures being affected. This is denoted by a Y in the column "prior notification". Where a document or some part of it requires acceptance by CNSC staff prior to implementation, a footnote has been added to the notification column.
Requires notification at time of implementation	The licensee shall notify the CNSC at the time of implementing a revised document. This is denoted by a N in the column "prior notification".

Changes that may affect the licensing basis, including any change that is not captured as a change to a document listed in the LCH (e.g., construction of new facilities/buildings, transitioning any facility/building from one phase of its life cycle to another, or infrastructure improvements at WL), requires written prior notification to the CNSC to verify they are in accordance with the licensing basis.

For any change that is outside the licensing basis defined in subsection G.1 of the LCH, the licensee shall obtain Commission approval before proceeding with the change.

Guidance:

For proposed changes that would not be in accordance with the licensing basis, the guidance for licence condition G.1 applies.

Licence Condition G.3: Financial Guarantee

The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

Preamble:

The *General Nuclear Safety and Control Regulations* requires that a licence application contains "*a description of any proposed financial guarantee relating to the activity to be licensed*".

The financial guarantee for decommissioning is to be reviewed and revised by the licensee every 5 years, or; when required by the Commission or person authorized by the Commission, or; following a revision to the cost estimate for decommissioning if it significantly impacts the financial guarantee.

The financial guarantee for WL is in the form of an expressed commitment from Atomic Energy of Canada Ltd (AECL) which is a Schedule III, Part 1 Crown Corporation under the *Financial Administration Act* and an agent of Her Majesty in Right of Canada. As an agent of Her Majesty in Right of Canada, AECL's liabilities are ultimately liabilities of Her Majesty in Right of Canada. While the restructuring of AECL has seen the ownership of Canadian Nuclear Laboratories Ltd. (CNL) transferred to a private-sector contractor, the Canadian National Energy Alliance (CNEA), AECL retains ownership of the lands, assets and liabilities associated with CNL's licences. These liabilities have been officially recognized by the Minister of Natural Resources in a letter dated July 31, 2015 (e-Doc 4803454, 4815508).

Compliance Verification Criteria:

The financial guarantee for decommissioning shall be reviewed and revised by the licensee every 5 years, when requested by the CNSC, or following a revision to the cost estimate for decommissioning or changes to the decommissioning strategy which significantly impacts the financial guarantee.

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notification
145-NRCANNO-15-0.001	Relating to Provision of Financial Guarantees for AECL Sites	5794303	N/A

Guidance:

Guidance Documents

Document Number	Document Title	Version
G-206	Financial Guarantee for the Decommissioning of Licensed Activities	2000

Licence Condition G.4: Public Information and Disclosure Program

The licensee shall implement and maintain a public information and disclosure program.

Preamble:

Class I Nuclear Facilities Regulations require that an application for a licence shall contain the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed.

The primary goal of the public information program, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public. The public information program includes a public disclosure protocol describing the information and the medium of disclosure in regard to information and reports of interest to the public.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
RD/GD-99.3	Public Information and Disclosure	2012	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
CW-513430-REPT-001	Public Information Program for Canadian Nuclear Laboratories (CNL)	5507946	N

Guidance:

None provided.

SCA – MANAGEMENT SYSTEM

Licence Condition 1.1: Management System

The licensee shall implement and maintain a management system.

Preamble:

Safe and reliable operation of nuclear facilities requires a commitment and adherence to a set of management system principles and, consistent with those principles, the implementation of planned and systematic processes that achieve expected results. The management system focuses on safety in all business activities and supports the safe conduct of licensed activities at CNL.

The *Class I Nuclear Facilities Regulations* require that an application for a licence shall contain the proposed management system for the activity to be licensed, including measures to promote and support safety culture.

The *General Nuclear Safety and Control Regulations* require that a licence application contain the applicant's organizational management structure, including the internal allocation of functions, responsibilities and authority.

The management system is in place to satisfy the requirements set out in the NSCA, regulations made pursuant to the NSCA, the licence and the measures necessary to ensure that safety is of paramount consideration in the implementation of the management system. The management system promotes and supports a healthy safety culture. Characteristics of a healthy safety culture are as follows:

- Safety is a clearly recognized value;
- Accountability for safety is clear;
- Safety is integrated into all activities;
- A safety leadership process exists; and
- Safety culture is learning driven

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
CSA N286	Management system requirements for nuclear facilities	2012 (R2017)	January 1, 2020
CSA N286.6	Decommissioning Quality Assurance for Nuclear Power Plants	1998 (R2003)	January 1, 2020
REGDOC-2.1.2	Management System: Safety Culture	2018	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-514100-MAN-001	Management System Manual	5507946	Y
900-514200-MAN-001	Quality Assurance	5507946	N
900-514100-LST-001	Functional Authorities	5507946	N

900-514300-LST-001	Site Licences, Certificates, Permits, Facilities and Licence Representatives	5507946	N
900-513000-LST-001	Codes, Regulations, Standards, and other Documents	5507946	N
WLD-508300-QAP-001	Whiteshell Laboratories Decommissioning QA Plan	5776580	Y

Guidance:

Guidance Documents

Document Number	Document Title	Version
CSA N286.0.1	Commentary on N286-12, Management system requirements for nuclear facilities	2014

SCA – HUMAN PERFORMANCE MANAGEMENT

Licence Condition 2.1: Human Performance Program

The licensee shall implement and maintain a human performance program.

Preamble:

Human performance is the outcome of human behaviours, functions and actions in a specified environment, reflecting the ability of workers and management to meet the system's defined performance under the conditions in which the system will be employed.

Human factors are factors that influence human performance as it relates to the safety of a nuclear facility or activity over all the phases, including design, operation, maintenance, and decommissioning. These factors may include the characteristics of the person, task, equipment, organization, environment, and training. The application of human factors to issues such as interface design, training, procedures, organization and job design may affect the reliability of humans performing tasks under various conditions.

The human performance program addresses and integrates the range of human factors that influence human performance, including but not limited to:

- The provision of qualified workers;
- The reduction of human error;
- Organizational support for safe work activities;
- The continuous improvement of human performance; and
- Monitoring hours of work.

The *General Nuclear Safety and Control Regulations* require the licensee to: ensure the presence of sufficient number of qualified staff; train the workers; and ensure the workers follow procedures and safe work practices.

The *Class I Nuclear Facilities Regulations* require that an application for a licence shall contain the proposed human performance program for the activity to be licensed, including measures ensure workers fitness for duty.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	January 1, 2020
RD-363	Nuclear Security Officer Medical, Physical, and Psychological Fitness	2008	January 1, 2020
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use, version 2	2017	TBD

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-514000-PDD-001	Program Description Document: Performance Assurance	5507946	N

900-514000-PRD-001	Program Requirements Document: Performance Assurance	5507946	Y

Guidance:

Guidance Documents

Document Number	Document Title	Version
G-323	Ensuring Presence of Sufficient Qualified Staff at Class I Nuclear Facilities: Minimum Staff Complement	2007

Licence Condition 2.2: Training Program

The licensee shall implement and maintain a training program.

Preamble:

This licence condition requires the licensee to develop and implement training programs for workers.

It also provides the requirements regarding the program and processes necessary to support responsibilities of, qualifications and requalification training of persons at the nuclear facility.

As defined by the *General Nuclear Safety and Control Regulations*, a worker is a person who performs work that is referred to in a licence. This includes contractors and temporary employees. Training requirements apply equally to these types of workers as to the licensee's own employees.

The *General Nuclear Safety and Control Regulations* require that licensees ensure that there are a sufficient number of properly trained and qualified workers to safely conduct the licensed activities.

The *Class I Nuclear Facilities Regulations* require that applicants for a Class I facility licence describe the training programs which have been implemented, and that licence applications include the proposed responsibilities, qualification requirements, training program and requalification program for workers; along with the results that have been achieved in implementing the program for recruiting, training and qualifying workers.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.2.2	Personnel Training, version 2	2016	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-510200-PDD-001	Program Description Document: Training and Development	5507946	N
900-510200-PRD-001	Program Requirements Document: Training and Development	5507946	Y

The licensee shall ensure that all workers are qualified to perform the duties and tasks required of their position.

Guidance:

None provided.

SCA – OPERATING PERFORMANCE

Licence Condition 3.1: Operating Program

The licensee shall implement and maintain an operating program, which includes a set of operating limits.

Preamble:

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed measures, policies, methods and procedures for safely operating and maintaining the nuclear facility.

The operational limits and conditions for WL are currently documented in

- Facility Authorizations, and
- laboratory protocols, criticality safety documents and other documents for other workplaces where operations with fissionable materials are performed involving handling, use, processing, movement and storage

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-505240-PDD-001	Program Description Document: Construction	5507946	N
900-505240-PRD-001	Program Requirements Document: Construction	5507946	Y
900-505250-PDD-001	Program Description Document: Commissioning	5507946	N
900-505250-PRD-001	Program Requirements Document: Commissioning	5507946	Y
AECL-FA-22	Facility Authorization for the Operation of the Concrete Canister Storage Facility at Whiteshell Laboratories	5776580	Y[1]
AECL-FA-25	Facility Authorization for the Operation of the Active Liquid Waste Treatment Centre at Whiteshell Laboratories	5776580	Y[1]
WLSF-00583-FA-001	Facility Authorization for the Operation of the Shielded Facilities at Whiteshell Laboratories	5776580	Y[1]
WLWMA-00583-FA-001	Facility Authorization for the Operation of the Waste Management Area at Whiteshell Laboratories	5776580	Y[1]

[1] Notification is required only for non-administrative changes. If administrative changes are made, the licensee shall provide updated facility authorizations to CNSC staff at the end of the next quarter.

WL Facilities Operations

The operational limits and conditions shall define the conditions that must be met to prevent situations or events that might lead to accidents, or to mitigate the consequences of accidents should they occur. The updated operational limits and conditions shall be based on safety analyses.

Limits and conditions for normal operation shall include limits on operating parameters, stipulation for minimum amount of operable equipment, actions to be taken by the operating staff in the event of deviations from the operational limits and conditions, and the time allowed for completing these actions.

The licensee shall review, revise and reissue as appropriate the operational limits and conditions when required due to changes in technologies, regulations, operational information or physical configuration.

Construction and operation of New Nuclear Facilities

The licensee may construct or install facilities, buildings, structures, components or equipment only if that construction or installation is compliant with the licensing basis.

Facilities in Permanent Safe Shutdown State

The licensee shall develop and maintain storage-with-surveillance plans (SWS plans) for Class I and Class II nuclear facilities in permanent safe shutdown state. The licensee shall maintain those facilities in permanent safe shutdown state according to the SWS plan for the facility. The SWS plans may also be combined with DDPs when the decommissioning is taking place in several phases.

Facilities under Decommissioning

See LCH Section 11.2 for details regarding the decommissioning of individual facilities at WL.

Modifications to Facilities and Processes

The licensee shall ensure that modifications to WL facilities do not negatively impact safe operation of the facility. The licensee shall define the process for making permanent or temporary modifications to operational limits and conditions. Such modifications shall be justified by analyses and safety reviews.

The licensee may only modify facilities, buildings, structures, components or equipment in compliance with the licensing basis.

The licensee shall ensure that:

(a) all temporary modifications are identified at the point of application and at any relevant control positions;

(b) operating personnel are informed of any modifications and their consequences for facility operations;

(c) the temporary modifications are reviewed and approved before installation; the review shall be documented to demonstrate the scope and conclusion of the review;

(d) the number of simultaneous temporary modifications is kept to a minimum;

(e) the duration of temporary modifications is limited and specified prior to implementation;

(f) testing is performed after installation and removal of the temporary modification;

(g) temporary modifications are shown on affected documents; and

(h) the facility is returned to the original state when the temporary modification is no longer needed.

Sealed Sources

The licensee shall ensure the sealed sources are controlled (by maintaining an inventory of sealed sources, and tracking and reporting their transfer) in order to achieve the objectives stated in paragraph 5.(a) of section II of IAEA's *Code of Conduct on the Safety and Security of Radioactive Sources*.

The inventory of sealed sources shall contain all sealed sources, both in use and in storage, of any category of sources as defined in Table 1 of the IAEA safety guide RS-G-1.9 *Categorization of Radioactive Sources*. The licensee shall provide details of their inventory at the CNSC staff's request.

<u>Guidance:</u>

None provided.

Licence Condition 3.2: Reporting Requirements

The licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission.

Preamble:

This licence condition sets the requirements for reporting information to CNSC, including compliance monitoring and operational performance, event reporting, and various types of notifications.

Many reportable occurrences included in REGDOC-3.1.2 do not necessarily show a degradation of licensee's performance, and do not fall under CNSC definition of a "reportable event" as included in REGDOC-3.6 Glossary of CNSC Terminology.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-3.1.2	Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	2018	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-514300-MCP-006	CNL Reporting to Regulatory Agencies	5507946	N

Compliance Monitoring: Annual Reporting

The licensee shall by the following dates submit to the Commission or any person authorized by the Commission, the following reports covering the preceding calendar year as follows:

1) By April 30th of each year:

a) the operation and maintenance of the following facilities: Concrete Canister Storage Facility, Active-Liquid Waste Treatment Centre, Shielded Facilities, Waste Management Area, Building 300 (Research and Development) and Building 402 (Health and Safety), summarizing facility and equipment performance and changes, changes to operating policies, changes in organization, reportable events, personnel radiation exposures, releases of nuclear substances from the facilities, and releases of hazardous substances from the facilities;

b) the status of the WR-1 Reactor, summarizing facility and equipment performance and changes, changes to operating policies, changes in organization, reportable events, personnel radiation exposures, releases of nuclear substances from the facilities, and releases of hazardous substances from the facilities;

c) a summary of changes to non-nuclear facilities and structures;

d) decommissioning activities associated with the following facilities: Concrete Canister Storage Facility, Active-Liquid Waste Treatment Centre, Shielded Facilities, Waste Management Area, Building 300 (Research and Development), Building 402 (Health and Safety) and WR-1 reactor, summarizing facility and equipment performance and changes, changes to operating policies, changes in organization, reportable events, personnel radiation exposures, releases of nuclear substances from the facilities, and release of hazardous substances from the facilities;

e) changes to emergency authorities and organization, updates or changes to the radiation emergency procedures, status/changes in other program documentation, training activities, drill and exercise activities, status of emergency resources and facilities, interactions with outside agencies, and unplanned events in which the emergency response organization has been tested;

f) the results of the effluent monitoring for nuclear substances, hazardous substances and personnel radiation exposures for WL.

2) By June 30th of each year:

a) the results of environmental monitoring for nuclear and hazardous substances;

b) the results and activities of the Environmental Assessment Follow-Up Program for Whiteshell Laboratories.

3) If an action level has been reached as set out in LC 7.1 and 9.1, the licensee shall submit a final written report of the matter within 45 days of becoming aware of the matter.

Guidance:

Event Reporting

To encourage reporting of situations or events that may result in improvement actions, event reporting should not be used as a tool for assessing or measurement of nuclear safety, or as a basis for assessing the licensee’s performance.

For low safety significance events where CNL has already provided a preliminary report verbally and where no significant additional information is likely to be determined from further investigation, CNL may elect to combine the submission of a written preliminary report with a written full report. CNSC staff may request additional information to be provided in order to achieve regulatory close out.

Compliance Monitoring: Annual Reporting

The annual reports should follow, where appropriate, the format and content presented in Appendix B of REGDOC-3.1.2.

SCA – SAFETY ANALYSIS

Licence Condition 4.1: Safety Analysis Program

The licensee shall implement and maintain a safety analysis program.

Preamble:

All event sequences which can occur in a nuclear facility must be analyzed to ensure safe operation. A deterministic safety analysis evaluates the facility's responses to such events by using predetermined rules and assumptions. The objectives of the deterministic safety analysis are stated in CSA N292.0.

The *General Nuclear Safety and Control Regulations* require that a licence application contain a description and the results of any analyses performed.

The *Class I Nuclear Facilities Regulations* require, amongst other requirements, that an application for a licence to operate a Class I nuclear facility contains a final safety analysis report, and additional supporting information.

The licensee holds the responsibility for ensuring that the safety analysis is accurate and meets the regulatory requirements, and shall maintain adequate capability to perform or procure safety analysis and to train safety analysts.

Compliance Verification Criteria:

Licensing Basis Publications

For compliance verification criteria for Safety Analysis refer to the CSA N292 series documents in LCH Section 11.1.

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508770-PDD-001	Program Description Document: Safety Analysis	5507946	N
900-508770-PRD-001	Program Requirements Document: Safety Analysis	5507946	Y
RC-1021	Whiteshell Laboratories Active Liquid Waste Treatment Centre Safety Analysis Report	5507946	Y[1]
RC-983	Whiteshell Laboratories Concrete Canister Storage Facility Safety Analysis Report	5507946	Y[1]
WLSF-03500-SAR-001	Safety Analysis Report Whiteshell Laboratories Shielded Facilities	5507946	Y[1]
WLWMA-508640-SAR-001	Safety Analysis Report for the Whiteshell Laboratories Waste Management Area	5507946	Y[1]
WLDP-36410-SAR-001	Safety and Hazards Analysis for the Shielded Modular Above-Ground Storage Facilities at Whiteshell Laboratories	5507946	Y[1]

[1] Notification is required only for non-administrative changes. If administrative changes are made, the licensee shall provide updated safety analyses to CNSC staff at the end of the next quarter.

Guidance:

Guidance Documents

Document Number	Document Title	Version
IAEA SSR-4	Safety of Nuclear Fuel Cycling Facilities	2017
IAEA TECDOC-1267	Procedures for Conducting Probabilistic Safety Assessment for Non-reactor Nuclear Facilities	2002
IAEA GSR Part 4, Rev. 1	Safety Assessment for Facilities and Activities	2016

Licence Condition 4.2: Nuclear Criticality Safety Program

The licensee shall implement and maintain a nuclear criticality safety program.

Preamble:

This licence condition requires the licensee to develop, implement and maintain a nuclear criticality safety program to ensure that the upper subcritical limits established in the criticality safety documents will not be exceeded under both normal and credible abnormal conditions (events or event sequences having the frequency of occurrence equal to or more than 10^{-6}/year) during operations with fissionable materials outside reactors.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC 2.4.3	Nuclear Criticality Safety	2018	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508550-PDD-001	Program Description Document: Nuclear Criticality Safety	5507946	N
900-508550-PRD-001	Program Requirements Document: Nuclear Criticality Safety	5507946	Y

For legacy activities or projects, the licensee may implement the requirements of the nuclear criticality safety on a graded approach, with appropriate criteria for categorization according to their safety significance. The legacy items are those nuclear criticality safety related activities and projects where work has begun prior to November 1, 2011.

Guidance:

None provided.

SCA – PHYSICAL DESIGN

Licence Condition 5.1: Design Program

The licensee shall implement and maintain a design program.

Preamble:

The *Class I Nuclear Facilities Regulations* require that a licence application contain a description of the structures, systems and components, and relevant documentation of the facility design.

A design program ensures that the facility design is managed using a well-defined systematic approach.

Implementing and maintaining a design program confirms that safety-related SSCs and any modifications to them continue to meet their design bases given new information arising over time and taking changes in the external environment into account. It also confirms that SSCs continue to be able to perform their safety functions under all facility states. An important cross-cutting element of a design program is design basis management.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
CSA N393	Fire Protection for Facilities that Process, Handle, or Store Nuclear Substances	2013 (2016)	January 1, 2020
	National Fire Code of Canada	2010	January 1, 2020
	National Fire Code of Canada	2015	TBD
	National Building Code of Canada	2010	January 1, 2020
	National Building Code of Canada	2015	TBD

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508120-PDD-001	Program Description Document: Design Authority and Design Engineering	5507946	N
900-508120-PRD-001	Program Requirements Document: Design Authority and Design Engineering	5507946	Y
900-508120-LST-001	Design Authorities	5507946	N

Guidance:

Guidance Documents

Document Number	Document Title	Version
G-276	Human Factors Engineering Program Plans	2003
G-278	Human Factors Verification and Validation Plans	2003

Licence Condition 5.2: Pressure Boundary Program

The licensee shall implement and maintain a pressure boundary program.

Preamble:

A pressure boundary program is comprised of the many programs, processes and procedures and associated controls that are required to ensure compliance with CSA standard N285.0, which defines the technical requirements for the design, procurement, fabrication, installation, modification, repair, replacement, testing, examination and inspection of pressure-retaining and containment systems, including their components and supports.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Revision	Effective Date
CSA N285.0	General requirements for pressure-retaining system and components in CANDU nuclear power plants	2008	January 1, 2020
CSA N285.0	General requirements for pressure-retaining system and components in CANDU nuclear power plants	2017	TBD
CSA B51	Boiler, Pressure Vessel and Pressure Piping Code	2003 (R2014)	

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508140-PDD-001	Program Description Document: Pressure Boundary	5507946	N
900-508140-PRD-001	Program Requirements Document: Pressure Boundary	5507946	Y
WLD-508140-PRO-001	Code Classification and Design Registration of Pressure – Retaining System/Components	5776580	Y
WL-508140-QAM-001	Pressure Boundary Quality Assurance Manual	5776580	Y

For the Whiteshell Laboratories, compliance with this licence condition will be assessed by the following;

a) Subject to b) and c) below, the licensee shall design, manufacture, fabricate, procure, install, modify, repair, test, examine, inspect or otherwise perform work related to vessels, boilers, systems, piping, fittings, parts, components and supports according to the specifications in CSA standards N285.0-08, B51-03 (R2014) or other codes and standards approved or prescribed by the Commission.

   Where indicated by these standards, the licensee shall obtain the following regulatory approvals for this work:

i) registered designs;

ii) accepted overpressure protection reports;

iii) approval of applicable standards and code classification;

iv) registered welding and brazing procedures;

v) qualified welders, welding operators, brazers and examination personnel;

vi) accepted quality assurance programs; and

vii) accepted plans and procedures (certificate(s) of authorization).

b) CNL may classify as Class 6 systems or sections of systems that contain tritium or other radioactive substances, if the consequence of failure limit of 20 mSv effective acute whole body dose is not exceeded.

c) CNL shall carry out the activities listed in a) above in accordance with B51-03 (R2014), or other codes and standards approved or prescribed by the Commission, for pressure boundary systems and components that do not contain nuclear substances, do not adversely impact a nuclear safety system, or do not cause an unreasonable risk involving nuclear substances at WL.

d) CNL shall operate vessels, boilers, systems, piping, fittings, parts, components, and supports safely and keep them in a safe condition. The licensee shall:

i) follow accepted plans and procedures to test, maintain, or alter overpressure protection devices;

ii) comply with operating limits specified in certificates, orders, designs, overpressure protection reports, and applicable codes and standards;

iii) inspect and perform material surveillance according to accepted schedules, plans and procedures;

iv) have any certified boiler or vessel that is in operation or use inspected and certified by an authorized inspector according to an accepted schedule; and

v) ensure that vessels, boilers, systems, piping, fittings, parts, components and supports have markings, as specified in the applicable standards.

e) CNL shall keep proper records of regulatory approvals and other documents required as set out in a) through d), and the standards applicable to the work or equipment.

f) In addition to any reporting requirements of the *Nuclear Safety and Control Act* and its associated Regulations, CNL shall report promptly to the Commission and to the Manitoba Department of Labour and Immigration when the licensee learns of any failure of a pressure boundary that has caused injury, death or property damage.

Guidance:

Guidance Documents

Document Number	Document Title	Version
CSA N285.0.1	Commentary on CSA N285.0-12, General requirements for pressure-retaining systems and components in CANDU nuclear power plants	2016

SCA – FITNESS FOR SERVICE

Licence Condition 6.1: Fitness for Service Program

The licensee shall implement and maintain a fitness for service program.

Preamble:

The *Class I Nuclear Facilities Regulations* requires that a licence application contain the proposed measures, policies, methods and procedures to maintain the nuclear facility.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508230-PDD-001	Program Description Document: Maintenance and Work Management	5507946	N
900-508230-PRD-001	Program Requirements Document: Maintenance and Work Management	5507946	Y
WLD-106100-PLA-001	Periodic Inspection Plan for Whiteshell Laboratories Waste Management Area Concrete Bunkers	5776580	Y

Guidance:

Guidance Documents

Document Number	Document Title	Version
REGDOC-2.6.3	Aging Management	2014

SCA – RADIATION PROTECTION

Licence Condition 7.1: Radiation Protection Program

The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

The Radiation Protection Regulations (RPR) requires that the licensee implement a radiation protection program and also ascertain and record doses for each person who performs any duties in connection with any activity that is authorized by the NSCA or is present at a place where that activity is carried out. This program must ensure that doses to persons do not exceed prescribed dose limits and are kept as low as reasonably achievable (ALARA), social and economic factors being taken into account. Also, the program ensures that occupational exposures are ascertained and recorded in accordance with the Radiation Protection Regulations through the establishment of dosimetry requirements.

The regulatory dose limits to workers and the public are explicitly provided in the RPR. The RPR also specifies the requirements related to action levels (ALs) and indicate that the licence will be used to identify their notification timeframes. ALs relate to the parameters of dose to workers.

ALs are designed to alert licensees before regulatory dose limits are reached. By definition, if an AL is reached, a loss of control of some part of the associated radiation protection program may have occurred, and specific action is required, as defined in the RPR and the licence. ALs are not intended to be static and are to reflect prevailing circumstances at the WL site.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508740-PDD-001	Program Description Document: Radiation Protection	5507946	N
900-508740-PRD-001	Program Requirements Document: Radiation Protection	5507946	Y
900-508740-MCP-006	Action Levels for Internal and External Exposures	5507946	Y
900-508740-MCP-007	Dose Control Points	5507946	N
900-508740-MCP-026	ALARA Review and Assessment - Planning and Control of Radiation Work	5507946	N
900-508740-STD-005	Design and Modification Considerations	5507946	N
900-508740-STD-012	Contamination Levels	5507946	N

Guidance:

Guidance Documents

Document Number	Document Title	Version

G-129, Rev. 1	Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable (ALARA)"	2004
G-228	Developing and Using Action Levels	2001
G-91	Ascertaining and Recording Radiation Doses to Individuals	2003
GD-150	Designing and Implementing a Bioassay Program	2014

The licensee should conduct a documented review and, if necessary, revise the ALs at least once every five years in order to validate their effectiveness. The results of such reviews should be provided to CNSC staff.

SCA – CONVENTIONAL HEALTH AND SAFETY

Licence Condition 8.1: Conventional Health and Safety Program

The licensee shall implement and maintain a conventional health and safety program.

Preamble:

The *Class I Nuclear Facilities Regulations* requires that a licence application contain the proposed worker health and safety policies and procedures.

As a federal regulated site, WL is also subject to the requirements of *Canada Labour Code* and *Canada Occupational Health and Safety Regulations*.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-510400-PDD-001	Program Description Document: Occupational Safety and Health	5507946	N
900-510400-PRD-001	Program Requirements Document: Occupational Safety and Health	5507946	Y

The *Ministry of Employment, Workforce Development and Labour* is mandated with overseeing and enforcing compliance with the *Canada Labour Code* and its regulations.

Guidance:

None provided.

SCA – ENVIRONMENTAL PROTECTION

Licence Condition 9.1: Environmental Protection Program

The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

The *Class I Nuclear Facilities Regulations* requires that a licence application contain information related to environmental protection. The *General Nuclear Safety and Control Regulations* requires every licensee to take all reasonable precautions to protect the environment. The *Radiation Protection Regulations* prescribe the radiation dose limits for the general public of 1 mSv per calendar year.

The *Radiation Protection Regulations* specify requirements related to "Action Levels" and indicate that the licence will be used to identify the action levels and the notification timeframes.

The release of hazardous substances is regulated by Environment and Climate Change Canada through various acts and regulations, as well as by the CNSC.

The environmental protection SCA includes the following:

- Effluent and emissions control (releases);
- Environmental management system (EMS);
- Assessment and monitoring;
- Protection of the public; and
- Environmental Risk Assessment.

Action levels (ALs) for environmental releases are calculated by the licensees and aim to alert licensees of a potential loss of control of their environmental protection program. By definition, if an action level is reached, a loss of control of some part of the associated environmental protection program may have occurred, and specific action is required. ALs are not intended to be static and are to reflect operating conditions at the WL site.

Compliance Verification Criteria:

The licensee will implement and maintain programs to ensure environmental protection as set out in licensing basis (LCH Section 1.1).

CSA N286, included in LCH Section 1.1, defines other specific compliance verification criteria that support environmental protection.

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.9.1	Environmental Principles, Assessments and Protection Measures, version 1.1	2017	Jan 1, 2020
N288.4	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	2010 (R2015)	Jan 1, 2020
N288.5	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	2011 (R2016)	Jan 1, 2020

Document Number	Document Title	Version	Effective Date
N288.6	Environmental risk assessment at Class I nuclear facilities and uranium mines and mills	2012 (R2017)	January 1, 2020
N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	Jan 1, 2020
N288.8	Establishing and implementing action levels to control releases to the environment from nuclear facilities	2017	Jan 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-509200-PDD-001	Program Description Document: Environnemental Protection	5507946	N
900-509200-PRD-001	Program Requirements Document: Environnemental Protection	5507946	Y
WL-509200-PRO-001	Administrative Levels and Action Levels for WL Air and Liquid Radioactive Effluents	5776580	Y
WL-509211-RRD-001	Derived Release Limits for AECL's Whiteshell Laboratories	5776580	Y
WL-509200-OV-001	Whiteshell Laboratories Integrated Monitoring Program Framework	5776580	N
WL-509200-PLA-001	WL Effluent Verification Monitoring Plan	5776580	Y
AECL Document No 03704 001	Environmental Assessment Follow up Program for Whiteshell Laboratories	5776580	Y

The licensee will implement all follow-up actions identified as a result of environmental assessments, and shall report the progress to CNSC staff on an annual basis.

The licensee will ensure effluent monitoring for nuclear and hazardous substances is designed, implemented and managed to respect applicable laws/regulation and to incorporate best practices. The effluent monitoring program will provide for control of airborne and waterborne effluents. The licensee will control, monitor and record releases of radioactive and/or hazardous substances such that the releases do not exceed the reference levels (limits).

The licensee will establish the DRLs in accordance with CSA N288.1. The dose to the critical group due to the sum of all radioactive releases shall not exceed 1 mSv.

The licensee will conduct an updated site-wide environmental risk assessment (ERA) in accordance with the CSA Standard N288.6-12 *Environmental Risk Assessment at Class I Nuclear Facilities and Uranium Mines and Mills* taking into account current conditions at the WL site.

The licensee will control radiological releases to ALARA, within the DRLs, and take action to investigate and correct the cause(s) of increased releases should they occur. The licensee shall report the releases in accordance with LCH Section 3.2.

Guidance:

Guidance Documents

Document Number	Document Title	Version
CSA N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014 (Update 3)
CSA N288.2	Guidelines for calculating the radiological consequences to the public of a release of airborne radioactive material for nuclear reactor accidents	2014

SCA – EMERGENCY MANAGEMENT AND FIRE PROTECTION

Licence Condition 10.1: Emergency Preparedness Program

The licensee shall implement and maintain an emergency preparedness program.

Preamble:

This licence condition requires the licensee to establish an emergency preparedness program to prepare for, to respond to, and to recover from the effects of accidental radiological/nuclear and/or hazardous substance release. As part of the emergency preparedness program, the licensee establishes an onsite emergency response plan and an emergency response organization and makes arrangements for coordinating off-site activities and cooperating with external response organizations throughout all phases of an emergency.

The Class I *Nuclear* Facilities Regulations requires measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to assist, notify, report to off-site authorities including the testing of the implementation of these measures.

A security response to malevolent acts is governed by a separate plan under the Nuclear Security program (see LCH Section 12.1) but provisions of the licensee site security report apply to any associated potential threat of release of radioactive material - for example, the need for off-site notification, situation updates and confirmation of any radioactive releases.

Liquid release response and radioactive materials transportation emergency response plan are also governed by separate plans (See LCH Sections 9.1 and 14.1, respectively).

WL has a communication program that covers a broad spectrum – community interface meetings, newsletters, websites, committees and various panels.

WL provides the local municipalities and the province (as required, federal) with hazard information that can be used for community communications during an emergency.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016	Jan 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508730-PDD-001	Program Description Document: Emergency Preparedness	5507946	N
900-508730-PRD-001	Program Requirements Document: Emergency Preparedness	5507946	Y
WL-508730-ERP-001	Whiteshell Laboratories Emergency Response Plan	5776580	Y

REGDOC-2.10.1 shall be applied to WL as a whole, not to individual facilities on site. Requirements for reactor facilities with a thermal capacity greater than 10MW are not applicable.

Guidance:

Guidance Documents

Document Number	Document Title	Version
CSA N1600	General requirements for nuclear emergency management programs	2016
	Canadian Guidelines for Intervention During a Nuclear Emergency	2003
	Canadian Guidelines for the Restriction of Radioactively Contaminated Food and Water Following a Nuclear Emergency	2000

Licence Condition 10.2: Fire Protection Program

The licensee shall implement and maintain a fire protection program.

Preamble:

Licensees require a comprehensive fire protection program to ensure the licensed activities do not result in unreasonable risk to the health and safety of persons and to the environment due to fire and to ensure that the licensee is able to efficiently and effectively respond to emergency fire situations.

Fire protection provisions, including response, are required for the design, construction, commissioning, operation, and decommissioning of nuclear facilities, including structures, systems, and components (SSCs) that directly support the plant and the protected area. External events such as an aircraft crash or security threats are addressed in LCH Section 12.1.

The *National Fire Code of Canada* sets out technical provisions regulating (a) activities related to the construction, use or demolition of buildings and facilities; (b) the condition of specific elements of buildings and facilities; (c) the design or construction of specific elements of facilities related to certain hazards; and (d) protection measures for the current or intended use of buildings.

The *National Building Code of Canada* sets out technical provisions for the design and construction of new buildings. It also applies to the alteration, change of use and demolition of existing buildings.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
CSA N393	Fire protection for facilities that process, handle, or store nuclear substances	2013 (R2016)	Jan 1, 2020
	National Fire Code of Canada	2010	Jan 1, 2020
	National Fire Code of Canada	2015	TBD
	National Building Code of Canada	2010	Jan 1, 2020
	National Building Code of Canada	2015	TBD

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508720-PDD-001	Program Description Document: Fire Protection	5507946	N
900-508720-PRD-001	Program Requirements Document: Fire Protection	5507946	Y
900-508720-MCP-006	Impairment, Notification and Compensatory Measures	5507946	N

Where CSA standard N393 requires items to be submitted to CNSC for review and/or acceptance, the licensee shall document the item in sufficient detail to ensure it is safe to proceed. The licensee may implement that item without prior review and/or acceptance from CNSC staff. Changes of use or modifications for which the fire screening assessment indicates no potential impact on fire protection design basis, goals or criteria may not be subject to any further third-party review or require submission to the CNSC.

The licensee shall submit the results of third-party reviews required by CSA N393 (review of modifications, review of performance-based design or operation, fire protection program audit, and evaluation of fire response capability). The results of these reviews shall be submitted to CNSC staff no later than six months after the review together with any corrective action plans with compensatory measures for identified non-compliances.

Fire Response

In accordance with N393, the licensee shall arrange for third party audits of the fire response capability at the frequencies stated in N393. The purpose of a Third Party Audit is to provide an in-depth analysis of the Industrial Fire Brigade (IFB) fire response performance against applicable regulatory criteria. A fire response is a planned, coordinated and controlled activity to provide emergency response to a fire. The audit is to analyze and ensure competencies of the IFB against CSA N393 standard and the referred NFPA 600 and 1081 standards.

An independent third party auditor is required to be an expert in the discipline, normally firefighting and qualified through specific education and relevant experience. The third party auditor is required to be independent or at "arm's length" from the facility to ensure impartiality. The review shall be of sufficient depth and detail to allow the reviewer to attest with reasonable confidence on the competencies of the IFB at the facility.

Guidance:

Where CSA N393 does not address a fire protection topic or issue in whole, or where additional guidance is beneficial, the standards and recommended practices set out by the NFPA are used as guidance by CNSC staff in determining the adequacy of a fire protection measure. The results of the Third Party Audit report will typically consist of a report which compares the requirements of the applicable codes and standards against the implementation of the fire protection program or the Fire Response exercised (based on the scope of the audit). The report should identify any non-compliance and formulate a conclusion on whether the licensee fire protection program or IFB meets the requirements of N393.

SCA – WASTE MANAGEMENT

Licence Condition 11.1: Waste Management Program

The licensee shall implement and maintain a waste management program.

Preamble:

The scope of this licence condition covers internal waste-related programs that form part of the WL operations. Topics include waste management, waste characterization, waste minimization and waste management practices.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
CSA N292.0	General principles for the management of radioactive waste and irradiated fuel	2014	January 1, 2020
CSA N292.2	Interim dry storage of irradiated fuel	2013 (R2015)	January 1, 2020
CSA N292.3	Management of low- and intermediate-level radioactive waste	2014	January 1, 2020
CSA N292.6	Long-term management of radioactive waste and irradiated fuel	2018	TBD

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508600-PDD-001	Program Description Document: Waste Management	5507946	N
900-508600-PRD-001	Program Requirements Document: Waste Management	5507946	Y
CW-508600-PLA-002	Plan: Canadian Nuclear Laboratories Integrated Waste Strategy	5507946	N

The licensee shall not produce, in the course of the licensed activities, or accept from outside clients, waste for which there is no identified treatment, or storage, or disposal facility.

Guidance:

Guidance Documents

Document Number	Document Title	Version
REGDOC-2.11.1	Waste Management, Volume III: Assessing the Long-Term Safety of Radioactive Waste Management	2018
CSA N292.5	Guideline for the exemption or clearance from regulatory control of materials that contain, or potentially contain, nuclear substances	2011 (R2017)

Licence Condition 11.2: Decommissioning Plan

The licensee shall maintain a decommissioning plan.

Preamble:

Class I Nuclear Facilities Regulations requires that a licence application contain the proposed plan for decommissioning of the nuclear facility or of the site. The decommissioning plan for WL site is documented in the *Whiteshell Laboratories Detailed Decommissioning Plan – Volume 1 – Program Overview* and the associated cost estimate.

Whiteshell Laboratories is undergoing decommissioning in a staged manner. Consequently, it is noted that not all volumes of the detailed decommissioning plan have been developed, as they are developed when so required by CNL. For volumes not yet developed, decommissioning activities cannot proceed without CNSC concurrence.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
CSA N294	Decommissioning of facilities containing nuclear substances	2009 (R2014)	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508300-PDD-001	Program Description Document: Decommissioning and Demolition	5507946	N
900-508300-PRD-001	Program Requirements Document: Decommissioning and Demolition	5507946	Y
RC-1291-R1	The Monitoring and Surveillance Plan for the WR-1 Deferment Period	5776580	Y
RC-2143-1	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 1 – Program Overview	5776580	Y[1]
WLDP-02000-DDP-001 AD	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 1 – Program Overview – Addendum	5776580	Y[1]
WLDP-21400-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 2 - Shielded Facilities	5776580	Y[1]
WLDP-25400-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 5 – Active Liquid Waste Treatment Centre Building 200	5776580	Y[1]
WLDP-26400-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 6 – Whiteshell Reactor #1: Building 100	5776580	Y[1]

WLDP-22500-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 7 – Concrete Canister Storage Facilities (CCFS)	5776580	Y[1]
	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 8 – Waste Management Area – Part 1 - Standpipes		Y[1]
	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 8 – Waste Management Area – Part 2 – ILW Bunkers, B417, Amine Tanks		Y[1]
WLDP-24400-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 8 – Waste Management Area – Part 3 – Operational Structures, LLW Liabilities and WMA Grounds		Y[1]
WLDP-23500-DDP-001	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 9 – Building 900	5776580	Y[1]
WLDP-23500-DDP-001 AD	Whiteshell Laboratories Detailed Decommissioning Plan – Volume 9 – Building 900 - Addendum	5776580	Y[1]
	Whiteshell Laboratories Detailed Decommissioning Plan - Volume 11: Building 402	5776580	Y[1]
RC-2143-12 Part 1	Volume 12 - Whiteshell Laboratories Licensed Site Supporting and General Infrastructure, Part 1: South-Side Buildings	5776580	Y[1]
WLDP-32000-DDP-001	Volume 12 - Whiteshell Laboratories Licensed Site Supporting and General Infrastructure, Part 2: North-Side Buildings	5776580	Y[1]
WLDP-33000-DDP-001	Volume 12 - Whiteshell Laboratories Licensed Site Supporting and General Infrastructure, Part 3: Outer-Area Building and Facilities	5776580	Y[1]
WLDP-34000-DDP-001	Volume 12 - Whiteshell Laboratories Licensed Site Supporting and General Infrastructure, Part 4: Site Services	5776580	Y[1]
WLDP-35000-DDP-001	Volume 12 - Whiteshell Laboratories Licensed Site Supporting and General Infrastructure, Part 5: Site Affected Lands and Contaminated Structures	5776580	Y[1]

[1] DDPs are to be reviewed and accepted by the CNSC in accordance with the requirements in CSA N294.

Note: The Whiteshell Laboratories Detailed Decommissioning Plan - Volume 3: Van de Graaff Accelerator, the Whiteshell Laboratories Detailed Decommissioning Plan - Volume 4: Neutron Generator and the Whiteshell Laboratories Detailed Decommissioning Plan - Volume 10: Decontamination Centre Building 411 have been completely decommissioned and are therefore not listed in the above table.

Facilities under Decommissioning

The licensee shall conduct decommissioning activities in accordance with Volumes 1 to 12 of the Whiteshell Laboratories Detailed Decommissioning Plan. Decommissioning plans are reviewed by CNSC staff and decommissioning activities cannot proceed without CNSC concurrence.

Guidance:

Guidance Documents

Document Number	Document Title	Version
G-219	Decommissioning Planning for Licensed Activities	2000

SCA – SECURITY

Licence Condition 12.1: Security Program

The licensee shall implement and maintain a security program.

Preamble:

The *General Nuclear Safety and Control Regulations* require that a licence application contain information related to site access control and measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.

The *Class I Nuclear Facilities Regulations* require that a licence application contain the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility.

The *Nuclear Security Regulations* require that a licence application contain specific information related to nuclear security, stipulates the requirements for high-security sites, and contains specific requirements pertaining to the transportation of Category I, II or III nuclear material.

The *Nuclear Security Regulations* require that a licensee of a high security site:

- maintain at all times a qualified onsite nuclear response force;
- obtain the applicable certifications, before issuing an authorization to a nuclear security officer;
- prevent and detect unauthorized entry into a protected area or inner area; and
- prevent unauthorized entry of weapons and explosive substances into a protected area or inner area.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.12.1 (prescribed information)	High-Security Sites, Volume I: Nuclear Response Force	2013	January 1, 2020
REGDOC-2.12.1 (prescribed information)	High-Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	2018	January 1, 2020
REGDOC-2.12.2	Site Access Security Clearance	2013	January 1, 2020
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	2013	January 1, 2020
CSA N290.7	Cyber-security for nuclear power plants and small reactor facilities	2014 (R2015)	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508710-PDD-001	Program Description Document: Security	5507946	N
900-508710-PRD-001	Program Requirements Document: Security	5507946	Y
900-511400-PDD-001	Program Description Document: Cyber Security	5507946	N
900-511400-PRD-001	Program Requirements Document: Cyber Security	5507946	Y
EPS-14000-RPT-18 (prescribed information)	Site Security Report	5776580	Y

The CSA standard N290.7 covers the cyber security of new and existing nuclear power plants (NPPs) and small reactor facilities.

The CNL document EPS-14000-RPT-18 *Site Security Report* document is required to be updated periodically and resubmitted to the CNSC staff. The site security report shall be updated and resubmitted when there are significant changes to the program.

Guidance:

Guidance Documents

Document Number	Document Title	Version
G-208	Transportation Security Plans for Category I, II or III Nuclear Material	2003
G-274	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities	2003

SCA – SAFEGUARDS AND NON-PROLIFERATION

Licence Condition 13.1: Safeguards Program

The licensee shall implement and maintain a safeguards program.

Preamble:

Safeguards is a system of inspection and other verification activities undertaken by the International Atomic Energy Agency (IAEA) in order to evaluate a Member State's compliance with its obligations pursuant to its safeguards agreements with the IAEA.

The *General Nuclear Safety and Control Regulations* requires the licensee to take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement.

The *Class I Nuclear Facilities Regulations* requires that a licence application contain information on the licensee's proposed measures to facilitate Canada's compliance with any applicable safeguards agreement.

Canada has entered into a safeguards agreement with the IAEA pursuant to its obligations under the Treaty on the Non-Proliferation of Nuclear Weapons. The objective of the Canada/IAEA Safeguards Agreement is for the IAEA to provide assurance on an annual basis to Canada and to the international community that all declared nuclear materials are in peaceful, non-explosive uses and that there is no indication of undeclared nuclear materials or activities. This conclusion confirms that Canada is in compliance with its obligations under the following Canada/IAEA Safeguards Agreement:

- *Treaty on the Non-Proliferation of Nuclear Weapons*;
- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*; and
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*.

These are reproduced in information circulars INFCIRC/140, INFCIRC/164, and INFCIRC/164/Add. 1.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508510-PDD-001	Program Description Document: Nuclear Materials and Safeguards Management	5507946	N
900-508510-PRD-001	Program Requirements Document: Nuclear Materials and Safeguards Management	5507946	Y

The licensee shall obtain prior written approval of the CNSC, for any changes to operation, equipment or procedures requested by the licensee that would affect the implementation of safeguards measures.

Guidance:

None Provided.

SCA – PACKAGING AND TRANSPORT

Licence Condition 14.1: Packaging and Transport Program

The licensee shall implement and maintain a packaging and transport program.

Preamble:

The *Class I Nuclear Facilities Regulations* require that a licence application contain information on the proposed procedures for transporting nuclear substances and hazardous substances.

The transport of nuclear substances or hazardous substances must be done in accordance with the requirements of the *Packaging and Transport of Nuclear Substances Regulations, 2015*, (PTNSR) and *Transportation of Dangerous Goods Regulations* (TDGR) set out by Transport Canada.

IAEA document SSR-6 *Regulations for the Safe Transport of Radioactive Material (2018 Edition)* is incorporated by reference in PTNSR. These Regulations establish standards of safety which provide an acceptable level of control of the radiation, criticality and thermal hazards to persons, property and the environment that are associated with the transport of radioactive material.

Compliance Verification Criteria:

Licensing Basis Publications

Document Number	Document Title	Version	Effective Date
IAEA SSR-6	Regulations for the Safe Transport of Radioactive Material (2012 Edition)	2018	January 1, 2020

Licensee Documents that Require Notification of Change

Document Number	Document Title	e-Doc	Prior Notice
900-508520-PDD-001	Program Description Document: Transportation of Dangerous Goods	5507946	N
900-508520-PRD-001	Program Requirements Document: Transportation of Dangerous Goods	5507946	Y

The licensee shall implement and maintain a packaging and transport program that will be in compliance with all the regulatory requirements set out in the Transport Canada TDGR and in the CNSC PTNSR.

Shipments of nuclear substances within the WL site where access to the property is controlled are exempted from the application of the PTNSR.

Based on the current versions of the PTNSR and TDGR, for the packaging and transport of nuclear substances

(a) to and from the WL site, both PTNSR and TDGR apply.

(b) between the WL facilities:

- according to paragraph 2(2)(*d*) of the PTNSR, the PTNSR do not apply to the transport of nuclear substances within the WL site, except for sections 6 and 7. Sections 6 and 7 refer to the CNSC *Nuclear Security Regulations*, specifically to the transport of Category I, II or III nuclear material.
- TDGR do not apply per subsection 1.25 of those regulations.

Guidance:

Guidance Documents

Document Number	Document Title	Version
RD-364	Joint Canada-United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages	2009
REGDOC-2.14.1	Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substances Regulations, 2015	2016

APPENDIX A: DEFINITIONS AND ACRONYMS

1. DEFINITIONS

The following is a list of definitions of words or expressions used in the LCH that may need clarification; they are defined for the purpose of the LCH only. All other terms and expressions used in the LCH are consistent with the definitions provided in the NSCA, the regulations made pursuant to the NSCA, or in the CNSC regulatory document REGDOC-3.6 *Glossary of CNSC Terminology*.

Approval – Commission's permission to proceed, for situations or changes where the licensee would be:

- not compliant with a regulatory requirements set out in applicable laws and regulations;
- not compliant with a licence condition; and
- not in the safe direction but the objective of the licensing basis is met.

Boundary Conditions – procedural, administrative rules and operating limits for ensuring safe operation of the facility based on safety analyses and any applicable regulatory requirements.

Compliance Verification Criteria – regulatory criteria used by CNSC staff to verify compliance with the licence conditions.

Design Basis – the entire range of conditions for which the nuclear facility is designed, in accordance with established design criteria, and for which damage to the fuel and/or the release of radioactive material is kept within authorized limits.

Effective Date – the date that a given document becomes effective within the licensing period. The effective date is either set to the licence issue date or to a future date when the given document becomes effective.

Guidance – guidance in the LCH is non-mandatory information, including direction, on how to comply with the licence condition.

Program(s) – a documented group of planned activities, procedures, processes, standards and instructions coordinated to meet a specific purpose.

Qualified Staff – trained licensee staff, deemed competent and qualified to carry out tasks associated with their respective positions.

Safe Direction – changes in facility safety levels that would not result in:

(a) a reduction in safety margins;

(b) a breakdown of barrier;

(c) an increase (in certain parameters) above accepted limits;

(d) an increase in risk;

(e) impairment(s) of safety systems;

(f) an increase in the risk of radioactive releases or spills of hazardous substances;

(g) injuries to workers or members of the public;

(h) introduction of a new hazard;

(i) reduction of the defence-in-depth provisions;

(j) reducing the capability to control, cool and contain the reactor while retaining the adequacy thereof; or

(k) causing hazards or risks different in nature or greater in probability or magnitude than those stated in the safety analysis of the nuclear facility.

Safety and Control Measures – measures or provisions which demonstrate that the applicant:

(i) is qualified to carry on the licensed activities; and

(ii) has made adequate provision for the protection of the environment, the health and safety of persons, the maintenance of national security and any measures required to implement international obligations to which Canada has agreed.

Written Notification – a physical or electronic communication between CNSC staff and a person authorized to act on behalf of the licensee.

2. ACRONYMS LIST

Acronym	Definition
AECL	Atomic Energy of Canada Limited
ALARA	As Low As Reasonably Achievable
CAF	Change Approval Form
CNEA	Canadian National Energy Alliance
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
DDP	Detailed Decommissioning Plan
DG-DNCFR	Director General, Directorate of Nuclear Cycle and Facilities Regulations
IAEA	International Atomic Energy Agency
LCH	Licence Conditions Handbook
NSCA	Nuclear Safety and Control Act
NT	Notification at time of making the change
PN	Prior Notification
PTNSR	Packaging and Transport of Nuclear Substances Regulations, 2015
SSC	Structures, Systems, Components
SWS	Storage with Surveillance
TDGR	Transportation of Dangerous Goods Regulations
TLD	Thermoluminescent Dosimeter
WL	Whiteshell Laboratories

CURRENT LICENCE

The current licence is provided on the following pages of the document.

e-Doc 5482676 (WORD)

e-Doc 5492696 (PDF)

e-Doc 5482676 (Word)
e-Doc 5492696 (PDF)

NUCLEAR RESEARCH AND TEST ESTABLISHMENT DECOMMISSIONING LICENCE

WHITESHELL LABORATORIES

I) LICENCE NUMBER: **NRTEDL-W5-8.05/2019**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act*, this licence is issued to

Canadian Nuclear Laboratories Limited
286 Plant Road
Chalk River, Ontario
K0J 1J0

III) LICENCE PERIOD: This licence is valid from January 1, 2019 and remains in effect until December 31, 2019 unless otherwise suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

a) operate and decommission the Whiteshell Laboratories (hereinafter "WL") located in Pinawa, Province of Manitoba as further described in the Whiteshell Laboratories *Licence Conditions Handbook* (LCH) ,

b) produce, possess, process, refine, transfer, use, package, manage, import, export and store the nuclear substances that are required for, associated with or arise from the activities described in a),

c) possess, use, produce and transfer prescribed equipment that is required for, associated with, or arises from the activities described in a),

d) possess, use and transfer prescribed information that is required for, associated with, or arises from the activities described in a),

e) carry out the site preparation, construction or construction modification or undertaking that is required for, associated with or arise from the activities described in a).

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Whiteshell Laboratories Licence Conditions Handbook (LCH) provides compliance verification criteria used to meet the conditions of this licence. The LCH also provides information regarding delegation of authority and applicable versions of documents.

VI) CONDITIONS:

1 GENERAL

1.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations

(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence

(iii) the safety and control measures described in the licence application and the documents needed to support that licence application

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (hereinafter "the Commission").

1.2 The licensee shall, in the event of any conflict or inconsistency between licence conditions, codes or standards or regulatory documents referenced in this licence, direct the conflict or inconsistency to the Commission, or a person authorized by the Commission, for resolution.

1.3 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

1.4 The licensee shall ensure that every contractor working at the facility complies with this licence.

1.5 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

1.6 The licensee shall comply with all commitments defined in the NRTEDL-W5-8.04/2018 LCH.

1.7 The licensee shall implement and maintain a public information and disclosure program.

1.8 The licensee shall implement and report on the progress of the Environmental Assessment Follow-Up Program.

2 DECOMMISSIONING

2.1 The licensee shall conduct decommissioning activities in accordance with Volumes 1 to 12 of the Whiteshell Laboratories Detailed Decommissioning Plan.

2.2 The licensee shall implement and maintain decommissioning policies, programs and procedures.

2.3 The licensee shall not make modifications to, or deviate from the design, operating conditions, purposes, methods, procedures or limits described in the safety analysis reports and/or operational limits and conditions documents that would result in an impact on health, safety or the environment that is different in nature or greater in magnitude or probability than that described in those documents without prior approval of the Commission or a person authorized by the Commission.

2.4 The licensee shall submit the project design requirements for construction of the approved second SMAG storage building prior to the commencement of construction activities described in paragraph e) of Part IV of this licence.

2.5 The licensee shall not carry out the activities referred to in paragraph a) of Part IV of this licence that relate to the completed construction activities in paragraph e) of Part IV of this licence for the approved second SMAG storage building until the submission of a commissioning report that is acceptable to the Commission.

3 SAFETY AND CONTROL AREA LICENCE CONDITIONS

MANAGEMENT SYSTEM

3.1 The licensee shall implement and maintain a management system.

4 HUMAN PERFORMANCE MANAGEMENT

4.1 The licensee shall implement and maintain a human performance program.

4.2 The licensee shall implement and maintain a training program.

5 OPERATING PERFORMANCE

5.1 The licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission.

6 SAFETY ANALYSIS

6.1 The licensee shall implement and maintain a safety analysis program.

6.2 The licensee shall implement and maintain a nuclear criticality safety program.

7 PHYSICAL DESIGN

7.1 The licensee shall implement and maintain a design program.

7.2 The licensee shall implement and maintain a pressure boundary program.

8 FITNESS FOR SERVICE

8.1 The licensee shall implement and maintain a fitness for service program.

9 RADIATION PROTECTION

9.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

10 CONVENTIONAL HEALTH AND SAFETY

10.1 The licensee shall implement and maintain a conventional health and safety program.

11 ENVIRONMENTAL PROTECTION

11.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

12 EMERGENCY MANAGEMENT AND FIRE PROTECTION

12.1 The licensee shall implement and maintain an emergency preparedness program.

12.2 The licensee shall implement and maintain a fire protection program.

13 WASTE MANAGEMENT

13.1 The licensee shall implement and maintain a waste management program.

13.2 The licensee shall maintain a cost estimate for decommissioning.

14 SECURITY

14.1 The licensee shall implement and maintain a security program.

15 SAFEGUARDS AND NON-PROLIFERATION

15.1 The licensee shall implement and maintain a safeguards program.

16 PACKAGING AND TRANSPORT

16.1 The licensee shall implement and maintain a packaging and transport program.

SIGNED at OTTAWA, AUG 0 1 2018.

M. Binder

Michael Binder, President
on behalf of the Canadian Nuclear Safety Commission

Minister
of Natural Resources

Ministre
des Ressources naturelles

ADMINISTRATION

Ottawa, Canada K1A 0E4

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Dr. Michael Binder
President and Chief Executive Officer
Canadian Nuclear Safety Commission
P.O. Box 1046, Station B
Ottawa, Ontario K1P 5S9

Dear Dr. Binder:

I am writing in response to your letter of July 15, 2015, with respect to the Canadian Nuclear Safety Commission's (CNSC) requirement for all of its licensees to establish sufficient funds for the decommissioning of their nuclear facilities, i.e. financial guarantees under paragraph 3(1)(l) of the *General Nuclear Safety and Control Regulations* made pursuant to the *Nuclear Safety and Control Act*.

Atomic Energy of Canada Limited (AECL) is a Schedule III, Part I Crown corporation under the *Financial Administration Act* and an agent of Her Majesty in Right of Canada. As an agent of Her Majesty in Right of Canada, AECL's liabilities are ultimately liabilities of Her Majesty in Right of Canada.

While the restructuring of AECL will see the ownership of Canadian Nuclear Laboratories Limited (CNL) transferred to a private-sector contractor, AECL will retain ownership of the lands, assets and liabilities associated with CNL's licences. Specifically, this letter addresses the licences held by CNL for the Chalk River Laboratories, the Whiteshell Laboratories, the Port Hope project, the Port Granby project, and the following three prototype power reactors: Nuclear Power Demonstration, Douglas Point and Gentilly-1.

Consistent with the policy of the Government of Canada that Her Majesty need not restate her commitment in the form of a guarantee, I trust that this letter will serve to address the requirement of the Commission.

Sincerely,

Greg Rickford

The Honourable Greg Rickford, P.C., M.P.
Minister of Natural Resources and Minister for the
Federal Economic Development Initiative for Northern Ontario

c.c.: Mr. Jon Lundy, Chief Transition Officer, Atomic Energy of Canada Limited
Mr. Ramzi Jammal, Executive Vice-President and Chief Regulatory Operations Officer, Canadian Nuclear Safety Commission

Canada

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

UNRESTRICTED

2020 AUGUST 25

145-CNNO-20-0028-L

Kavita Murthy, Director General
Directorate of Nuclear Cycle and Facilities Regulation
Canadian Nuclear Safety Commission
280 Slater Street
P.O. Box 1046, Station B
OTTAWA, Ontario K1P 5S9

OPERATIONS
Office of the Vice-President & CNO

Submission of Information Regarding Financial Guarantees for all Atomic Energy of Canada Limited Sites Operated by Canadian Nuclear Laboratories

Dear Ms. Murthy:

The purpose of this letter is to submit to Canadian Nuclear Safety Commission (CNSC) staff information recently received [1] by Canadian Nuclear Laboratories (CNL) from Atomic Energy of Canada Limited (AECL) regarding the requirements under the *Nuclear Safety and Control Act* to make funding provisions for decommissioning financial guarantees. The information received relates specifically to liabilities associated with the nuclear licensed sites that are owned by AECL, and operated by CNL under a Government owned – Contractor operated (GoCo) contract.

Accordingly, please find enclosed the letter received from AECL [1], which explicitly confirms that the provisions of financial guarantees previously stated in 2015 [2], by the then Minister of Natural Resources, are reaffirmed as remaining valid.

CNL trusts that the submission of references [1] and [2] will be satisfactory for the purposes of CNSC staff, in their consideration of AECL's liabilities and for providing decommissioning financial guarantees for the sites that are managed by CNL on behalf of AECL under the GoCo contract.

If you should have any questions with respect to the foregoing, please contact me directly or Mr. Shaun Cotnam, CNL's Chief Regulatory Officer at 613-639-1353.

Yours sincerely,

Phillip Boyle
Vice-President, Operations
Chief Nuclear Officer
Site Licence Holder – Chalk River Laboratories
Phone: 613-584-3311, ext. 42408
Email: Phillip.boyle@cnl.ca

Enclosures – (2)

References:

[1] Letter, R.J. Sexton to J. McBrearty, *Financial Guarantee for all AECL Sites*, DWM-401676415-1638, 2020 August 12.

[2] Letter, G. Rickford to M. Binder, 'Untitled', 145-NRCANNO-15-0001-L, 2015 July 31.

c.				
	R.J. Sexton (AECL)	S. Quinn (AECL)	A. MacDonald (AECL)	
	R. Velshi (CNSC)	R. Jammal (CNSC)	C. Cianci (CNSC)	
	S. Brewer	S. Cotnam	J. Gilbert	J. Griffin
	M. Gull	S. Karivelil	J. McBrearty	D. McIntyre
	S. Parnell	F.P. Quinn	L. Riccoboni	K. Schruder
	M. Steedman	C. Williams	D. Wood	

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Nuclear Criticality Safety (PDD)
REV 3

900-508550-PDD-001

Information Use

Approved by	Title	Date
Jennifer Turcotte	Mgr, Controls & Safeguard Mgmt	2023/02/28

Effective Date: 2023/03/10
Expiry Date: 2026/02/28

Refer to ATOM for current version. Printed copies should not be considered current without first consulting ATOM.

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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
3	2022/02/17	Issued as “Approved for Use”	K. Erlandson	Z. Barnicoat	J. Turcotte
3D1	2022/01/03	Issued for “Review and Comment” Major changes: • Updated template • Updated definitions (alignment with REGDOC-3.6, and redefined several CNL-owned terms: BAP, NCCA/Non-NCCA, CSD, TLA) • Updated Section 4 to ensure established responsibilities are functional rather than procedural • Replaced requirement to have a minimum of one NCCO Designate with requirement to have an appointed NCCO in order to operate	K. Erlandson	Z. Barnicoat J. Carver A. Dash D. Garrick C. Gallagher J. Sylvestre J. Turcotte G. Von Appen	
2	2021/04/16	Issued as “Approved for Use”	J. Wang	R. Dranga	J. Turcotte

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
2D2	2021/04/05	Issued for "Review and Comment" • Addressed reviewer comments from 2D1 • Revised Purpose section to describe the purpose of the PDD instead of the FSA • Updated Roles and Responsibilities section to include Security FSA and Training & Development FSA. • Updated Nuclear Criticality Control Officer role to match all responsibilities associated with the appointment form • Updated References section • Updated Definitions to reference and align with REGDOC 3.6	J. Wang	F. Adams K. Boniface R. Dranga Z. Barnicoat A. Coulas	
2D1	2021/02/16	Issued for "Review and Comment" • Updates to interfaces to include TGD program • Updates to roles and responsibilities to align with CNL management system • Update to references	M. Boileau	F. Adams K. Boniface R. Dranga F. Yazdani Z. Barnicoat A. Coulas J. Wang	
1	2019/01/16	Issued as "Approved for Use"	R. Dranga	J. Wang	J. Turcotte

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By		Approved By
1D1	2018/11/20	Issued for "Review and Comment" Minor updates to internal interfaces group names, added reference to the Criticality Safety Analyst Training Qualification Card, updated references to match CNSC REGDOC-3.6, revised document references, and revised document template as per new Management System Document Template for PDD.	R. Dranga	Z. Barnicoat A. Coulas Y. Dube G. Edwards	C. McNally J. Turcotte J. Wang	
0	2017/02/03	Issue as "Approved for Use" Supersedes 145-508550-OV-001, Nuclear Criticality Safety, and 145-508550-REQ-001, Nuclear Criticality Safety Requirements	C. McNally	K. Leroux		K. Leroux
D1	2016/12/06	Issued for "Review & Comment"	C. McNally	Z. Barnicoat C. Bennett M. Boileau A. Coulas J. deRuiter R. Dranga G. Edwards G. Finley K. Gauthier S. Johnston K. Leroux K. Lundie M. Mantha E. Masala A. McIvor	S. Mistry D. Onagi C. Paquette D. Pilgrim P. Playford D. Ryland B. Sanderson J. Schnelle R. Sparling S. Suppiah G. Thambithurai J. Turcotte J. Wang N. Wang	K. Leroux

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Section **Page**

1. Scope and Applicability

This Company-wide Interpretation document applies to all activities unique to the Nuclear Criticality Safety (NCS) Function performed by Canadian Nuclear Laboratories (CNL) at the Chalk River Laboratories (CRL) and Whiteshell Laboratories (WL) sites.

The scope of the NCS Function includes the control and oversight of operations involving the handling, storage, processing, and transportation of fissionable material (FM) and the long-term management of nuclear waste. It is applicable during the construction, operation, decommissioning, or abandonment of the licensed facility.

The following is outside the scope of the NCS Function:

- Operations with FM inside nuclear reactors; and
- Events leading to nuclear criticality arising from terrorism, sabotage, or other malicious acts.

2. Purpose

The NCS Function establishes the framework for ensuring that accidental nuclear criticality is prevented and that the consequences of accidental nuclear criticality are mitigated during operations with FM outside nuclear reactors.

3. Definitions and Acronyms

This document relies primarily on word meaning as found in common dictionaries. The CNL current *Glossary of Terms and Definitions* [1] contains specific meanings for those words that require further clarification.

The definitions and acronyms in this section are those owned or created by the NCS Function.

3.1 Definitions

Accidents or Accident Sequences	Events or event sequences, including external events, that lead to violation of the subcriticality margin (that is, to exceeding the upper subcritical limit) [2].
Active Engineered Control	A physical device that uses active sensors, electrical components, or moving parts to maintain safe process conditions without any required human action [2].
Areal Density	The product of the thickness of a uniform slab and the density of fissionable material within the slab; hence, areal density is the mass of fissionable material per unit area of slab. For non-uniform slurries, the areal density limits are valid for a horizontal slab subject to gravitational settling, provided the restrictions for uniform slurries are met throughout [2].

Array	Any fixed configuration of fissile or fissionable material units maintained by mechanical devices [2].
Balance After Processing	The balance of fissionable material that was known to be present but cannot be accounted for due to physical processing or uncertainties in measurement. Examples of Balance After Processing include material caught in air filters, residue, dust, and shavings generated by cutting, grinding, etc.
Benchmark Experiment	With respect to nuclear criticality safety, a well-characterized experiment at the critical state that may be used to establish the reliability of calculational methods [2].
Controlled Parameter	A parameter that is kept within specified limits and, when varied, influences the margin of subcriticality [2].
Conservatism	The use of assumptions that make predictions regarding consequences more severe than if best-estimate assumptions had been used [2].
Conservative Calculations	Calculations that are designed to over-predict a parameter with the intention that the reality will not be greater than the prediction. These calculations can be based on simplifications of the processes being simulated (the structure of a model) or on limits of data values used in the model [2].
Credible Abnormal Conditions	Accidents or accident sequences that have a frequency of occurrence equal to or more than one in a million years [2].
Criticality Accident	The release of energy as a result of accidental production of a self-sustaining or divergent neutron chain reaction [2].
Criticality Accident Alarm System	A radiation detection system meeting the requirements established in Section 3.0 of REGDOC-2.4.3 [3] that reliably detects the occurrence of a criticality accident in a prescribed area and promptly alerts personnel.
Criticality Safety Analysis	The process used to demonstrate that an adequate margin of subcriticality is maintained under normal and credible abnormal conditions.

Criticality Safety Control	Structures, systems, equipment, components, and activities of personnel that are relied on to prevent accidents or to mitigate their potential consequences [2]. Criticality Safety Controls are categorized as one of the following (see relevant definitions for each): • Passive Engineered Control • Active Engineered Control • Enhanced Administrative Control • Simple Administrative Control
Criticality Safety Document	A document that identifies and defines all known nuclear criticality safety concerns; documents nuclear criticality safety assumptions, requirements, limits, and controls; and demonstrates subcriticality [2].
Cross-section (σ), Neutron	The proportionality factor that relates the rate of a specified reaction to the product of the number of neutrons per second impinging normally onto a unit area of a thin target and the number of target nuclei per unit area. It may be considered a small area assigned to each target nucleus, usually expressed in barns (i.e., 10^{-24} cm^2) [4].
Depleted Uranium	Uranium that contains ^{235}U in a concentration that is less than that normally found in nature. With respect to nuclear criticality safety, the concentration of this isotope is less than 0.71 percent by weight [2].
Double Contingency Principle	A characteristic or attribute of a process that has incorporated sufficient safety factors so that at least two unlikely, independent, and concurrent changes in process conditions are required before a nuclear criticality accident is possible [2].
Effective Neutron Multiplication Factor	**Physically**, the ratio of the total number of neutrons produced during a time interval (excluding neutrons produced by sources whose strengths are not a function of fission rate) to the total number of neutrons lost by absorption and leakage during the same interval [2]. **Mathematically** (computationally), the eigenvalue number that, when divided into the actual mean number of neutrons emitted per fission in an assembly of materials, would make the calculated result for the nuclear chain reaction of that assembly critical [2].

Enhanced Administrative Control	A procedurally required or prohibited human action, combined with a physical device that alerts an operator to take action to maintain safe process conditions, or that otherwise adds substantial assurance of the required human performance [2].
Enriched Uranium	Uranium having a higher abundance of the fissile isotopes (^{235}U, ^{233}U, or a combination of both) than natural uranium [2].
Excessive Radiation Dose	In a nuclear criticality accident, any dose to personnel corresponding to an absorbed dose from neutrons and gamma rays equal to or greater than 0.12 gray in free air [2].
Fertile Material	Nuclear material that can be converted into special fissionable material through the capture of one neutron per nucleus. There are two naturally occurring fertile materials: ^{238}U and ^{232}Th. Through the capture of neutrons followed by two beta decays, these fertile materials are converted to fissionable ^{239}Pu and ^{233}U, respectively [2].
Fissile Material	A material, other than natural uranium, that is capable of sustaining a thermal neutron chain reaction [2].
Fissile Nuclide	A nuclide capable of undergoing fission by interaction with slow neutrons provided the effective thermal neutron production cross-section, $\upsilon\sigma_f$, exceeds the effective thermal neutron absorption cross-section σ_a [2].
Fission	Disintegration of a nucleus (usually Th, U, Pu, or heavier) into two (rarely more) masses of similar order of magnitude, accompanied by a large release of energy and the emission of neutrons [4].
Fission Cross-Section	See the definitions for *fission* and *cross-section*. The fission cross-section is designated as σ_f.
Fissionable Material	Any material that can undergo nuclear fission [2].
Fixed Moderator	A moderator with an established geometric relationship to the locations occupied by the fixed neutron absorber and fissionable material [2].
Fixed Neutron Absorbers	Neutron absorbers in solids with an established geometric relationship to the locations occupied by fissionable material [2].

High-Enriched Uranium	Uranium containing 20 percent or more by weight of isotope ^{235}U, isotope ^{233}U, or combined ^{233}U and ^{235}U. Also called highly-enriched uranium [2].
Immediate Evacuation Zone	The area surrounding a potential criticality accident location that must be evacuated without hesitation if a criticality accident alarm signal is activated [2].
Logarithmic Energy Decrement	The decrease per collision in the logarithm of the neutron energy [5].
Long-Term Management of Nuclear Waste	The long-term management of radioactive nuclear waste by means of storage or disposal, including handling, treatment, conditioning, or transport for the purpose of storage or disposal. Also called long-term waste management [2].
Low-Enriched Uranium	Enriched uranium containing less than 20 percent by weight of isotope ^{235}U, ^{233}U, or combined ^{233}U and ^{235}U [2].
Minimum Accident of Concern	An accident resulting in a dose to free air of 0.20 gray in the first minute at a distance of 2 metres from the reacting material [2].
Minimum Critical Mass	The smallest mass of a fissionable material which, under specific conditions (neutron reflection, neutron moderation, geometry, etc.), can result in a self-sustaining fission chain reaction.
Moderating Ratio	The moderating ratio is the ratio of the macroscopic slowing down power (a product of the logarithmic energy decrement and the macroscopic neutron scattering cross section) to the macroscopic cross-section for absorption. The higher the moderating ratio, the more effectively the material performs as a moderator [5].
Moderator Control Area	An area defined by a Criticality Safety Document in which moderators are limited and controlled for nuclear criticality safety [2].
Natural Uranium	Uranium that contains ^{235}U in a concentration that is normally found in nature. With respect to nuclear criticality safety, the concentration of this isotope is equal to or less than 0.71 percent by weight [2].

Neutron Absorber	A neutron-capture material; that is, a substance with a large neutron absorption cross-section. When neutron absorption is not desired, a neutron absorber may be called a neutron poison. Some examples of neutron absorbers are [2]: • boron, used in some shutdown systems • some of the products generated during fission that have a high neutron absorption cross-section, such as ^{135}Xe and ^{149}Sm
Neutron Absorption	A neutron-induced reaction, including fission, in which the neutron disappears as a free particle [6].
Neutron Absorption Cross-Section	See definitions for *neutron absorption* and *cross-section.* The neutron absorption cross-section is designated as σ_a.
Neutron Leakage	Transport of neutrons by their physical motion from one region to another or from a system as a whole [7].
Neutron Moderation	The process of decreasing the energy of neutrons through successive collisions with moderator nuclei without appreciable competing capture [2].
Neutron Moderator	A material used to slow down or “moderate” neutrons produced by nuclear fuel. The moderator reduces neutron energy by scattering without appreciable capture. Materials of prime concern are those containing light nuclei with large scattering cross-sections and relatively low absorption cross-sections [2].
Neutron Reflection	The process in which neutrons that would otherwise leak from a material volume are returned as a result of scattering from a surrounding material [7].
Neutron Reflector	Material outside the core of a fissionable system capable of scattering back to the core some neutrons that would otherwise escape [4].
Neutron Scattering	Reaction between a neutron and a nucleus in which the net result is a change in the neutron energy and direction of travel [7].
Neutron Scattering Cross-Section	See the definitions for *neutron scattering* and *cross-section*. The scattering cross-section is designated as σ_s.

Non-Nuclear Criticality Controlled Area	A defined area (e.g., a building, a series of labs, a waste management area, an on-site flask, or transfer package) that is permitted to contain quantities of fissionable material that satisfy the Canadian Nuclear Safety Commission exemption criteria for nuclear criticality safety (Section 5.1).
Normal Conditions	Conditions or ranges of conditions that are expected during normal or routine operation.
Nuclear Criticality	A self-sustaining chain reaction of nuclear fission [2].
Nuclear Criticality Controlled Area	A defined area (e.g., a building, a series of labs, a waste management area, an on-site flask, or transfer package) that is permitted to contain quantities of fissionable material that do not satisfy one of the Canadian Nuclear Safety Commission exemption criteria for nuclear criticality safety (Section 5.1).
Nuclear Criticality Safety	Protection against the consequences of a criticality accident, preferably by prevention of the accident [2].
Operations with Fissionable Material	Any activity involving the handling, use, processing, movement, and storage of fissionable material and the long-term management of nuclear waste containing fissionable material [2].
Passive Engineered Control	A device that uses only fixed physical design features to maintain safe process conditions without any required human action [2].
Reactivity	A quantity (k_{eff} – 1) / k_{eff}, where k_{eff} is the effective neutron multiplication factor. The reactivity of a subcritical assembly is a negative quantity indicating the degree of subcriticality. The reactivity of a critical assembly is zero [2].
Representative Nuclear Criticality Accident	A postulated nuclear criticality accident that is used to demonstrate compliance with the CNSC criticality safety requirements on the mitigation of nuclear criticality accident consequences [2].
Simple Administrative Control	A procedural human action that is prohibited or required to maintain safe process conditions [2].
Single-Parameter Limit	The limiting value assigned to a single controlled parameter that results in a subcritical system under specified conditions. Single parameter limits allow for uncertainties in the calculations and experimental data used in its derivation but not for contingencies such as double batching or inaccuracies in analytical determinations.

Special Fissionable Material	Fissionable material that contains fissile isotopes (excluding natural uranium, depleted uranium, and natural thorium).
Subcritical Limit	The limiting value assigned to a controlled parameter that results in a subcritical system under specified conditions. The subcritical limit allows for uncertainties in the calculations and experimental data used in its derivation but not for contingencies such as double batching or inaccuracies in analytical determinations [2].
Time-Limited Amendment	A document that amends a Criticality Safety Document in order to demonstrate the safety of operations that are not covered under the Criticality Safety Document.
Upper Subcritical Limit	The maximum allowed value of the calculated effective multiplication factor (k_{eff}) or of a single-parameter subcritical limit, under both normal and credible abnormal conditions, including allowance for the bias, uncertainty in the bias, and an administrative margin of subcriticality [2].

3.2 Acronyms

AEC	Active Engineered Control
BAP	Balance After Processing
CAAS	Criticality Accident Alarm System
CHI	Criticality Hazard Identification
CSA	Criticality Safety Analysis
CSC	Criticality Safety Control
CSD	Criticality Safety Document
DCP	Double Contingency Principle
DU	Depleted Uranium
EAC	Enhanced Administrative Control
EU	Enriched Uranium
FM	Fissionable Material
HEU	High-Enriched Uranium / Highly-Enriched Uranium
IEZ	Immediate Evacuation Zone
k_{eff}	Effective Neutron Multiplication Factor
LEU	Low-Enriched Uranium

MAGIC MERV HD	Mass Absorption Geometry Interaction Concentration Moderation Enrichment Reflection Volume Heterogeneity Density
MCM	Minimum Critical Mass
NCCA	Nuclear Criticality Controlled Area
NCCO	Nuclear Criticality Control Officer
NCS	Nuclear Criticality Safety
NT	Natural Thorium
NU	Natural Uranium
PEC	Passive Engineered Control
SAC	Simple Administrative Control
SFM	Special Fissionable Material
SCL	Subcritical Limit
SPL	Single-Parameter Limit
TLA	Time-Limited Amendment
USL	Upper Subcritical Limit

4. Roles and Responsibilities

The sections below contain only functional responsibilities (i.e., responsibilities related to setting rules and controls, and oversight of the implementation of those rules and controls). Additional procedural responsibilities are established in the suite of NCS implementing documents. Where applicable, these documents are referenced in the sections below.

4.1 Nuclear Criticality Safety Functional Support Manager

The NCS Functional Support Manager (FSM) has the overall responsibility to ensure that the NCS FSA implements effective processes that meet all NCS regulatory requirements as per the CRL and WL Licence Conditions Handbooks (LCHs) [8] [9] and the *NCS Program Requirements Document (PRD)* [10].

As per the FSM responsibilities established in the *CNL Management System Manual* [11], the NCS FSM is responsible for:

- Ensuring that all applicable NCS requirements are implemented in appropriate implementing documents;
- Acting as a final authority for interpretation and applicability of NCS functional requirements to Line Management;

- Performing applicability reviews on new and revised NCS requirements, identifying the impacts, and planning the strategy for implementation;
- Establishing and implementing the NCS attributes and training expectations for the training and qualification of NCS FSA personnel;
- Ensuring that the quality of documentation that is under the direct purview of the NCS FSA meets the NCS Function requirements and overall company requirements;
- Establishing and maintaining effective relationships and coordination of the NCS FSA interfaces with Atomic Energy of Canada (AECL), Canadian Nuclear Safety Commission (CNSC) staff, and oversight organizations; and
- Developing and performing assessments in accordance with *Integrated Assessment Plan* [12] to evaluate the implementation of program elements in order to verify that NCS FSA requirements are adequately implemented.

4.2 Nuclear Criticality Safety Functional Support Manager Designate

The NCS Program Manager normally fulfills this role.

As per the FSM Designate responsibilities established in the *CNL Management System Manual* [11], the NCS FSA Designate is responsible for:

- Assisting the NCS FSM in fulfilling the responsibilities listed in Section 4.1;
- Maintaining effective communication and working relationships with Line Management and other FSM Designates;
- Interfacing with facilities, projects, and other support organizations to ensure that the quality of documentation under the direct purview of the NCS FSA meets the NCS Function requirements and overall company requirements;
- Maintaining proficient knowledge of the NCS FSA requirements;
- Providing support to Line Management by identifying and interpreting the applicable NCS FSA requirements;
- Developing NCS FSA implementing documents;
- Supporting and monitoring NCS training and qualification programs to ensure that NCS requirements are implemented effectively and the applicable employees are trained and qualified to perform their work;
- Participating in internal or third-party audits and other assessments and reviews, as requested;
- Being familiar with events and issues related to NCS within facilities, projects, and other support organizations and assisting in developing the associated corrective action plans and lessons learned; and

- Supporting assessments evaluating the implementation of program elements to verify that NCS FSA requirements are adequately implemented.

In addition to this, the NCS FSA Designate is responsible for:

- Performing responsibilities pertaining to NCS Program Officers listed in Section 4.3.

4.3 Nuclear Criticality Safety Program Officer

NCS Program Officers are responsible for:

- Maintaining proficient knowledge of the requirements of the NCS FSA, and of current NCS regulations, standards, guides and codes;
- Providing NCS support and oversight to ensure that the requirements of the NCS FSA are being implemented effectively;
- Performing work in accordance with NCS FSA processes and procedures;
- Reviewing the following to ensure that NCS FSA requirements are being implemented:
    - Procedures related to operations with FM in NCCAs;
    - General and area-specific NCS training material;
    - Emergency Procedures for areas with a Criticality Accident Alarm System (CAAS) installed or adjacent buildings that would be impacted by the actuation of a CAAS;
    - Pre-Incident Plans for response to a fire in NCCAs;
- Developing and delivering NCS training; and
- Performing responsibilities pertaining to Criticality Safety Analysts listed in Section 4.4.

4.4 Criticality Safety Analysts

Criticality Safety Analysts are responsible for:

- Performing work in accordance with NCS FSA processes and procedures; and
- Providing advice and guidance to CNL personnel on technical NCS matters, as required.

4.5 Safety Analysts

Safety Analysts support the development of Criticality Safety Analysis (CSA). Safety Analysts are responsible for:

- Performing work in accordance with NCS FSA processes and procedures; and
- Providing advice and guidance to NCS personnel on safety analysis matters related to NCS, as required.

4.6 Line Management of NCCAs and Non-NCCAs

Line Managers (e.g., Facility Authority, Manager, Director, etc.) are responsible for ensuring that work is performed safely by implementing and ensuring operations are conducted within CNL's requirements in their respective department/facility [11].

In addition to the Line Management responsibilities established in the *CNL Management System Manual* [11], Line Management of areas containing FM is responsible for ensuring that the requirements of the NCS Program are implemented in their area, as established in Table 1.

Table 1: Responsibilities for Line Management of NCCAs and Non-NCCAs

Responsibility	NCCA	Non-NCCA
Accept overall responsibility for the nuclear criticality safety of the operations in the area, and provide regular and systematic oversight to ensure that all applicable NCS requirements (as documented in this document and the *NCS for Operations* Standard [13]) are adhered to.	✓	✓
Ensure that all operations involving FM have been evaluated for NCS in a CSD or TLA, and that the NCS Panel has accepted the CSD or TLA prior to the operations being performed.	✓	
Ensure that all limits, restrictions, and Criticality Safety Controls (CSCs) established in the applicable CSD and all active TLAs are adhered to.	✓	
Ensure that all limits and restrictions established in the CNSC exemption criteria for NCS (see Section 5.1) are adhered to.		✓
Appoint an NCCO and NCCO Designates as per the Standard for *Qualification and Appointment of NCCOs* [14]. If an NCCA does not have an appointed NCCO, **<u>all operations with FM are halted, and the NCS FSA is notified</u>**. Under exceptional circumstances where prompt NCCO action is required to ensure either safety or compliance with NCS Functional requirements, Line Management for the NCCA may perform specific actions in the place of the NCCO upon receipt of written approval from the NCS FSA.	✓	
Ensure their staff have been assigned the correct training categorization and have completed and maintained the associated required NCS training (including refresher training) as per the *NCS Training* Standard [15].	✓	✓
Ensure completion of the NCS Compliance Assessment on an annual basis as per the *NCS Compliance Assessment* Standard [16].	✓	✓

Responsibility	NCCA	Non-NCCA
Ensure that issues and unplanned events related to NCS are promptly communicated to the NCS Function.	✓	✓

4.7 Employees in NCCAs and Non-NCCAs

Employees in NCCAs are responsible for:

- Working within the limits and restrictions established in the applicable CSD(s) and all active TLAs; and
- Promptly reporting issues and unplanned events related to NCS to Line Management and the NCCO.

Employees in Non-NCCAs are responsible for:

- Working within the limits and restrictions established by the CNSC exemption criteria for NCS (see Section 5.1); and
- Promptly reporting issues and unplanned events related to NCS to Line Management.

4.8 Nuclear Criticality Control Officers

NCCOs and NCCO Designates are appointed as per the Standard for *Qualification and Appointment of NCCOs* [14], and are responsible for:

- Overseeing operations involving FM within an NCCA to ensure compliance with all requirements established in the applicable CSD(s) and all active TLAs.
- Promptly reporting issues and unplanned events related to Line Management and the NCS FSA.

4.9 Nuclear Criticality Safety Panel

The NCS Panel is a subcommittee of the Safety Review Committee (SRC) comprised of members with broad skills and expertise in at least the following: criticality safety analysis, chemistry, decommissioning, operations, and physics [17]. They are responsible for performing independent review and acceptance of [18]:

- Documentation that has satisfactorily demonstrated NCS for activities involving FM and on-site transport packages used to transport FM;
- Documentation that evaluates the requirements for CAAS for existing and new NCCAs, including documentation that justifies the removal of CAAS from existing NCCAs; and
- Criticality safety analysis of CNL-owned transport packages used in the shipment of FM off-site before these transport packages are submitted to the CNSC for licensing.

4.10 Training & Development

The Training and Development FSA is responsible for [19]:

- Ensuring NCS-related training is included in training plans according to the requirements established in the *NCS Training* Standard [15]; and
- Supporting the development of NCS training (including the training of NCS FSA staff and of NCCA and Non-NCCA staff).

4.11 Fire Protection

The Fire Protection FSA is responsible for [20]:

- Including NCS information in building-specific Pre-Incident Plans and submitting these plans to the NCS FSA for review; and
- Participating in the emergency response to CAAS actuation.

4.12 Security

The Security FSA is responsible for [21]:

- Participating in the emergency response to CAAS actuation.

4.13 Emergency Preparedness

The Emergency Preparedness FSA is responsible for [22]:

- Incorporating NCS requirements for buildings with CAAS and adjacent buildings that would be impacted by the actuation of a CAAS into their emergency drill plans and submitting these to the NCS FSA for review; and
- Incorporating criticality accident mitigation measures into emergency response activities.

5. Functional Programs

The NCS Function establishes the framework for ensuring that accidental nuclear criticality is prevented, and the consequences of accidental nuclear criticality are mitigated during operations with FM outside nuclear reactors.

The NCS function at CNL implements standards and regulations as described in the *Nuclear Criticality Safety PRD* [10].

The following are the foundation of the NCS FSA:

- NCS principles and requirements are part of the foundation of CNL's *Nuclear Safety Policy* [23];
- All operations with FM are demonstrated to be subcritical under both normal and credible abnormal conditions (accidents or accident sequences that have a frequency of

occurrence equal to or more than once in a million years) by using quantitative or semi-quantitative methods;

- Upper subcritical limits (USLs) are not exceeded under all normal and credible abnormal conditions;
- The consequences of a potential criticality accident are mitigated to limit the on-site and off-site doses; and
- CNL is compliant with site licence requirements for NCS through NCS Program processes and procedures.

Figure 1 presents an overview of the NCS FSA processes.

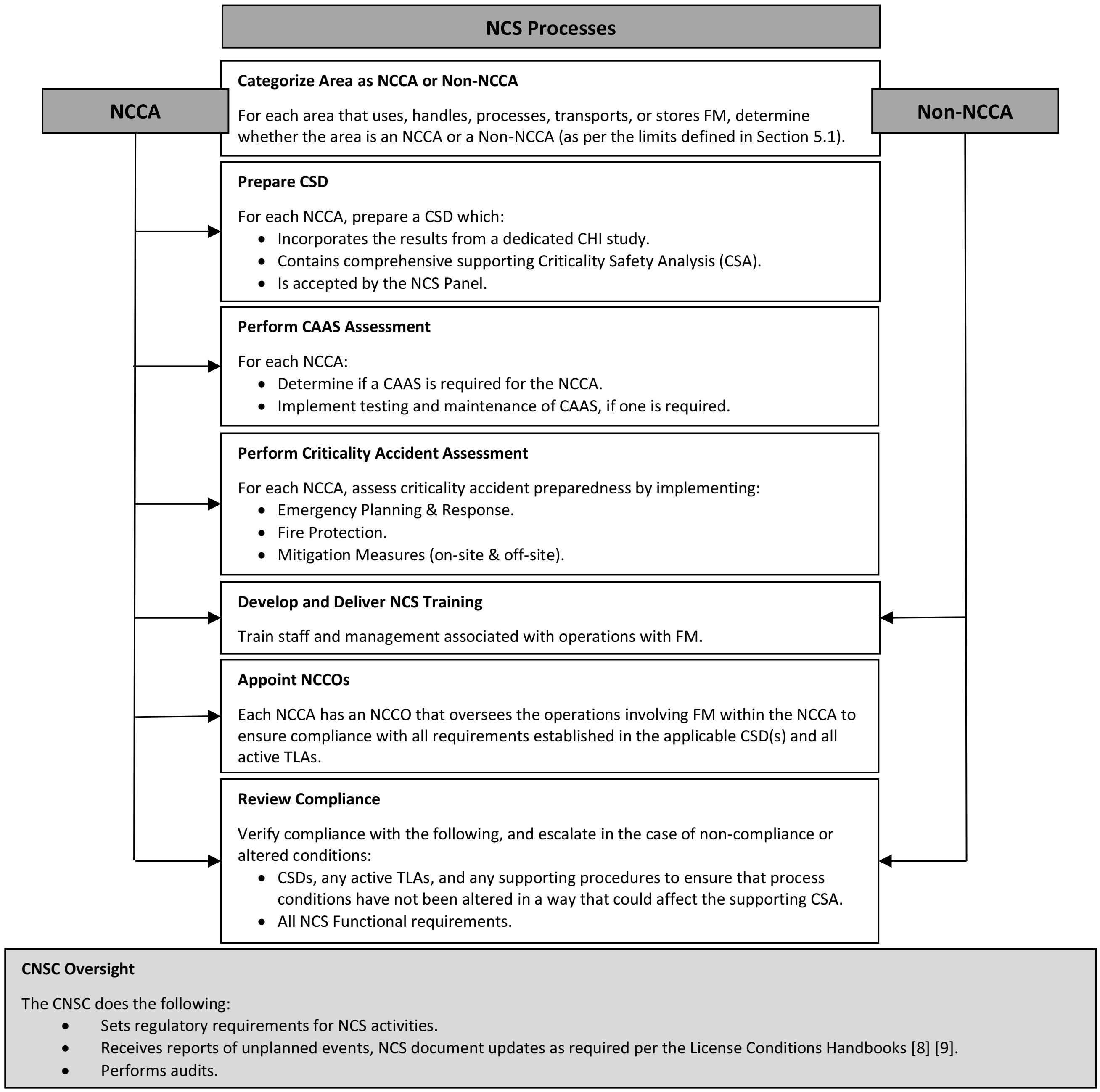

Figure 1: Process Flow Overview – Nuclear Criticality Safety

5.1 Nuclear Criticality Controlled Areas & Non-Nuclear Criticality Controlled Areas

The CNSC exemption criteria for NCS is defined as follows [3]:

1. Less than 100 g of ^{233}U, or ^{235}U, or ^{239}Pu, or any combination of these three isotopes in FM combined in any proportion; or

2. An unlimited quantity of natural or depleted uranium or natural thorium, if no other FM nor significant quantities of graphite, heavy water, beryllium, or other moderators more effective than light water are present in the area; or
3. Less than 200 kg in total of natural or depleted uranium or natural thorium if some other FM is present in the area, but the total amount of fissile nuclides in the FM is less than 100 g.

A Non-NCCA is a defined area (e.g., a building, a series of labs, a waste management area, an on-site flask, or transfer package) that is permitted to contain quantities of FM that satisfy one of the criteria listed above. An NCCA is a defined area (e.g., a building, a series of labs, a waste management area, an on-site flask, or transfer package) that is permitted to contain quantities of FM that do not satisfy one of the criteria listed above.

Nuclear sources and standards that meet the following criteria are exempt from consideration when defining an area as an NCCA or Non-NCCA:

- Any single source or standard that contains ≤ 1 g FM.
- Any number of sources or standards provided the total amount contained within the sources and standards is ≤ 10 g FM.

5.2 Processes / Activities

The NCS FSA processes and activities are described in the sections below.

5.2.1 Control of Fissionable Material

To ensure the control of FM, Line Management follows NCS FSA procedures and documents summarized in the *NCS Governing Document Index* [24].

Nuclear criticality is a risk associated with using, processing, handling, moving, and storing FM. The quantity of FM in both NCCAs and Non-NCCAs is an important criticality control parameter. Therefore, each NCCA and Non-NCCA must maintain accurate inventories of FM to support effective criticality control. FM is used, handled, moved, processed, and stored in a controlled manner, with procedures and training in place, to ensure that limits and restrictions are not exceeded, and criticality safety controls are implemented.

Access to areas where FM is used, handled, processed, or stored is controlled.

FM accounting and procedure adherence are essential to NCS. Line Management, NCCOs, and staff of NCCAs and Non-NCCAs know the locations and the amount of FM in their area, maintain accurate FM inventories and follow the requirements and processes of the *Nuclear Materials and Safeguards Management* FSA [25]. The movement of FM on-site follows the requirements and procedures covered under the *Nuclear Materials and Safeguards Management* FSA [25].

5.2.2 Criticality Safety Documents and Time-Limited Amendments for Nuclear Criticality Controlled Areas

Each NCCA has a CSD (and potentially one or several TLAs) that has been accepted by the NCS Panel. The NCS FSA supports the preparation, development, and review of CSDs.

The process for generating a CSD or TLA is documented in the Management Control Procedure for *Preparing a CSD or TLA* [26]. Inputs to the preparation of a CSD or TLA include:

- Criticality Safety Analysis: All NCCAs have criticality safety analysis as part of their CSD. This demonstrates that a sufficient safety margin has been established and will be maintained under all normal and credible abnormal conditions. The requirements for Criticality Safety Analysis are established in the *Criticality Safety Analysis* Standard [27].
- A CHI study: This type of study provides a systematic approach for the identification of credible abnormal conditions (events or event sequences that have an expected frequency of occurrence equal to or greater than 10^{-6}/year) and supports the identification of CSCs. The findings from the CHI study are inputs to the CSA, which is incorporated in the CSD. The requirements for CHIs are established in the *CHI Study* Standard [28].

Off-site transport packages are exempt from having a CSD, provided that the transport package is CNSC-certified, has a valid Safety Analysis Report (SAR), and is used according to the limits and restrictions in the SAR and the CNSC certificate.

5.2.3 Nuclear Criticality Safety Training

The content of the general NCS training is developed by the NCS FSA in collaboration with Training and Development (T&D). NCCA-specific training is developed by the NCCA with the support of NCS and T&D. NCS training is provided to all workers (employees or contractors) who work at CNL sites where NCS requirements apply. More information on NCS training requirements and categorizations can be found in the *NCS Training* standard [15].

All NCS training (general and area-specific) is reviewed and evaluated by the NCS Program staff periodically (and as needed). NCCA-specific training prepared by the NCCA staff is reviewed by the NCS Program staff when it is updated and prior to implementation.

5.2.4 Nuclear Criticality Safety Conduct of Operations

Procedures that impact NCS are reviewed by the NCS FSA staff.

Operations for which NCS is a concern (i.e., those conducted within NCCAs) are governed by operating procedures that incorporate NCS to ensure the safe and efficient conduct of operations.

Procedures incorporate the limits and restrictions for criticality control (from the applicable CSD and all active TLAs). Note that in some cases where the inclusion of complex limits and/or restrictions might present a Human Performance (HU) error trap, it may be appropriate for the procedure to direct the user to the applicable CSD and/or TLA. These procedures specify any parameters that are to be controlled. Procedures are provided for monitoring, testing, and maintaining process equipment listed for criticality control in the CSD and all active TLAs. They are written such that no credible, single, inadvertent departure from a procedure can cause a criticality accident.

A review of operations is performed to verify that procedures are being followed and that process conditions have not been altered in such a way that would affect the applicable criticality safety analysis (documented in the applicable CSD). This review can be documented during the criticality safety compliance self-assessment (see Section 5.2.5), which must be conducted on a yearly basis. Procedures shall be revised as changes become desirable.

5.2.5 Nuclear Criticality Safety Compliance Assessments

An NCS Compliance Assessment is completed annually by each NCCA and Non-NCCA as per the *NCS Compliance Assessment* Standard [16]. These assessments are reviewed by NCS Program Staff and are designed to help the areas identify and resolve potential safety and/or compliance vulnerabilities should any exist.

For NCCAs, this assessment aids in verifying that procedures related to NCS are being followed and that process conditions have not been altered in a way that affects the NCS analysis in the applicable CSD and all active TLAs. This assessment also aids in verifying compliance with the NCS Function requirements.

For Non-NCCAs, this assessment aids in verifying compliance with the NCS Function requirements.

5.2.6 Qualification and Appointment of NCCOs

NCCOs are responsible for overseeing operations involving FM in an NCCA to ensure compliance with all requirements established in the applicable CSD(s) and any active TLAs. The process for qualifying and appointing NCCOs ensures that candidates are evaluated against consistent qualification requirements and that their suitability for the role is assessed in a controlled manner prior to formal appointment.

This process is described in the *Qualification and Appointment of NCCOs* Standard [14]. The NCCO appointment is performed by NCCA Management.

Each NCCA must have an NCCO in order to perform operations with FM. If an NCCA does not have an appointed NCCO, **<u>all operations with FM are halted, and the NCS FSA is notified</u>**. Under exceptional circumstances where prompt NCCO action is required to ensure either safety or compliance with NCS Functional requirements, Line Management for the NCCA may perform specific actions in the place of the NCCO only upon receipt of written approval from the NCS Function.

5.2.7 Criticality Accident Alarm System (CAAS)

A CAAS is required in any NCCA where inadvertent criticality can occur, and excessive radiation dose to personnel is credible should the inadvertent criticality occur. The methodology for assessing whether a CAAS is discussed in [29]. For areas that are determined to require a CAAS, an assessment is performed to determine the appropriate number and locations for the detectors [30]. The purpose of this assessment is to ensure that the installed CAAS is able to respond to the minimum accident of concern.

Periodic maintenance and testing of CAAS is necessary to ensure the instrument performs as intended. Each NCCA with a CAAS is responsible for ensuring that the CAAS is maintained and tested regularly, following guidelines in REGDOC-2.4.3 [3] and *Radiation Protection Instrumentation* [31]:

- CAAS is tested after modifications or repairs;
- Each detector is tested at least annually; and
- New CAAS installations are successfully commissioned prior to operational use.

5.2.8 Fire Protection

Guidelines for firefighting within NCCAs areas are based on comparisons of the risks of accidental criticality with the risks of postulated fires for the respective areas. The introduction of moderators is considered during firefighting activities and is included in the Pre-Incident Plans developed by the *Fire Protection* FSA staff [20].

5.2.9 Mitigation Measures – On-Site and Off-Site

The NCS Function supports NCCAs in the determination of suitable on-site and off-site criticality accident mitigation measures (e.g., protective measures are in place to limit on-site radiological dose to personnel and off-site dose consequences).

- On-site: NCCAs demonstrate that adequate mitigation measures are put in place to limit on-site radiological dose to personnel;
- Off-site: NCCAs demonstrate that adequate mitigation measures are in place such that off-site consequences of a criticality accident, as calculated from the start of the accident, do not violate criteria established as a trigger for a temporary public evacuation.

5.3 Non-Compliances (or Unplanned Events)

The process for unplanned event reporting to the CNSC [32] is followed to determine if a non-compliance or an unplanned event is reportable to the CNSC (not all non-compliances and unplanned events related to criticality safety are reportable).

Any potential non-compliance with the NCS FSA procedures, requirements, CSDs/TLAs, or change in process condition that could alter the supporting CSA is reported immediately to the

NCS FSA for review. Examples of potential non-compliance (or unplanned event) related to NCS include:

- With respect to a CSD or TLA: exceedance of any limit, failure to adhere to a restriction, failure to implement a CSC, or the conduct of a work activity that is not bounded by the CSD criticality safety analysis for normal operating conditions.
- With respect to NCS Functional requirements: failure to implement any requirements established in the NCS FSA implementing documents; and /or
- Any NCS-related incident of a potentially hazardous nature that was not analyzed in the CSD for NCCAs or exceeding the exemption criteria in non-NCCAs.

5.4 Records and Documentation

Permanent records and documentation associated with the FSA include:

- NCS Function interpretation and implementing documents (e.g., Program Requirements Document, Program Description Document, Management Control Procedures, Standards);
- CSDs and TLAs;
- NCS Analyses and technical evaluations in support of NCS (e.g., Software Validation Report, off-site dose consequences, etc.);
- NCS Panel Acceptance documentation;
- CHI studies;
- CAAS needs assessment;
- CAAS detector location and dose contour evaluations;
- General NCS training material; and
- NCCO Training Qualification Card.

6. Interfaces

6.1 Internal Interfaces

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Line Management of NCCAs	Guidance and technical expertise for CSD and TLA development, changes in activities (design and operational changes), the appointment of NCCOs, information and recommendation on CAAS, and verification of compliance, reporting of unplanned events.	CSDs, TLAs, NCCO acceptance forms, compliance assessments, criticality safety analysis, CHI studies, and unplanned event reports.	Line Manager responsible for the area.
Line Management of Non-NCCAs	Guidance and technical expertise, verification of compliance, and reporting of unplanned events.	Compliance assessments and unplanned event reports.	Line Manager responsible for the area.
Nuclear Response & Analysis (NRA) Branch (S&T)	Perform criticality safety analysis upon request from NCS Program	CSDs, TLAs, technical evaluations, and reports	Section Head of Nuclear Systems and Radiation Analysis in NRA Branch

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Design (Engineering)	Documentation on the design of new and modified buildings and/or systems is reviewed to ensure applicable requirements related to NCS are being met and to determine if engineered barriers need to be designed to ensure criticality safety of an area. Design lifetime of the area is taken into account at the planning and design stage for a new or existing NCCA. Develop design specifications for CAAS.	Notification via ECC checklist for NCS, e-mail, telephone, and meetings	Design Subject Matter Expert (SME)
Integrated Work Control (IWC)	Document assessment for activities that may impact NCS	Hazard Screening Checklist Tool, Job Hazard Analyses	Any staff completing the IWC
Nuclear Materials and Safeguards Management (NM&SM)	Modifications to the permissions in the Integrated Nuclear Materials Accounting System (INMAS) for appointed NCCOs, modifications to the mass limits with integrated NCCAs	E-mail, INMAS	NM&SM Program Specialists and Nuclear Materials Assistants
Fire Protection	Pre-Incident Plans for all areas on-site that have FM are reviewed by an NCS SME to ensure they include NCS measures.	Pre-Incident Plans	Fire Protection SME

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Emergency Preparedness	Emergency planning and response for criticality accidents, yearly criticality drills and exercises for areas with a CAAS, review of emergency response issues/concerns for areas with CAAS, documentation of immediate evacuation routes and zones for areas with a CAAS or impacted by a CAAS.	Criticality drills and exercises, memos, and technical evaluations documents	Emergency Preparedness SME
Radiation Protection (RP)	Ensure immediate evacuation zones and evacuation routes are determined and documented for NCCAs with CAAS. Ensure CAAS detectors are placed in the correct location for new facilities that require a CAAS installed, as per criticality analysis/detector location analysis performed by the NCS Function SMEs.	Memos, technical documents, CAAS detector placement for new facilities	RP SME
Engineering Safety and Licensing	Participates in CHI study meetings and/or writes CHI study documents (e.g., CHI plan, CHI report).	CHI study	Safety Analysis SME
Training & Development (T&D)	Ensures criticality safety training is incorporated for NCCAs Training Development / Delivery	NCCO quarterly reports, training curriculum review committee quarterly meetings, training session	T&D Training SME and Coordinators

Functions/Lines Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
Safety Review Committee's sub-committee: NCS Panel	Provides independent review and acceptance of documentation relating to criticality safety (e.g., CSDs, time-limited amendments, CAAS justification)	Meetings, correspondence	NCS Panel Chair and Technical Secretary
Transportation of Dangerous Goods	Ensures review of new/revised criticality safety analysis for transportation packages with Fissionable Material consignment is carried out by NCS Program SMEs	Review of documentation	Transportation of Dangerous Goods SME

6.2 External Interfaces

Groups Interfaced With	Interface Activity/Purpose (Type of Information Exchanged)	Interface Mechanism	Primary Interface Contact(s)
CNSC	Correspondence on reportable events, program/CSD updates, and requests for information.	Letters, e-mails, meetings, telephone	CNSC Project Officer and Technical Officer
American Nuclear Society (ANS)	Participation in working groups on ANS-8 criticality safety standards through the NCS Division.	Working group meetings, conferences	ANS working group members
International Standards Organization (ISO)	Participation in working group on criticality safety; review of proposed and draft standards related to criticality safety.	Standards Council of Canada (SCC) web-based system to review standards, annual working group meetings	SCC and SCC working group Chair

7. References

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[10] *Nuclear Criticality Safety*, 900-508550-PRD-001, 52931473.

[11] *CNL Management System Manual*, 900-514100-MAN-001, 12489834.

[12] *Integrated Assessment Plan*, 900-514000-MCP-010, 12497536.

[13] *Nuclear Criticality Safety for Operations*, 900-508550-STD-005, 52224951.

[14] *Qualification and Appointment of Nuclear Criticality Control Officers*, 900-508550-STD-006, 58045856.

[15] *Nuclear Criticality Safety Training*, 900-508550-STD-001, 12640322.

[16] *Nuclear Criticality Safety Compliance Assessment*, 900-508550-STD-004, 46987467.

[17] *Nuclear Criticality Safety Panel*, 900-514300-TOR-001, 40810893.

[18] *Nuclear Criticality Safety Panel Review and Acceptance*, 900-514300-STD-001, 40764482.

[19] *Training and Development*, 900-510200-PDD-001, 51748477.

[20] *Fire Protection*, 900-508720-PDD-001, 40793276.

[21] *Security*, 900-508710-PDD-001, 50823241.

[22] *Emergency Preparedness*, 900-508730-PDD-001, 50982494.

[23] *Nuclear Safety*, 900-508200-POL-001, 40865185.

[24] *Nuclear Criticality Safety*, 900-508550-GDI-001, 50382454.

[25] *Nuclear Materials and Safeguards Management*, 900 508510-PDD-001, 47487725.

[26] *Preparing a Criticality Safety Document or Time-Limited Amendment*, 900-508550-MCP-002, 41557537.

[27] *Criticality Safety Analysis*, 900-508550-STD-002, 35283708.

[28] *Criticality Hazards Identification Study*, 900-508550-STD-003, 40755887.

[29] *Criteria for Evaluating the Requirements for CAAS Installation*, 145-508550-PS-001, 22300249.

[30] *Criticality Accident Alarm System Location Assessment*, 145-508550-TE-001, 22294624.

[31] *Radiation Protection Instrumentation*, 900-508740-STD-018, 52882892.

[32] *CNL Reporting to Regulatory Agencies*, 900-514300-MCP-006, 41554361.

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Nuclear Criticality Safety (PRD)
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Information Use

Approved by	Title	Date
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Revision History

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
3.1	2023/07/26	Issued as “Approved for Use”.	K. Erlandson	Z. Barnicoat	D. Garrick
3.1D1	2022/10/04	Issued for “Review and Comment”. Minor changes include: • New PRD template • Update from 145-508550-PS-001 to 900-508550-MCP-001398 • Update from N292.0-14 to N292.0-19 • Resolved transcription error from REGDOC-2.4.3, Section 3.3.1.	K. Erlandson	Z. Barnicoat C. Gallagher S. Toelly	
3	2021/09/02	Issued as “Approved for Use”.	R. Dranga	J. Wang	J. Turcotte

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
3D1	2021/07/30	Issued for “Review and Comment”. Annual Document Review; New PRD template applied, including: removal of References section; and relocation of implementing documents that do not reside within the NCS function to the Notes/Comments column; Removed references to ANSI/ANS 8.x Standards; Realigned requirements to applicable section in REGDOC-2.4.3 and removed references to RD/GD-327; Added back requirements that were missed in Revision 2 (but existed in prior revisions) associated with Sections 6.4, 6.5, 7.4, 8.3, 11.4, 12.8, 13.7; Added CSA N292.0-14 as per Requirements Management Database.	R. Dranga	C. Ball Z. Barnicoat K. Boniface J. Carver J. Turcotte J. Wang	
2	2020/05/31	Issued as “Approved for Use”.	M. Boileau	K. Boniface	J. Turcotte
2D1	2020/02/04	Issued for “R&C”. Update document to reference the updated Regulatory Document for Nuclear Criticality Safety REGDOC 2.4.3. Provide more granularity associated with requirements from REGDOC 2.4.3.	M. Boileau	C. Ball Z. Barnicoat K. Boniface J. Carver Y. Dube G. Edwards	

Rev. No.	Date	Details of Rev.	Authored By	Reviewed By	Approved By
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1. Scope and Applicability

This company-wide document applies to all activities unique to the Nuclear Criticality Safety Functional Support Area performed by Canadian Nuclear Laboratories (CNL) at the Chalk River Laboratories (CRL) and Whiteshell Laboratories (WL) sites.

2. Purpose

The following is a mapping of requirement source documents to the Management System documentation that implements those requirements. It reflects the current operational implementation of the requirements. Given the diverse nature of the CNL business, the dynamic nature of the regulatory environment, and the complexity of the regulations, the mapping is not intended to be complete for every possible requirement.

3. Requirements and Flowdown

- *Nuclear Criticality Safety*, Version 1.1, REGDOC-2.4.3, Canadian Nuclear Safety Commission, September 2020
- *Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence* NRTEOL-01.00/2028*, Licence Conditions Handbook,* NRTEOL-LCH-01.00/2028 Revision 3/CRL-508760-HBK-002 Revision 3, Canadian Nuclear Safety Commission, February 14, 2023.
- *Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence NRTEDL-LCH-08.00/2024, Licence Conditions Handbook*, NRTEDL-LCH-08.00/2024 Revision 1/WLD-508760-LCH-002 Revision 1, Canadian Nuclear Safety Commission, April 03, 2023.
- *General Principles for the management of radioactive waste and irradiated fuel*, N292.0-19, Canadian Standards Association, March 2019

Table 1: *Nuclear Criticality Safety*, Version 1.1, REGDOC-2.4.3, Canadian Nuclear Safety Commission, September 2020

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
Section 2.3.1 Categorization of operations with fissionable materials	Defines the nuclear criticality safety requirements of a full scope and reduced scope program based on exempted quantities, small quantities and large quantities of fissionable materials in work areas.	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
Section 2.3.2.1 Responsibilities	The requirement to establish responsibility at a high level (above the operating level) for nuclear criticality safety, the provision of personnel skilled in the interpretation of data pertinent to nuclear criticality safety and the assurance associated with the implementation of nuclear criticality safety controls.	900-508550-PDD-001, Nuclear Criticality Safety	900-514100-MAN-001, Canadian Nuclear Laboratories Management System Manual
Section 2.3.2.2 Process Analysis	Before a new operation with fissionable material is begun, or before an existing operation is changed, it shall be determined that the entire process will be subcritical under both normal and credible abnormal conditions that have frequency of occurrence equal to or greater than 10^{-6} per year. • An adequate upper subcritical limit (USL) shall be established and justified, and • The established adequate USL shall be maintained under all normal and credible abnormal conditions It shall be demonstrated that adequate mitigation measures are in place such that off-site consequences of a representative nuclear criticality accident, as calculated from the start of the accident, do not violate criteria established as a trigger for a temporary public evacuation	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 900-508550-STD-002, Criticality Safety Analysis 190-123400-TE-001, Evaluation of Upper Subcritical Limits in Criticality Safety Documents 190-123400-TE-002, Evaluation of Postulated Criticality Accidents at CRL and WL	
Section 2.3.2.3 Written	Operations to which nuclear criticality safety is pertinent shall	900-508550-STD-005, Nuclear Criticality	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
Procedures	be governed by written procedures. All persons participating in these operations shall understand and be familiar with the procedures. The procedures shall specify all parameters that they are intended to control. They should be such that no single, inadvertent departure from a procedure can cause a criticality accident.	Safety for Operations	
Section 2.3.2.4 Materials Control	Movement of FM shall be controlled, including any labelling, signage and area posting. Appropriate material labelling, signs, and area posting shall be maintained specifying material identification and all limits on parameters subject to procedural control.	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	900-508510-PDD-001, Nuclear Materials and Safeguards Management
Section 2.3.2.5 Equipment Control	For any new activities or projects (including new or modified process or process lines) it shall be ascertained that all equipment is consistent in dimensions and materials with the assumptions that were made to ensure subcriticality.	900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment	
Section 2.3.2.6 Quality Management Program	The NCS Function conforms to the CNL established quality management program and records management process.		900-514200-PDD-001, Quality
Section 2.3.2.7 Operational Control	Operational control shall follow CNL processes and requirements for reporting deviations in procedures, review lessons learned from other organizations	900-508550-STD-005, Nuclear Criticality Safety for Operations	900-514000-PDD-001, Performance Assurance

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	and initiate improvements.		
Section 2.3.2.8 Operational Reviews	Frequent (at least annually) reviews of operations shall be performed to verify that procedures are being followed and that process conditions have not been altered in any way that would affect the applicable criticality safety analysis. These reviews shall be conducted in consultation with operating personnel, by individuals who are knowledgeable in nuclear criticality safety and who, to the extent practicable, are not immediately responsible for the operation.	900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-004, Nuclear Criticality Safety Compliance Assessment	
Section 2.3.2.9 Emergency Procedures	Emergency procedures are prepared and approved by management. These procedures include information related to nuclear criticality safety.		900-508730-PDD-001, Emergency Preparedness
Section 2.3.3 Technical Practices	Nuclear criticality safety shall be ensured by means of preventive measures that are, as far as reasonably achievable, established in the design; that is, by engineered nuclear criticality safety controls.	900-508550-STD-002, Criticality Safety Analysis	
Section 2.3.3.1 Controlled Parameters	All controlled parameters and their limits shall be specified. The influence of variations in these parameters on the k^{eff} of the system shall be understood.	900-508550-STD-002, Criticality Safety Analysis 900-508550-PDD-001, Nuclear Criticality Safety	
Section 2.3.3.2 Availability and Reliability	The licensee shall ensure that the necessary levels of availability and reliability are maintained for nuclear criticality safety controls,	900-508550-STD-002, Criticality Safety Analysis	900-508200-MCP-005, Surveillance Testing

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	as established by the process analysis for normal and credible abnormal conditions.		
Section 2.3.3.3 Geometry Control	All dimensions and nuclear properties on which reliance is placed shall be verified prior to the beginning of operations, and control shall be exercised to maintain them. Reliance should be placed on equipment design in which dimensions are limited rather than on administrative controls. Process areas where criticality control vessels contain significant quantities of nuclear materials in liquid form should be equipped with alarms to prevent overfilling and drip trays of appropriate capacity and critically safe configuration.	900-508550-STD-002, Criticality Safety Analysis 900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 900-508550-PDD-001, Nuclear Criticality Safety	
Section 2.3.3.5 Subcritical Limit	Where applicable data are available, subcritical limits shall be established on bases derived from experiments, with adequate allowance for uncertainties in the data. In the absence of directly applicable experimental measurements, the limits may be derived from calculations made by a method shown by comparison with experimental data to be valid.	900-508550-STD-002, Criticality Safety Analysis	
Section 2.3.3.6 Neutron Reflection	Where applicable, neutron reflection shall be considered as a parameter for criticality control. Careful consideration shall be given to systems where significant thicknesses of other common structural materials	900-508550-STD-002, Criticality Safety Analysis	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	which may be more effective neutron reflectors than water.		
Section 2.3.3.7 Neutron Interaction	Consideration shall be given to neutron interaction between units when at least two units containing fissionable materials are present.	900-508550-STD-002, Criticality Safety Analysis	
Section 2.3.4 Validation of a Calculational Method	Suitable calculational methods for determining the subcritical state of a system shall be selected and justified (validated) in accordance with an applicable Quality Assurance standard.	145-123400-SVR-001, Validation Report for KENO V.a Applications for Criticality Safety Applications	
Section 2.3.4.1 Establishment of Bias	Bias shall be established by correlating the results of critical and exponential experiments with results obtained for these same systems by the calculational method being validated.	145-123400-SVR-001, Validation Report for KENO V.a Applications for Criticality Safety Applications	
Section 2.3.4.3 Bias uncertainties	The uncertainty in the bias shall contain allowances for the following: • The uncertainties in the experimental conditions, • The lack of accuracy and precision in the calculational method; and • The extension of the area (or areas) of applicability. The margin in k_{eff} (or other correlating parameter) shall be applied such that it is sufficient to ensure that conditions will actually be subcritical.	145-123400-SVR-001, Validation Report for KENO V.a Applications for Criticality Safety Applications	
Section 2.3.4.4 Computer dependence	If the calculational method involves a computer program, checks shall be performed to confirm that the mathematical		900-514200-QAP-002, Analytical, Scientific and Design Computer Programs

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	operations are performed as intended. Any changes in the computer program shall be followed by reconfirmation that the mathematical operations are performed as intended.		
Section 2.3.4.6 Validation Report	A written report of the validation shall be prepared which includes: • A description of the method, • Experimental data and parameters derived from the data, • The area of applicability, • The bias and uncertainties, • The margin of sub criticality, with justification, and • The upper subcritical limit.	145-123400-SVR-001, Validation Report for KENO V.a Applications for Criticality Safety Applications	
Section 2.4 Single-parameter Limits for Fissile Nuclides Section 2.5 Multiparameter Control	An adequate administrative margin of sub-criticality shall be applied to ensure compliance with section 2.3.2.2 Process Analysis of REGDOC-2.4.3, for single / multi parameter limits on ^{233}U, ^{235}U and plutonium. Process specifications shall incorporate margins to protect against uncertainties in process variables and against a limit being accidently exceeded.	900-508550-STD-002, Criticality Safety Analysis	
Section 3.3.1 General	A criticality alarm system shall be installed in areas where an inadvertent criticality can occur and where excessive radiation dose to personnel is credible should the inadvertent criticality occur. Where alarm systems are	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-MCP-001398, Needs Assessment – Criticality Accident Alarm System	900-508730-PRD-001, Emergency Preparedness

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	installed, emergency procedures shall be maintained.	900-508550-STD-005, Nuclear Criticality Safety for Operations	
Section 3.3.2 Coverage	The need for such a system shall be evaluated for all activities in which the inventory of fissionable materials in individual unrelated areas exceeds the subcritical mass limits noted as follow: • All activities involving ^{233}U, ^{235}U, and ^{239}Pu, in which the inventory of fissionable materials exceeds 500 g of ^{233}U, 700 g of ^{235}U, 450 g of ^{239}Pu, or 450 g of any combination of these three isotopes, • For all activities involving fissionable materials, in which neutron moderators or reflectors more effective than light water are present or unique material configuration exists such that critical mass requirements may be less than the subcritical mass limits listed above, and • For all activities in which inventory of fissionable materials exceeds 80% of the appropriate critical mass if subcritical mass limits listed above are not applicable. In areas where criticality alarm coverage is required, a means shall be provided to detect a criticality and to signal that prompt protective action is	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-MCP-001398, Needs Assessment – Criticality Accident Alarm System 900-508550-STD-005, Nuclear Criticality Safety for Operations	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	required.		
Section 3.3.3 Criticality Alarm	Criticality alarm signals shall: • Be for prompt evacuation or other protective action, and • Be distinctive from other signals or alarms that require a different response. The signal generator shall be automatically and promptly actuated upon detection of a criticality accident. After actuation, the signal generators shall continue to function as required by emergency procedures. The number and placement of criticality alarm signal generators shall be such that the signals are adequate to notify personnel promptly.	900-508550-PDD-001, Nuclear Criticality Safety 153-123540-440-002 Process for Criticality Accident Alarm System (CAAS) Detector Placement Analysis for Facilities at CRL.	
Section 3.3.4 Dependability	Consideration shall be given to the avoidance of false alarms. In redundant systems, failure of any single channel shall not prevent compliance with the detection criterion of the alarm system. Where portable instruments are used to augment the installed criticality alarm system, the usage of portable instruments shall be evaluated to determine appropriate criteria are met. The criteria shall be specified in procedures. Detectors shall not fail to trigger an alarm when subjected to		900-508740-STD-018 Radiation Protection Instrumentation

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	intense radiation exceeding 1000 Gy/h.		
Section 3.4 Criteria for System Design	The system shall be designed for high reliability. The system shall be designed to produce the criticality alarm signal within 0.5 s of detector recognition of a criticality accident. The system shall be designed to respond immediately, and the alarm trip point shall be set low enough to detect the minimum accident of concern. The basis for the minimum accident of concern shall be justified (default or documented alternative). The alarm actuation shall occur as a result of the minimum duration of the transient (can be assumed to be 1 ms). The placement of detectors shall be consistent with the alarm trip point and with the detection criterion.	900-508550-PDD-001, Nuclear Criticality Safety	900-508740-STD-018, Radiation Protection Instrumentation
Section 3.5 Testing	CAAS functionality (alarm signals, manual resets and manual actuation), CAAS dependability, reliability, and CAAS design criteria shall be followed and include requirements for dependability, reliability, response time, detection, sensitivity, and placement. CAAS testing criteria is required and includes initial tests, special tests, response to radiation, periodic tests, corrective action	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	900-514000-PDD-001, Performance Assurance 900-511300-PDD-001, Information Management 900-514300-STD-001, Nuclear Criticality Safety Panel Review and Acceptance

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	and test procedures, records of tests, and out of service criteria.		
Section 3.6 Employee Familiarization	Where CAAS is installed, emergency procedures shall be maintained. Instructions regarding response to criticality alarm signals shall be posted at strategic locations within areas requiring alarm coverage.	900-508550-STD-005, Nuclear Criticality Safety for Operations	900-508550-STD-001, Nuclear Criticality Safety Training 900-508730-STD-002, Emergency Management 900-508730-MCP-001, Building Emergency Procedures
Section 6.3.1. Administrative Practices	Methods of storage control and operational practices approved by management shall be described in written procedures, the users of which shall be familiar with them. Limits for storage shall be posted. Access to storage areas shall be controlled.	900-508550-STD-005, Nuclear Criticality Safety for Operations	
Section 6.3.2 Technical Practices Section 6.4 Parameters, Limits and Conditions Section 6.5 Other Applications	Storage facilities and structures shall be designed, fabricated and maintained in accordance with good engineering practices. Fissile material shall be stored in such a way that accident nuclear criticality resulting from fire or from flood, earthquake, or other natural calamities is not a concern. Where the presence of significant quantities of combustible materials is unavoidable, a fire protection system shall be installed. Shelving shall be sturdy and non-combustible.	900-508550-STD-002, Criticality Safety Analysis	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	Containers of fissile materials in areas with sprinkler systems shall be designed to prevent accumulation of water. Good housekeeping shall be incorporated as an important part of nuclear criticality safety practices.		
Section 7.3 Criteria for adequate shielding and confinement Section 7.4 Criticality safety practices	Shielding and confinement design criteria are required when: • All operations and manipulations involving fissile and fissionable materials are conducted remotely by persons located outside the shielded area, and • Shielding and confinement provided are adequate to meet the radiation dose limits discussed in Section 7.3.2 of REGDOC-2.4.3.	900-508550-STD-002, Criticality Safety Analysis	
Section 8.3 Nuclear Criticality Safety Practices	Criteria for nuclear criticality safety and control of plutonium-uranium fuel mixtures outside reactors shall be applied.	900-508550-STD-002, Criticality Safety Analysis	
Section 10 Nuclear Criticality Safety Control of Selected Actinide Nuclides (all subsections)	Nuclear criticality control of selected actinides ^{232}U, ^{234}U, ^{237}Np, ^{236}Pu, ^{238}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{242m}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{249}Cf, ^{251}Cf shall be applied for nuclear criticality safety evaluations involving the listed isotopes.	900-508550-STD-002, Criticality Safety Analysis	
Section 11.3 General Safety Criteria Section 11.4	Prior to first use of, or before implementing changes to, any operation or system involving handling, transportation, storage,	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-002,	

Nuclear Criticality Safety, REGDOC-2.4.3			
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Criteria to establish subcriticality	or long-term waste management of reactor fuel outside reactors, a criticality safety evaluation shall be performed and documented. Prior to commencing operations, an assessment shall be performed to confirm the adequacy of the criticality safety evaluation. In performing the criticality safety evaluation de composition and nuclear characteristics of the fuel shall be considered and implemented as needed.	Criticality Safety Analysis 900-508550-STD-005, Nuclear Criticality Safety for Operations	
Section 12.3.1 Management Responsibilities	Management shall: • Accept overall responsibility of operations and provide regular and systematic oversight, • Formulate nuclear criticality safety policy and make it known to all employees involved in operations with fissionable materials, • Assign responsibility and delegate commensurate authority to implement established policy, • Provide personnel familiar with the physics of nuclear criticality and with associated safety practices to furnish technical guidance appropriate to the scope of operations, • Establish a method of monitoring the nuclear criticality safety program,	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	900-514100-MAN-001, Canadian Nuclear Laboratories Management System Manual 900-514100-LST-001, Functional Authorities 900-508200-POL-001, Nuclear Safety

Nuclear Criticality Safety, REGDOC-2.4.3			
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	• Periodically participate in auditing the overall effectiveness of the nuclear criticality safety program, • Establish a defined process and procedures for equipment change control, and • Establish operating procedures and a process for modifying those procedures.		
Section 12.3.2 Supervisory Responsibilities	Each supervisor shall: • Accept responsibility for the safety of operations under their control, • Be knowledgeable in those aspects of nuclear criticality safety relevant to operations under their control, • Provide training and require that personnel under their supervision have an understanding of procedures and safety considerations such that they may be expected to perform their functions without undue risk, • Develop (or participate) and maintain written procedures applicable to the operations under their control. maintenance of these procedures to reflect changes in operations shall	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	be a continuing supervisory responsibility, • Require conformance with good safety practices including unambiguous identification of fissionable materials and good housekeeping, and • Be responsible for the inspection, testing and maintenance of engineered controls.		
Section 12.3.3 Nuclear Criticality Safety Staff Responsibilities	The nuclear criticality safety staff shall: • Provide, and accept responsibility for, technical guidance in the design of equipment and processes and for the development of operating procedures, • Maintain familiarity with current developments in nuclear criticality safety standards, guides, and codes, • Maintain familiarity with all operations requiring nuclear criticality safety controls, • Conduct or participate in audits of criticality safety practices and compliance with procedures as directed by management, • Examine reports of procedural violations and other deficiencies, for possible improvement of safety practices and	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-004, Nuclear Criticality Safety Compliance Assessment	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	procedural requirements, and shall report their findings to management, and • Upon request, participate in the verification of compliance with nuclear criticality safety specifications for intended new or modified processes or equipment.		
Section 12.4 Operating Procedures	Operating procedures shall include those controls and limits significant to NCS, and be periodically reviewed by supervisory personnel and NCS staff, and approved by management. Deviations from these procedures shall be reported, investigated, corrected as appropriate and documented. Action shall be taken to prevent reoccurrence. Operations shall be reviewed (at least annually) to ensure that process conditions have not been altered so as to affect the nuclear criticality safety evaluation.	900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-004, Nuclear Criticality Safety Compliance Assessment	
Section 12.5 Process Evaluation for Nuclear Criticality Safety (Nuclear Criticality Safety Evaluations)	• Before the start of a new operation with fissionable material, or before an existing operation is changed, it shall be determined and documented that the entire process is subcritical under both normal and credible abnormal conditions,	900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 900-508550-STD-002, Criticality Safety Analysis 900-508550-STD-003,	900-514300-STD-001, Nuclear Criticality Safety Panel Review and Acceptance

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	• The nuclear criticality safety evaluation shall determine and explicitly identify the controlled parameters and their associated limits upon which nuclear criticality safety depends. The effect of changes in these parameters, or in the conditions to which they apply, shall be understood, • The nuclear criticality safety evaluation shall be documented with sufficient detail, clarity, and lack of ambiguity to allow independent judgment of results, and • Before the start of operation, there shall be an independent assessment that confirms the adequacy of the nuclear criticality safety evaluation.	Criticality Hazards Identification Study	
Section 12.6 Material Control	• The movement of fissionable materials shall be controlled as specified in documented procedures. • Appropriate material labelling and area posting shall be maintained, specifying material identification and all limits on parameters that are subject to procedural criticality control. • If reliance for criticality control is placed on neutron-absorbing materials that are	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-002, Criticality Safety Analysis	900-508510-PDD-001, Nuclear Materials and Safeguards Management 900-508520-PDD-001, Transportation of Dangerous Goods

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	incorporated into process materials or equipment, procedural control shall be exercised to maintain their continued presence with the intended distributions and concentrations. • Access to areas where fissionable material is handled, processed, or stored shall be controlled. • Control of spacing, mass, density and geometry of fissionable material shall be maintained.		
Section 12.7 Planned Response to Nuclear Criticality Accidents	Emergency procedures shall: • Be prepared, • Be approved by management, • Clearly designate evacuation routes, • Provide for shutting off ventilation to prevent release of fission gases, and • Address re-entry procedures and the membership of the response team. Training shall be provided for personnel in the evacuation area (or equivalent for transient personnel). The personnel assembly area shall be: • Designated, • Established to provide personnel accountability, and	900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations	900-508730-PRD-001, Emergency Preparedness RADP-508740-EP-004, Radiation Surveyor Response to Criticality Alarms

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	• Monitored for radiation intensity appropriate equipment and approved procedures Drills shall be: • Conducted at least annually, and • Announced in advance. Evacuation routes shall be clearly identified. Arrangements shall be made in advance for the care and treatment of injured and exposure persons. The possibility of personnel contamination by radioactive materials shall be considered.		
Section 12.8 Nuclear Criticality Safety Program	The NCS Program must identify applicable standards, guidelines and CNSC requirements, list the requirements, define a model for the implementation of these requirements, identify responsibilities raising from these requirements, and identify and document the administrative margin of subcriticality and methodologies used to ensure that the upper subcritical limit is not exceeded	900-508550-PDD-001, Nuclear Criticality Safety	
Section 13.4 Program Responsibilities	• Management shall establish a nuclear criticality safety training program that provides confidence in the continuing proficiency of personnel, • Supervisors shall ensure that their staffs are suitably trained, and	900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-STD-005, Nuclear Criticality Safety for Operations	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	• Nuclear criticality safety staff shall participate in the development of the training program and its implementation.		
Section 13.5 Program Structure	• Training and refresher training shall be determined and documented, • Refresher training shall be provided at least every 2 years, and • The content of the training shall be tailored to the job responsibility.	900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-TM-001, Nuclear Criticality Training Manual	
Section 13.6 Program content	Criticality safety training shall include the following: • Health effects of criticality accidents, • Recognition and response to criticality alarms, • Examples of the reduction in the received dose as a function of distance, time and shielding. • Emphasis on the need for prompt evacuation, • Factors that are relevant to criticality safety, • Single parameter limits appropriate to the facility, • Illustration of criticality safety appropriate to the area, • The concept of contingencies for checking the validity of criticality safety limits, • The nuclear (criticality) safety policy.	900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-PDD-001, Nuclear Criticality Safety	900-510200-PDD-001, Training and Development

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	• The facility policy for the use of checklists, sign-off sheets, and documentation in the execution of procedures that are pertinent to criticality safety, • Relevant procedures that pertain to criticality safety and emphasis on criticality safety limits, controls and emergency procedures, • The policy that relates to situations not covered by procedures and to situations in which the safety of the operations is in question, and • The employee's right to question any operations that they believe may not be safe.		
Section 13.7 Evaluation	• The criticality safety training program shall be evaluated periodically, documenting the process and the results, • Satisfactory completion of training shall be based upon a pre-determined performance criteria, • Identified weaknesses [of personnel] shall be addressed by additional training, • Acceptance of the adequacy of the individual's total training record shall be the responsibility of the immediate supervisor and of any other organizational	900-508550-STD-001, Nuclear Criticality Safety Training 900-508550-PDD-001, Nuclear Criticality Safety	900-510200-PDD-001, Training and Development

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	units designated by management, and • The employee's training record shall be documented and retained for a minimum of four years Management may specify a longer period of time for retention.		
Section 15.3.1 Administrative Practices for Limitation and Control of Moderators	Written procedures shall: • Include the nuclear criticality safety limits and controls of operation, • Be provided for monitoring, testing, and maintenance to ensure that the limits and controls specified in process evaluations are maintained, and • Be provided for moderator sampling and analysis as required by the process evaluation Moderator control areas shall be identified to personnel in accordance with facility specific practices. Posting shall include appropriate limits and/or means for moderator control. Moderator control requirements shall be included in firefighting plans. Training in understanding and complying with moderator limits and controls shall be provided to appropriate personnel as part of nuclear criticality safety training.	900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-002, Criticality Safety Analysis 900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 153-508720-TE-001, Evaluation of Effects of Fire Fighting Methods on Nuclear Criticality Safety in Nuclear Criticality Controlled Areas (NCCAS) at CRL and WL	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
Section 15.3.2 Process Evaluation for Limitation and Control of Moderators	The process evaluation shall: • Define the moderator control area and explicitly identify the limits, controls and engineered barriers for that area. • Address properties of all materials present that could change the moderator content (see Notes/Comments), • Address moderators present in, introduced to, or accumulated in a moderator control area, either by design or by accident. • Address the distribution of the moderators within the fissionable material and between discrete fissionable material units. Non-uniform distribution of moderators that might occur during mechanical (e.g., mixing), thermal, or chemical processes shall also be addressed. • Address moderators that might be encountered during maintenance, decontamination, construction, and non-operational activities, • Address the need for special controls involving fire prevention and suppression, and	900-508550-STD-005, Nuclear Criticality Safety for Operations 153-508720-TE-001, Evaluation of Effects of Fire Fighting on Nuclear Criticality Safety in Nuclear Criticality Safety in Nuclear Criticality Controlled Areas (NCCAS) at CRL and WL 900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 900-508550-STD-002, Criticality Safety Analysis 900-508550-PDD-001, Nuclear Criticality Safety	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	• Establish the requirements for moderator measurement necessary to ensure specified limits and controls are maintained.		
Section 15.4 Engineered Practices for Moderator Control Areas	• Moderator control areas shall be provided with engineered barriers as required by the process evaluation, and • Fissionable material processing equipment and containers used in moderator controlled areas shall be designed, constructed, and made to limit and control moderators in accordance with the process evaluation. • Systems that penetrate a moderator control area and normally contain moderators shall have limits and controls as required by the process evaluation, • Systems (such as ventilation ducts, compressed gas lines, electrical conduits, and drains) that penetrate a moderator control area, but do not normally contain moderators, shall have controls as required by the process evaluation, and • Fire control in moderator control areas shall	900-508550-MCP-002, Preparing a Criticality Safety Document or Time-Limited Amendment 900-508550-STD-002, Criticality Safety Analysis 153-508720-TE-001, Evaluation of Effects of Fire Fighting Methods on Nuclear Criticality Safety in Nuclear Criticality Controlled Areas (NCCAS) at CRL and WL 900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-PDD-001, Nuclear Criticality Safety	

Nuclear Criticality Safety, REGDOC-2.4.3			
Section and Title	**Description**	**Implementing Document(s)**	**Notes/Comments**
	incorporate the design features identified by the process evaluation.		
Section 16 Nuclear Criticality Accident Emergency Planning and Response (all subsections)	Management shall be responsible to ensure that emergency planning and response is implemented for areas on site where a criticality accident alarm system is installed. Emergency response planning shall be conducted and documented to identify potential criticality accident locations and establish immediate evacuation zones. An emergency response plan shall be established and maintained, including guidance to management, technical staff and response personnel for response to a criticality accident. Emergency procedures shall be maintained for each area where a CAAS is installed or has been identified as required, and in adjacent buildings that are within the immediate evacuation zone. Emergency planning and response related to nuclear criticality safety accidents includes training for emergency responders.	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-005, Nuclear Criticality Safety for Operations 900-508550-STD-001, Nuclear Criticality Safety Training 153-123540-440-001, Process for Dose Contour Calculations for non-Credible Postulated Accidents in Facilities at CRL 153-123540-440-002, Process for Criticality Accident Alarm System (CAAS) Detector Placement Analysis for Facilities at CRL	900-508730-STD-002, Emergency Management 900-508730-MCP-001, Building Emergency Procedures CRL-508730-ERP-001, Chalk River Laboratories Site Emergency Response Plan

Table 2: Licence Conditions Handbooks

Section and Title	Description	Implementing Document(s)
Licence Conditions Handbook, NRTEOL-LCH-01.00/2028 Chalk River Laboratories Nuclear Research and Test Establishment Operating Licence, NRTEOL-01.00/2028 Licence Condition 4.2: Nuclear Criticality Safety Program	The licensee is required to develop, implement and maintain a nuclear criticality safety program.	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-GDI-001, Nuclear Criticality Safety
Licence Condition Handbook, NRTEDL-LCH-08.00/2024 Whiteshell Laboratories Nuclear Research and Test Establishment Decommissioning Licence, Whiteshell Laboratories, NRTEDL-W5-8.00/2024 Licence Condition 4.2: Nuclear Criticality Safety Program	The licensee is required to develop, implement and maintain a nuclear criticality safety program.	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-GDI-001, Nuclear Criticality Safety

Table 3: General Principles for the management of radioactive waste and irradiated fuel, CSA N292.0-19

Section and Title	Description	Implementing Document(s)
Section 4.10.3 Nuclear Criticality Safety Analysis	Where the possibility of nuclear criticality exists, a nuclear criticality safety analysis shall be performed	900-508550-PDD-001, Nuclear Criticality Safety 900-508550-STD-002, Criticality Safety Analysis 900-508550-STD-005, Nuclear Criticality Safety for Operations

4. Requirements Applicability

All requirements identified above are applicable to both the CRL and WL sites.

5. Requirements Specifying Assessment Activities

The requirements specifying assessment activities section provides a summary and traceability of the requirements that indicate a compliance need for an assessment.

Table 4: Assessment activities for Nuclear Criticality Safety, REGDOC-2.4.3

Nuclear Criticality Safety, REGDOC-2.4.3			
Source, Section, and Title	**Description**	**Planned Frequency**	**Assessment Mechanism**
CNSC REGDOC-2.4.3 2.3.2.8 Operational Reviews	Frequent (at least annually) reviews of nuclear criticality safety operations shall be performed to verify that procedures are being followed and that process conditions have not been altered in any way that would affect the applicable criticality safety analysis.	Annual	Self-Assessment

Canadian Nuclear Laboratories | Laboratoires Nucléaires Canadiens

Environmental Monitoring in 2023 at Whiteshell Laboratories

WL-509243-ACMR-2023

Revision 0

Authored by:	Peter Vilks	2024/06/26
	Environmental Specialist	Date
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	GM & WL Site License Holder	Date
Approved by:	George Dolinar	2024/06/27
	Director, Corporate Environmen	Date

UNRESTRICTED

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Revision History

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SUMMARY

Canadian Nuclear Laboratories (CNL) is required, as a condition of its Nuclear Research and Test Establishment Decommissioning Licence for Whiteshell Laboratories (WL), to submit to the Canadian Nuclear Safety Commission (CNSC) a series of annual reports. Collectively, these reports summarize the results of monitoring radiation exposures to personnel, the results of monitoring radioactive and non-radioactive materials in airborne and liquid effluents, and the results of environmental monitoring at and around the site.

Measurements of radiation levels and radioactive contamination within and outside the WL site boundary were performed during 2023. These measurements verified that levels of radiation and radioactive contamination due to operations at the site, as well as the resulting radiation doses to members of the public, continue to be below regulatory limits[†] and guidelines [1].

Monitoring of potential liquid effluent exposure pathways confirmed very small but measurable contributions from WL operational and decommissioning activities to downstream concentrations of radionuclides in Winnipeg River water (Cesium-137). This correlates with effluent monitoring results [2]. Radioactive contaminants in Winnipeg River water remain very small fractions of allowable levels defined in the Canadian Drinking Water Standard [1].

Radioactivity assaying of groundwater, soil and native vegetation conducted this year and earlier years indicate there is no significant radioactive migration from the waste management facilities.

Monitoring of potential atmospheric effluent exposure pathways did not indicate any measurable dose contributions from the site activities in excess of natural background levels. This is also consistent with effluent monitoring results, which indicated that airborne emissions dose contributions were very small (1.5×10^{-6} mSv/a).

The 2023 environmental monitoring results correlate with the activities that were conducted during the current year and previous years. These results and effluent monitoring results at the release points continue to support the dispersion pathway models on which the Derived Release Limits are based within the uncertainty of the results at these low levels.

In 2010, the Canadian Standards Association (CSA) issued a new version of standard, CSA N288.4-10 [3] which explicitly includes the protection of the environment in conformance with the regulations under the *Nuclear Safety and Control Act* [4]. It addresses monitoring of radiological and non-radiological contaminants, physical stressors, potential biological effects, and pathways for both human and non-human biota. Implementation of N288.4-10 (R 2015) involved a transition of the existing Environmental Monitoring Program to meet the requirements of the standard.

Participation in laboratory proficiency tests and internal quality verification tests were both used to assess the performance of analytical methods needed to produce the data included in

[†] The regulatory limit for non-occupational effective radiation dose to members of the public from operations and products involving ionizing radiation (excluding medical procedures) is 1 mSv per year [1].

this report. The results were acceptable based on established acceptance criteria. Findings from program audits and assessments were minor in nature and are being addressed.

The estimated dose to the most exposed members of the public due to radioactivity in WL effluents, based on the effluent and environmental monitoring results for 2023, is summarized in Table 1 and illustrated in Figure 1. Note that the doses from liquid effluents for 2023 and previous years were calculated using consumption rates consistent with updated DRLs. Based on the data presented in this report, the estimated dose for 2023 from air effluent pathways continues to be small (1.5 x 10^{-6} mSv/a). The dose from liquid effluents (5.9 x 10^{-5} mSv/a), based on environmental monitoring data, is higher than that observed in 2022, but within the range of the previous five years. The estimated 2023 total effective dose of 5.9 x 10^{-5} mSv/a remains a small fraction (0.0059 %) of the regulatory public dose limit of 1 mSv/a. As a percentage of the typical average natural background radiation dose an adult would experience in Canada, WL effluents would contribute 0.0018 % (see Table 1). Overall, the environmental impact can be characterized as low risk, in that the potential for human or ecological impacts is low, and overall trending indicates stable performance.

Table 1: Total Estimated Doses to Critical Groups Based on Monitoring at Whiteshell Laboratories, 2018 to 2023

Effluent Pathways	Airborne	Liquid From Effluents	Liquid From Environmental Monitoring
Critical Group	**Adults and Infants Living at Boundary**	**Adult Living Downstream**	**Adult Living Downstream**
2018 Total Effective Dose (mSv/a)	1.6 E-06	3.79 E-03	3.6 E-05
2019 Total Effective Dose (mSv/a)	2.3 E-06	9.27 E-03	8.7 E-05
2020 Total Effective Dose (mSv/a)	1.9 E-06	6.71 E-03	2.9 E-06
2021 Total Effective Dose (mSv/a)	1.9 E-06	4.49 E-03	1.1 E-05
2022 Total Effective Dose (mSv/a)	1.5 E-06	5.78 E-03	2.1 E-05
2023 Total Effective Dose (mSv/a)	1.5 E-06	2.00 E-03	5.9 E-05
As % of annual public dose limit, 1 mSv.	1.5 E-04	2.00 E-01	5.9 E-03
As % of typical average background radiation dose in Canada, 3.3 mSv.	4.5 E-05	6.06 E-02	1.8 E-03

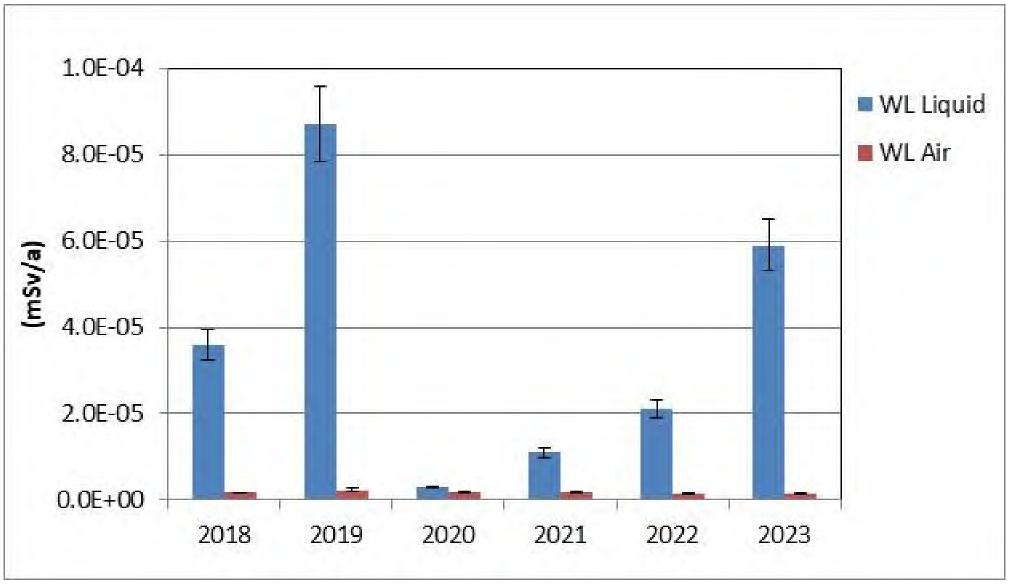

Figure 1: Estimated Total Dose to Members of Critical Groups from Whiteshell Laboratories Liquid and Air Effluents, 2018 to 2023

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Figures

Tables

1. Introduction

1.1 Purpose and Scope

Canadian Nuclear Laboratories (CNL) is required, as a condition of its Nuclear Research and Test Establishment Decommissioning Licence [5] for Whiteshell Laboratories (WL), to submit to the Canadian Nuclear Safety Commission (CNSC) a series of annual reports. Collectively, these reports summarize the results of monitoring radiation exposures to personnel, the results of monitoring radioactive and non-radioactive materials in airborne and liquid effluents, and the results of environmental monitoring at and around the site. They also describe the progress made on the work tasks identified in the Environmental Assessment Follow-Up Program (EAFP) [6] for the current year.

This report, WL-509243-ACMR-2023, addresses for the calendar year 2023, the licence requirement regarding radiological and non-radiological environmental monitoring at and around the WL site. It also addresses the radiological environmental monitoring requirements listed under Work Package #1 of the EAFP [6]. The results and interpretation of the additional monitoring conducted in 2023 as part of the other work packages listed in the EAFP will be included in the WL Decommissioning Project Environmental Assessment reports, generated as part of the EAFP Program. Annual progress on the work packages, including references to these reports, is detailed in the EAFP report [7]. The routine Environmental Monitoring Program (EMP) may be modified to include additional sampling based on the results of these studies.

Results of personnel dose monitoring, non-radiological, and radiological effluent monitoring can be found in the WL Annual Compliance Monitoring Report [8].

This report does not cover results of environmental monitoring for operational control purposes within individual facilities as that information is included and discussed in the WL Annual Compliance Monitoring Report [8].

1.2 Whiteshell Laboratories Site, Facilities and Operations

1.2.1 Whiteshell Laboratories Facilities and Operations

The 4375 hectare WL site (Figure 22 in Appendix A) is owned by Atomic Energy of Canada Ltd. (AECL) and operated by CNL under a licence [1] issued by the CNSC. It is located about 100 km east northeast of Winnipeg, along the east bank of the Winnipeg River. It is downstream from the towns of Pinawa and Seven Sisters Falls, and upstream of the communities of Lac du Bonnet and Pine Falls.

The Whiteshell Reactor 1 (WR-1) organic-cooled experimental test reactor was shut down in 1985. In 1997 the federal government and AECL decided to discontinue research programs and decommission WL. Clean up and operational activities associated with the decommissioning of the site have been underway since 2003.

The major operating facilities are the Shielded Facilities and the Waste Management Area (WMA). The Shielded Facilities includes the Hot Cell Facility and the Immobilized Fuel Test Facility area, which includes a decontamination center and waste processing/handling area.

Since the decommissioning of the Active Liquid Waste Treatment Center (ALWTC) near the end of 2017, the major sources of radiological airborne effluent releases from the site are the Hot Cell Facility, the Immobilized Fuel Test Facility and WR-1. The primary source of liquid effluent releases at WL is the process water outfall (Outfall), which discharges continuously to the Winnipeg River. The secondary source of liquid effluent is the sewage lagoon (Lagoon), which is normally discharged semi-annually to the Winnipeg River.

Figure 22 in Appendix A is a regional map showing the location of the WL site, major geographical features including the Winnipeg River, the local roads network, and the nearby communities.

1.2.2 Summary of Contaminant Pathways

The monitoring and evaluation of environmental impacts from WL operations is carried out using a wide range of effluent and environmental monitoring activities that enable the measurement of contaminant concentrations and loadings in every significant environmental compartment involved in the migration of contaminants through the environment. The network of contaminant pathways is illustrated schematically in Figure 2, with the first tier of potential impacts from a facility or operation being its effluents (airborne and liquid) and, for some facilities, groundwater.

Liquid effluents, whether storm water, or treated facility wastewater, can affect the quality of nearby surface waters, in turn leading to exposure to humans living downstream of the site. These exposures may result from the ingestion of water or food (e.g., fish) that has come into contact with the water, and from direct exposure through swimming or bathing.

Airborne effluents lead to exposure to humans through inhalation and air immersion. Some airborne effluents may also be deposited onto soils, vegetation, and surface waters, and lead to ingestion exposures through the consumption of water, plant and animal products. The monitoring of contaminants in airborne and liquid effluents, and in the different environmental compartments (e.g., surface water, drinking water, produce, game animals, etc.) along exposure pathways, is therefore an important element in evaluating the impacts of WL operations to the public. Through similar pathways, liquid and airborne effluents can lead to exposure to ecological receptors at the WL site.

The transfer of contaminants from facilities and site operations to soils may have an impact on the quality of groundwater, as infiltrating rainwater and snow melt flush contaminants downward into the water table. Unlike the contaminant migration associated with airborne and liquid effluents, this form of contaminant migration in the environment occurs very slowly, due to the slow velocity of groundwater movement and the tendency of most contaminants to adsorb to soil particulate and organic matter, reducing their mobility. Nevertheless, contaminants that do exhibit mobility in groundwater flow systems eventually discharge into surface waters on the WL site, which drain to the Winnipeg River or discharge directly to the Winnipeg River. Sampling of groundwater is therefore another important element in evaluating the impacts of site operations.

Figure 2 illustrates the pathways along which monitoring is carried out in support of the EMP. This integrated approach to environmental monitoring ensures the evaluation of impacts on the environment from WL facilities and operations is carried out in a logical and comprehensive manner.

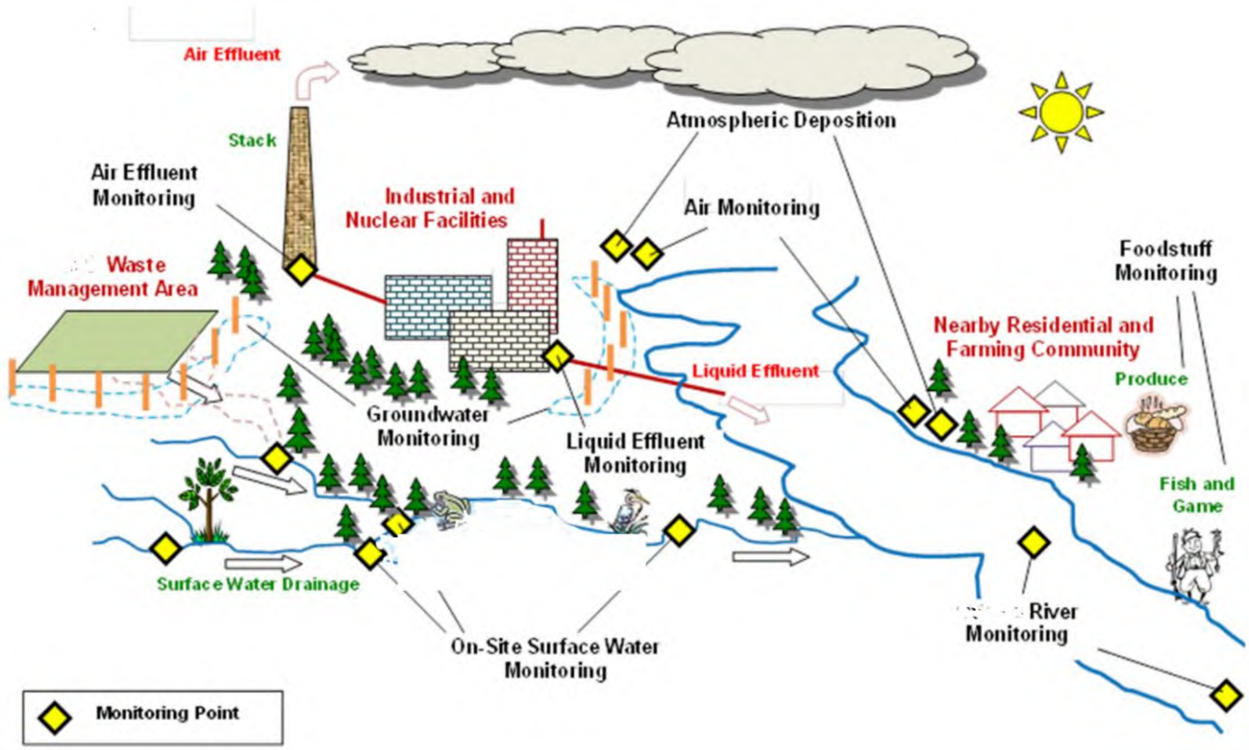

Figure 2: Integrated WL Environmental Monitoring Program

1.2.3 Annual Report Structure

This annual report is structured to allow readers to easily understand the network of monitoring and the results of specific monitoring activities, in addition to providing an overview of the overall impact (performance) of the WL site.

- Section 2 summarizes the objectives of the EMP.
- Section 3 summarizes modifications to the EMP.
- Section 4 summarizes and assesses the field and laboratory Quality Assurance (QA) results.
- Section 5 summarizes the results of effluent monitoring at the WL site, with detailed results reported in the WL Annual Compliance Monitoring Report [8]
- Section 6 provides detailed results of environmental, groundwater and biodiversity monitoring, representing the impact of WL operations and providing a measure of the impact of WL operations from contaminant transport through various environmental media including surface water, ambient air, and foodstuffs.

- Section 7 provides a detailed assessment of dose to the public from WL operations. This assessment utilizes the exposure pathways and assumptions used in the derivation of the Derived Release Limits (DRLs) for the WL site [9], providing a means of validating the monitoring results against the transport modelling underlying the DRLs.
- Section 8 summarizes the results of investigative studies carried out over the year, which can be initiated for several reasons. These may provide the data required to reduce uncertainty in monitoring, increase knowledge of the behaviour of contaminants in the environment, or investigate specific EMP findings.
- Section 9 provides a discussion of Environmental Assessment at WL.
- Section 10 provides concluding remarks.

2. Whiteshell Laboratories Environmental Monitoring Program

Canadian Nuclear Laboratories maintains a comprehensive Environmental Monitoring Program.

The Canadian Standards Association standard CSA N288.4-10 [10] explicitly includes the protection of the environment in conformance with the regulations under the *Nuclear Safety and Control Act* [11]. WL's Implementation of N288.4-10 has involved the transition of the existing EMP to meet the requirements of the new standard. WL's Integrated EMP [12] is designed to track radiological and non-radiological contaminants throughout the different compartments of the geosphere, atmosphere, and biosphere and consists of three distinct programs: the Effluent Verification Monitoring Program (EVMP), the Environmental Monitoring Program and the Groundwater Monitoring Program (GWMP) [13].

2.1 Environmental Monitoring Program Scope and Objectives

Canadian Nuclear Laboratories maintains a comprehensive EMP at the WL site in order to achieve the following primary objectives:

- To assess the level of risk on human health and safety, and the potential biological effects in the environment of the contaminants and physical stressors of concern arising from the facility;
- To demonstrate compliance with limits on the concentration and/or intensity of contaminants and physical stressors in the environment or their effect on the environment;
- To check, independently of effluent monitoring, on the effectiveness of containment and effluent control, and provide public assurance of the effectiveness of containment and effluent control;

- To verify the predictions made by an Environmental Risk Assessment (ERA) (or equivalent), Derived Release Limit (DRL) model, and/or Environmental Assessment (EA), refine the models used in the ERA (or equivalent), DRL[1] model and/or EA, or reduce the uncertainty in the predictions made by the ERA (or equivalent), DRL model and/or EA;
- Further to the objectives described above, which provides an indication on effectiveness of effluent control, where waste storage facilities and contaminated lands exist, the objective is to provide an indication of unusual or unforeseen conditions that might require corrective action or additional monitoring such as groundwater monitoring.

The Program is also designed to:

- Provide data required to support site restoration programs, site operations or to plan for future stages of the facility lifecycle (e.g., decommissioning);
- Provide resources and data that may be of value during the response to an accident or upset condition, and in the recovery from such an event;
- Demonstrate due diligence;
- Meet a stakeholder commitment as required; and
- Fulfill other business purposes (e.g., monitoring emissions to support international treaties).

The design of the EMP takes into account the facilities and processes at the site, past and present emissions from the site, the environmental pathways leading to radiation dose to the most exposed members of the public (i.e., critical groups) as identified by the DRL calculations, and to biota, as well as various other scientific and public considerations.

3. Modifications to the EMP

The Environmental Protection program includes the sampling of several environmental media at various locations at the site and in surrounding communities, representing potential pathways for radiation exposure to members of the public. It also includes media and sample locations serving as trend indicators. Monitored environmental media include ambient air, precipitation, surface, and groundwater including the Winnipeg River, vegetables, fish, game, soil and river sediments. The WL effluent and environmental monitoring activities conducted in 2023 are shown in

[1] The DRL for a given radionuclide is the release rate that would cause a member of the public to receive a dose equal to the regulatory annual dose limit due to the release of the radionuclide during normal operation of a nuclear facility over the period of a calendar year. They are derived based on pathways modelling. The DRL values for the WL site are provided in Reference [9].

Table 2.

Table 2: Summary of WL Monitoring Activities

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
Air	WL Perimeter and Off-Site	γ (Thermoluminescent Dosimeters (TLDs)	Continuous	No change
	WL Site	Dust Particulates (TSP, $PM_{2.5}$ Gross α/β, γ-spec)	Continuous during building demolition	No Change
Air	WL Site	Quantities of fuel combusted for building heating. Diesel burned in their standby generators. Quantity of Total (filterable) Particulate Matter[2] Record of Dust Control Treatments and Site Inspections Halocarbon	Annually internal worksheet tools are used to perform the calculations required to report to the NPRI. In addition, Environment Canada provides companies with various calculators (road dust, landfill gas) Annually all releases of halocarbons are recorded and those over 10 kg are reported to Environment Canada	No Change
Air Effluents	WL Facilities (B100 (WR1), Shielded Facilities)	Gross α/β, γ-spec, tritium[3]	Continuous	No Change
Noise	WL Site	Noise monitoring	During periods of high activity	No change

2 As the result of travel on gravel roads, sand blasting activities, use of gas-powered vehicles, propane tanks, other CO_2 emissions.

3 Tritium analysis is only required for Building 100 air effluent.

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
Topography	Surface drainage areas	Visual inspection of OFS pipe (above ground) for evidence of subsidence Visual Inspection of WMA ditch system and other drainage pathways identified in Storm Water Management plan. Visual Inspection of the Winnipeg River Bank in the vicinity of the WL site	Semi-Annually	No change
Surface Water	Winnipeg River	Gross α/β, Sr-90, Tritium, γ-spec, non-radiological (total metals including U)	Daily to Weekly, monthly composite analyzed	No change
	WMA Ditches[4]	Tritium, Uranium, Gross α/β, C-14 γ-spec, Sr-90 (as required), Isotopic Pu (as required), Tc-99 non-radiological (total metals including U)	Periodically during ice free periods[5]	No change
	Landfill Dugouts	Gross α/β, Tritium, Sr-90, γ-spec, non-radiological (total metals including uranium) Tc-99	Annually	No change

4 If gross beta levels are above 10 Bq/L, the samples are submitted for strontium-90 analysis. If the alpha activity is above 0.5 Bq/L and gross alpha is not accounted for by uranium, and americium-241 is present in the gamma spec, the samples are submitted for isotopic plutonium analysis. Additional analyses may be performed at Facility Management or Environmental Protection Program Manager request.

5 Ditch locations are checked and, if water is flowing, are sampled after rain events greater than 5 millimetre of rain in a 24-hour period, preceded by at least 48 hours of no precipitation. Samples are also taken during the spring (snow) melt and not more than weekly unless there is some operational concern that triggers additional sampling.

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
	Primary Cell of the Sewage Lagoon	Gross α/β, γ-spec	Prior to isolation from Secondary Cell and/or Discharge	No change.
	Main Campus Miscellaneous (manholes, excavations, sumps)	Gross α/β, γ-spec, pH, visual inspection for film, sheen or discoloration, deleterious substances, and conductivity	Prior to pump-out/relocation	No change
	B417 Tank catch/containment tray	Gross α/β, γ-spec	Monthly (April to October)	No change
	B923 Sump, SSC Sump, SSC Standing Water, WMA Misc Sumps and WMA standing water (excavations)	Gross α/β, γ-spec, tritium, pH, visual inspection for film, sheen or discoloration, deleterious substances, and conductivity	Prior to pump-out/relocation	No change
Atmospheric Deposition	Off-Site	Gross α/β, γ-spec	Monthly	No change
Groundwater	WMA[6]	Gross α/β, Sr-90, tritium, γ-spec, uranium non-radiological, field measurement of pH, conductivity and temperature water level measurements	Semi-Annually	No change

6 If gross beta levels are above 2 Bq/L the samples are submitted for gamma spectrometric analysis, if it exceeds 5 Bq/L the samples are submitted for strontium-90 analysis. If the alpha activity is above 0.5 Bq/L, the samples are submitted for gamma spectrometric analysis and possibly isotopic plutonium analysis. Additional analyses may be performed at Facility Management or Environmental Protection Program Manager request.

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
	Landfill, Lagoon	Gross α/β, γ-spec, Sr-90 (as required) tritium, U non-radiological, field measurement of pH, conductivity and temperature water level measurements	Annually (Spring)	No change
	Main Campus (including locations in the vicinity of, and up and down gradient of, WR-1)	Gross α/β, γ-spec, Sr-90 (as required), tritium, U non-radiological, field measurement of pH, conductivity and temperature Water Level measurements	Semi-Annually (basal and bedrock), Annually (water table and clay-till)	No change
Liquid Effluents	B100 (WR-1) and B300 tanks, Outfall Sampling Location Sewage Lagoon, Ditch location 8, 9 and Control	Gross α/β, tritium, γ-spec. Sr-90, U, non-radiological, Pu-238, Pu-239/240[7], C-14[8]	Continuous on discharge	No change
Sediments	Winnipeg River (depositional zone cores)	Gross α/β, γ-spec, Sr-90 (composite for each sample) and non-radiological parameters	Every 20 years starting 2006[9]	No change
	Winnipeg River (surface sediment)	Gross α/β, γ-spec, Sr-90 (composite sample for each location)	Annually	No change

7 Plutonium (quarterly composite) analysis (plutonium-238, plutonium-239/240) is performed on outfall effluent.

8 Carbon-14 analysis is performed on Building 100 tank discharges and on the Outfall Sampling location.

9 For Deposition Areas, thirteen cores are collected at each site. Depositional zones are to be sampled every 20 years to verify validity of EA conclusions.

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
Fish[10]	Winnipeg River (one upstream location and two downstream)	Gross β, γ-spec	Annually	No change
Wildlife Deer, Bear, Grouse, Rabbit	On-Site, Off-Site	Gross α/β, γ-spec, Sr-90 (bone)	As Available[11]	No change
Garden Crop[12] Includes mushrooms and wild berries	Up and Downstream of Whiteshell Laboratories	Gross α/β, γ-spec, and Sr-90, total and organically bound tritium	Annually	No change
Honey/Canola[13]	Off-site local sources	Gross α/β, γ-spec, Sr-90, total and organically bound tritium	Annually	No change
Beef/Pork/Lamb/ Poultry	Off-site local sources	Gross α/β, γ-spec	Annually	No change
Native Vegetation	WL Perimeter ARMs, WMA	Gross α/β, γ-spec, Sr-90, total and organically bound tritium	Annually	No change
Soils	WMA affected areas	Gross α/β, Sr-90, γ-spec	Annually	No change

10 Fish netting activities must be in compliance with the annual permit issued under the Fisheries Act (Manitoba). Report of these activities must also be completed as the conditions listed in the permit.

11 Animals are obtained by CNL staff through road kills and/or from local trappers. Animal collection activities must be in compliance with the permit issued under the Wildlife Act. Reporting of these activities must also be completed as per the conditions listed in the permit. Species (normally deer, moose, bear, grouse or rabbit) sex and age should be reported to the WL Environmental Specialist along with the radioactivity in Bq/kg, fresh weight for flesh (and bone - for deer/moose).

12 Leafy vegetables should include local wild mushrooms and fruit should include local wild berries (possible choices -blue berries, Saskatoon berries, raspberries, strawberries, plums, gooseberries, chokecherries, pin cherries) [14].

13 This is an air deposition pathway, canola, honey, poultry, pork, and beef can be obtained from the local colony near Whitemouth. Background samples can be obtained from local stores that bring in produce from un-impacted areas.

Environmental Component	Sampling Location	Parameters	Sampling Frequency	Proposed Changes for 2024
Soils/sediments	Excavations/Land Clearance[14]	Gross α/β, γ-spec, non-radiological parameters (	Pre-clearance	No change
	Landfill Dugouts	Gross α/β, γ-spec, non-radiological parameters	Every 5 years (starting 2007)	No change
	Sewage Lagoon flocculent and Discharge Paths	Gross α/β, γ-spec, Sr-90, non-radiological parameters	Every 5 years (starting 1999)	No change
Land Surveys	On-Site, Off-Site	γ-spec	Annually[15]	No change
Species at Risk (Barn Swallows and Bats)	On-Site	Monitor Compensatory Habitat	Installed in 2018	No change
Wildlife Mortality	On-Site (plant road)	Track wildlife mortality (including birds, reptiles and mammals)	Continuous as reported by staff	No change

4. Quality Assurance

General quality assurance (QA) objectives for CNL's Environmental Monitoring Program are set out in an Environmental Management quality assurance plan, and for laboratory handling of TLD dosimeters, in a dosimetry services quality assurance manual. In 2023 samples were also sent to off-site contract labs that were ISO 17025 certified.

Radiological analysis is conducted in accordance with laboratory-specific environmental monitoring quality assurance processes, including detailed working procedures for field operations, laboratory operations, laboratory administration, equipment performance, and quality verification of analytical results. These are written in an effort to conform to the Standards Council of Canada CAN P 4D (ISO/IEC 17025) [15] for analytical laboratories.

The following sections discuss the results of laboratory inter-comparison activities in 2023.

4.1 Radiological Analysis

The Environmental Management group conducts frequent internal checks of their technical capabilities as they perform their measurements. These are referred to as Quality Verification tests, and are grouped as follows according to purpose:

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14 If gross beta levels are not accounted for by potassium-40 and cesium-137 (or other beta/gamma emitters), strontium-90 analysis is performed.

15 Land Gamma (Road Survey) must be performed in the fall before the first snowfall.

- *Contamination Tests*, such as measurement of the reagent blank, establish the level of analyte present resulting from contamination of the analysis system or system components. Acceptance criteria for these performance tests are related to each analyte's method detection limit.
- *Reproducibility Tests*, such as measurement of sample replicates, establish the relative precision of the method(s). To be acceptable, replicate measurements must agree within limits established by long-term method performance.
- *Accuracy Tests*, such as blanks or samples, each spiked with known amounts of the analyte(s), establish the presence or absence of any biases due to sample matrix, sample preparation, or instrument function. To meet acceptance criteria, the spike quantity must be recovered within limits established by long-term method performance.

Table 3 summarizes the results of internal quality verification tests conducted by Environmental Management at WL. As a part of the sampling program, 5405 quality verification tests were performed in 2023. Performance, accuracy, and precision were verified by means of spike and duplicate tests and by laboratory and field blank and spiked blank tests. Results are for four (4) different methods with an overall pass rate of 98.8%.

In 2023, the WL Environmental Management group took part in four inter-laboratory comparison studies. Two of these studies, which focused on radiological analyses, were offered through the Environmental Research Associates. The other two studies which focused on non-radiological analyses, were offered through the Canadian Association for Laboratory Accreditation. The results of the WL Environmental Monitoring laboratory performance are shown in

Table 4 and Table 5.

For all inter-laboratory tests pertaining to the effluent verification monitoring program CNL, had a 100% passing rate. However, the inter-laboratory test for soil failed because cesium-137, cobalt-60 and zinc-75 were significantly higher than expected. The reason for the failure has not been established. All the other isotopes passed and they were not consistently high. Testing of previous MRAD soil samples consistently produced the same results as before. This suggests that the gamma spec equipment was functioning properly and the MRAD sample contained more cesium-137, cobalt-60 and zinc-75 than expected.

Table 3: Results of Radiological Internal Quality Verification Tests at WL, 2023

Method	No. of Tests	No. of Failures	% Pass
Total Alpha Instrumentation	1212	10	99.2
Total Beta Instrumentation	1061	23	97.8
Gamma Instrumentation	2904	12	99.6
Tritium	228	18	92.1
2023 Total	5405	63	98.8

Table 4: Whiteshell Laboratories Performance in Environmental Resource Associates Proficiency Testing Program, 2023

Test Method	Sample ID	Isotope	Expected	Found	Evaluation Pass/Fail
ERA MRAD-038 units pCi/filter					
Gspec	Air Filter	Am-241	55.6	53.17	**Pass**
		Cs-134	153	106.94	**Pass**
		Cs-137	892	832.92	**Pass**
		Co-60	467	443.1	**Pass**
		Zn-65	1110	1172.9	**Pass**
		Gross Alpha	76.8	79.68	**Pass**
		Gross Beta	32.8	35.45	**Pass**
ERA MRAD-038 units pCi/L					
Gspec	Water	Am-241	32.1	28.91	**Pass**
		Cs-134	298	231.72	**Pass**
		Cs-137	762	707.38	**Pass**
		Co-60	412	393.84	**Pass**
		Zn-65	228	228.71	**Pass**
		Gross Alpha	148	115.84	**Pass**
		Gross Beta	170	172.17	**Pass**
LSC		Tritium	28,000	27,119	**Pass**
ERA MRAD-039…units..pCi/filter					
Gspec	Air Filter	Am-241	69.3	72.3	**Pass**
		Cs-134	1350	1046	**Pass**
		Cs-137	932	938	**Pass**
		Co-60	95.5	107	**Pass**
		Zn-65	2030	3331	**Pass**
		Gross Alpha	79.8	102	**Pass**
		Gross Beta	42.6	51.8	**Pass**
ERA MRAD-039…units..pCi/L					
Gspec	Water	Am-241	71	70.2	**Pass**
		Cs-134	1010	791	**Pass**
		Cs-137	1010	966	**Pass**
		Co-60	2020	1960	**Pass**
		Zn-65	1990	2088	**Pass**
		Gross Alpha	71.6	47.1	**Pass**
		Gross Beta	51.1	56.3	**Pass**
LSC		Tritium	8630	8500	**Pass**

Test Method	Sample ID	Isotope	Expected	Found	Evaluation Pass/Fail
ERA MRAD-039…units..pCi/kg					
Gspec	Soil	Ac-228	1590	1490	**Pass**
		Am-241	1300	1760	**Pass**
		Bi-212	1670	937	**Pass**
		Bi-214	786	872	**Pass**
		Cs-134	1570	1843	**Pass**
		Cs-137	1780	2555	**Fail**
		Co-60	7960	11571	**Fail**
		Zn-65	2030	3331	**Fail**
		Pb-212	1650	1267	**Pass**
		Pb-214	851	830	**Pass**
		K-40	41800	42661	**Pass**

4.2 Non-Radiological Analysis

With the exception of HB-40 analysis, pH and conductivity, all the samples which required non-radiological analyses were sent to contract laboratories in 2023.

Certificates of analysis were reviewed and results of all the analyses were verified to be within acceptance criteria.

In 2023, the WL Environmental Management group participated in a semi-annual proficiency testing program offered through Proficiency Testing Canada (PTC). There were two inter-laboratory testing performed on the non-radiological parameters in 2023. As shown in Table 5, all results were satisfactory.

Table 5: Whiteshell Laboratories Performance in PTC Proficiency Testing Program, 2023

Proficiency Testing Canada	Sample ID	Units	Expected Value	Found Value	Evaluation Pass/Fail
March 2023 Study	Conductivity	µS/cm	738	744	Pass
			423	429	
			509	509	
			575	575	
	Total Suspended Solids (TSS)	mg/L	223	227	Pass
			90	95	
			43	39	
			162	163	
	pH	pH units	8.26	8.19	Pass
			5.88	5.86	

			3.41	3.38	
			7.01	6.99	
October 2023 Study	Conductivity	µS/cm	573	571	Pass
			318	314	
			373	372	
			565	577	
	Total Suspended Solids (TSS)	mg/L	168	144	Pass
			108	98	
			138	132	
			35	39	
	pH	pH units	8.06	8.15	Pass
			4.5	4.49	
			7.41	7.43	
			9.87	9.95	

4.3 Sample Management Office

The following samples for 2023 were sent to a contract laboratory for analysis:

1. Animal, fish and vegetation samples for gross alpha, gross beta and Gamma Spectrometry (Gspec).
2. Soil and sediments for gross alpha, gross beta and gamma spectroscopy.
3. Groundwater samples for gross alpha, gross beta, strontium-90, and gamma spectroscopy analysis.
4. Surface water samples that included ditches, rivers and Outfall.

Certificates of analysis were reviewed and results of all the analyses were verified to be within acceptance criteria.

4.4 Audit and Inspections

As per the requirements of the Management System [16], both Safety Control Areas (SCA's) and Facilities conduct various self-assessments to ensure that the management system is functioning according to expectations and that any policy, programmatic, or procedural deficiencies are identified and appropriate action taken to resolve any deficiencies. See the WL Annual Compliance Monitoring Report [8] and specifically the ISO 14001 EMS audit report.There was also a CSA-N288 Compliance audit performed in November.

All actions resulting from audits, inspections, reviews and self-assessments are being managed and tracked through CNL's Problem Identification and Resolution Program.

5. Summary of Emissions from Whiteshell Laboratories

5.1 Summary of Radioactive Emissions from Whiteshell Laboratories

Cleanup and operational activities associated with the decommissioning of the site have been underway since 2003 January. Specific sources that may have influenced the 2023 air releases included the Hot Cells Facility (Building 300), the Immobilized Fuel Test Facility (Building 300) and the Reactor Building (Building 100). The sources contributing to the liquid releases are the Outfall and the Lagoon. The discharge from the Outfall is composed of storm water runoff from paved roadways or around buildings, cooling water used in process and experimental facilities, and holding tank discharges from the active liquid waste treatment system tanks based in Building 100 and Building 300. Specific activities that may have influenced the 2023 liquid releases are similar to those for the past five years. The use of disposable rubber shoe covers was introduced in 2018 to reduce the impact of shoe cover washing on the waste stream.

The Lagoon collects sanitary and wastewater from most buildings on the site, as well as from the laundry facility. Lagoon water residence time is more than three months, to allow for biodegradation and settling. Prior to each planned discharge, the secondary cell is isolated, and tested for a series of non-radiological parameters (discussed in the WL Annual Compliance Monitoring Report [8]). If these are acceptable, the accumulated contents of the secondary cell only are released to the Winnipeg River via a small drainage ditch leaving the Lagoon's north side. The outflow of the Lagoon is continuously sampled during discharge. The resulting composite sample is analyzed for gross alpha, gross beta, and radio-strontium and it is also scanned by gamma spectrometry. In 2023 the Lagoon was not discharged because the annual precipitation was low and as a result freeboard in the Lagoon was low enough that a discharge was not required.

Detailed results of the monitoring of radioactive material in airborne and liquid effluents from the WL site are in the WL Annual Compliance Monitoring Report [8]. This section contains brief summaries of airborne and liquid releases from WL during 2023. The releases are expressed as average quantities per monitoring period (in Becquerels) and as percentages of the applicable Derived Release Limit (DRL[16]) [9] based on the most exposed members of the public outside the site boundaries. These limits came into effect on 2021 January 31. Data are reported against the revised DRLs, and any tables/figures with previous years' data were re-calculated against the revised DRLs for proper comparisons. Table 6 and Table 7 also indicate the critical groups outside the sites, and the dominant exposure pathways to the critical groups, as identified by the DRL calculations [9], using the methodology of the National Standard of Canada, N288.1-08 [17]. Farm A is located just north of the WL boundary. Farm D, Farm E and Farm F are on the west side of the Winnipeg River. Note that for liquid releases (Table 7) the % DRL is given for

[16] Derived Release Limits are the upper limits, approved by the CNSC, for releases of radioactive materials in emissions from a nuclear facility or site. They are derived based on the dose limit for members of the public by means of environmental pathway analysis. The DRL values in effect for the WL site are contained in Reference [9].

the alpha emitting radionuclides instead of for gross alpha. For practical purposes, the sum of site releases during the year, as percent of the DRLs multiplied by the dose limit (1 mSv), represents a generally conservative radiation dose estimate to the most exposed members of the public, due to emissions from the site. All releases were below the regulatory Action Levels[17] derived from the DRLs, as specified in [5] and [18].

Table 6: Whiteshell Laboratories Air Emissions – Average Releases in 2023 and Dominant Dose Pathways

Radionuclide	DRL* (Bq/week)	Average Release [8]		Dominant Dose Pathway [9]	Critical Group [9]
		(Bq/week)	(%DRL)		
Tritium	1.65E+15	4.04E+08	2.45E-05	Water Ingestion	Adults at Farm F
Gross Beta Particulates (as Sr-90)	6.79E+09	2.74E+03	4.03E-05	Terrestrial Animals and Mother's Milk (ingestion)	Infants at Farm A
Gross Alpha Particulates (as Pu-239)	1.73E+09	1.47E+03	8.51E-05	Air Inhalation	Adults at Farm A
WL Total – Airborne			**1.50E-04**		

* DRL based on critical groups outside the site [9]

Table 7: Whiteshell Laboratories Liquid Emissions – Average Release in 2023 and Dominant Dose Pathways

Radionuclide	DRL* (Bq/month)	Average Release [8]		Dominant Dose Pathway [9]	Critical Group [9]
		(Bq/month)	(%DRL)		
Uranium (total)	1.25E+10	8.59E+05	6.88E-03	Water Ingestion	Infants at Farm A
Plutonium-239/240	1.11E+09	7.66E+05	6.90E-02	Water Ingestion	Infants at Farm A
Plutonium-238	1.16E+09	6.48E+05	5.59E-02	Water Ingestion	Infants at Farm A
Americium-241	1.04E+09	5.29E+05	5.09E-02	Water Ingestion	Infants at Farm A
Strontium-90	1.30E+10	1.75E+06	1.35E-02	Terrestrial Animals Mother's Milk	Infants at Farm A
Cesium-137	1.16E+10	4.21E+05	3.63E-03	Fish Ingestion	Adults at Farm A
WL Total – Liquid			**2.00E-01**		

* DRL based on critical groups outside the site [9]

[17] Action Level – In the context of CNL's Environmental Protection Program, an "Action Level" for radioactive emissions is a release rate of radioactive emissions that, if reached, may represent a loss of control of performance for a facility's environmental protection program or emission control system. Releases above Action Levels must be investigated and reported to the CNSC. Action Levels for WL radioactive effluents are lower than the DRLs.

5.2 Summary of Non-Radiological Emissions from Whiteshell Laboratories

This section addresses the licence requirement regarding hazardous substances monitoring of airborne and liquid effluents for the WL site for 2023.

5.2.1 Airborne Non-Radiological Emissions

Airborne emissions from the WL site are compiled on an annual basis for the purpose of reporting under the National Pollutant Release Inventory (NPRI) and the federal Greenhouse Gas report. The releases to air include emissions caused by burning of Number 2 fuel oil and propane for heating, as well as diesel fuel used from site generators, dust emissions from unpaved roads, sandblasting and excavation projects.

Emission factors are applied to fuel and sandblasting product consumption data, as well as estimated kilometres travelled on unpaved roads, to determine the amount of Criteria Air Contaminants (CACs) that are generated on site. Criteria Air Contaminants consist of carbon monoxide, oxides of nitrogen, sulphur dioxide, total (filterable) particulate matter (PM), and particulate matter below 10 microns (PM_{10}), particulate matter below 2.5 microns ($PM_{2.5}$), and Volatile Organic Compounds. Dust emissions from excavation projects were estimated based on a calculation for total particulate matter generated per excavation day. Dust generated from demolition activities in 2023 are captured in the EAFP report [7].

Table 8 outlines the annual CACs generated from site activities, and shows a large increase in emissions seen in 2022 compared to the 5-year average for the values for total particulate matter, PM10, and PM2.5. This is a result of CNL not applying any dust suppressant to the gravel roadways in 2022. In 2023 CNL resumed the application of dust suppression, resulting in a significant decrease in total particulate matter, PM10, and PM2.5. As a result the Whiteshell site dust emissions returned to values similar to previous years and only needed to report on PM10, as before.

Under the authority of the Canadian Environmental Protection Act, 1999 (CEPA, 1999), WL is required to calculate releases under the Greenhouse Gas (GHGs) emissions notice providing the facility emits over 10,000 tonnes of carbon dioxide equivalent or more within the 2023 calendar-year. GHG emissions from WL include carbon dioxide, methane and nitrous oxide. Emissions are primarily from the burning of propane, the use of diesel generators, the on-site transportation fleet, the on-site landfill and open-pit wood burning. They are reported in CO_2 equivalent tonnes which is a measure used to compare between gases that have different Global Warming Potential (GWP).

GHG emissions from the WL site were similar to 2022 and have decreased significantly from 2018-2020 (Table 9). This decrease can be attributed to the decrease in propane required to heat the site from 2021 through 2023. Building 200 did not require any building heating since 2020, and Buildings 402 and 305 no longer had to be heated starting in the fall of 2021 due to demolition activities. Overall, greenhouse gases in 2023 are 26% less than the average for the last 5 years.

In the atmosphere, halocarbons contribute both to global warming and to ozone depletion, via separate mechanisms. Losses of halocarbon refrigerants and fire suppressants are reported semi-annually to Environment and Climate Change Canada, pursuant to the Federal Halocarbon Regulations. All releases greater than 10 kg are considered reportable. There were no reportable releases of halocarbons in 2023.

Table 8: WL Stationary Combustion Data and Emissions from 2018 to 2023

Parameter	Unit	Data for Previous Five Years						Data for 2023	NPRI Reporting Threshold
		2018	2019	2020	2021	2022	Average		
Airborne Emissions									
NO_x (as NO_2)	Mg	0.536	0.621	0.602	0.331	0.485	0.569	0.617	20
SO_2	Mg	0.014	0.016	0.017	0.005	0.014	0.014	0.025	20
CO	Mg	0.233	0.271	0.256	0.162	0.202	0.254	0.218	20
PM (total particulate)	Mg	14.562	10.574	8.883	8.174	46.9	11.17	10.516	20
PM_{10}	Mg	3.726	2.712	2.281	2.091	11.97	2.862	2.702	0.5
$PM_{2.5}$	Mg	0.391	0.292	0.249	0.218	1.21	0.305	0.298	0.3
Volatile Organic Compounds	Mg	0.042	0.049	0.048	0.026	0.038	0.045	0.049	10

Table 9: Greenhouse Gas Emissions from 2018 to 2023

Parameter	Releases from Previous Five Years						2023 Releases
	2018	2019	2020	2021	2022	5-yr. Avg.	
GHG CO_2e tonnes	1,678	1,756	1,692	1,177	1,215	1,635	1,203

Notes:

GHG CO_2e tonnes - A unit of measure used to compare between gases that have different Global Warming Potentials (GWP). For example, the GWP for methane is 25. This means that emissions of one metric ton of methane is equivalent to emissions of 25 metric tons of carbon dioxide. In 2013, the GWP for methane and nitrous oxide were changed from 21 to 25 and 310 to 298 respectively under the *Canadian Environmental Protection Act Notice with Respect to Reporting of Greenhouse Gases for 2013* [19]

5.2.2 Liquid Non-Radiological Emissions

The non-radiological effluent monitoring program established by CNL continues to supply valuable information about the potential impacts of operations on the Winnipeg River, and thus the local environment. Two effluent streams, the Lagoon and Process Outfall, discharge significant volumes of water to the Winnipeg River. Normal surface land run off also reaches the river through Ditches Locations 8 and 9. Non-radiological emissions to the river are summarized as loadings, expressed as kg released per year. Table 10 summarizes emission loadings of non-radiological parameters for the Lagoon and Outfall. Ditches are not included in loading calculations because the volumes discharged could not be quantified.

For the Lagoon, the volume-weighted average concentration of a parameter was calculated as follows:

1. The measured concentration for each day was averaged with that of the next day;
2. The average was multiplied by the estimated volume discharged over the 24-hour period;
3. The products for all days were summed, then;
4. The resulting sum was divided by the total volume released during the period (Spring, Fall or entire year). The load was then given as the product of the calculated volume-weighted average concentration, multiplied by the total volume for the period.

At the Outfall, the total discharge volume for each month was multiplied by the monthly average concentration of the parameter. Table 10 contains the results of calculations described above, grouped by parameter and by final outflow source. All mass-related parameters are shown. The table also compares them to previous years, and to the five-year averages.

When examining the WL site total loads, notable results are:

- Phenolics and oil and grease are the parameters that had a load increase greater than 10% when compared to the five-year average. These parameters are typically non-detects or at concentrations around the detection level, so when they are detected, they have an impact on the overall load.
- The majority of loads decreased in 2023. This is due to the safety stand down that occurred in 2023, which reduced operations on site from May to December. Another contributor to the decrease is the street sweeping operations were conducted after the spring melt in 2023.

Table 10: Loading for Current Year and Previous Five Years

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2023		
			2018	2019	2020	2021	2022	Average	# Spl. [b]	NDs[c]	Load (kg)
-	CBOD	Lagoon	216	0	0	0	340	111	0	0	0
		Site Total	**216**	**0**	**0**	**0**	**340**	**111**	**0**	**0**	**0**
-	Un-ionized Ammonia	Lagoon	0.118	0.042	0.043	0	0.006	0.042	0	0	0
		Site Total	**0.118**	**0.042**	**0.043**	**0**	**0.006**	**0.042**	**0**	**0**	**0**
-	Total Residual Chlorine	Lagoon	0.220	0.831	1.743	0	0.001	0.559	0	0	0
		Site Total	**0.220**	**0.831**	**1.743**	**0**	**0.001**	**0.559**	**0**	**0**	**0**
5b	Total Organic Carbon	Outfall	-	-	16,814	12,230	29,960	19,668	52	0	10,138
		Site Total	-	-	**16,814**	**12,230**	**29,960**	**19,668**	**52**	**0**	**10,138**
6	Phosphorus	Lagoon	1.59	1.90	2.30	0	0.003	1.16	0	0	0

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2023		
			2018	2019	2020	2021	2022	Average	# Spl. [b]	NDs[c]	Load (kg)
		Outfall	42.6	27.7	25.2	25.9	59.2	36.1	52	0	25
		Site Total	**44.2**	**28.6**	**27.5**	**25.9**	**59.2**	**37.1**	**52**	**0**	**25**
8	TSS	Lagoon	46.4	44.7	120	0	216	85.4	0	0	0
		Outfall	2,031	5,764	6,657	6,630	21,533	8,523	52	19	1467
		Site Total	**2,077**	**5,809**	**6,777**	**6,630**	**21,749**	**8,608**	**52**	**19**	**1,467**
9	Chromium	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.06	0.818	0.651	0.035	0.100	0.3328	52	48	0.0122
		Site Total	**0.06**	**0.818**	**0.651**	**0.035**	**0.100**	**0.3328**	**52**	**48**	**0.0122**
9	Copper	Lagoon	0.018	0.027	0	0	0.072	0.023	0	0	0
		Outfall	7.63	7.03	13.5	8.44	8.42	9	52	0	5.39
		Site Total	**7.65**	**7.06**	**13.5**	**8.44**	**8.49**	**9.03**	**52**	**0**	**5.39**
9a	Iron	Lagoon	4.52	4.56	3.57	0	6.76	3.88	0	0	0
		Outfall	258	296	381	322	1,200	491	52	0	187
		Site Total	**263**	**301**	**385**	**322**	**1,207**	**496**	**52**	**0**	**187**
9	Lead	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.23	0.220	0.481	0.303	0.711	0.389	52	42	0.047
		Site Total	**0.23**	**0.220**	**0.481**	**0.303**	**0.711**	**0.389**	**52**	**42**	**0.047**
9	Nickel	Lagoon	0.019	0.042	0	0	0.036	0.019	0	0	0
		Outfall	0.836	0.742	0.972	1.49	2.17	1.24	52	43	0.22
		Site Total	**0.855**	**0.784**	**0.972**	**1.49**	**2.21**	**1.26**	**52**	**43**	**0.22**
9	Potassium	Outfall	-	-	1,348	1,302	1,931	1527	52	0	1183
		Site Total	-	-	**1,348**	**1,302**	**1,931**	**1527**	**52**	**0**	**1183**
9	Sodium	Outfall	-	-	5,223	5,086	7,348	5886	52	0	4643
		Site Total	-	-	**5,223**	**5,086**	**7,348**	**5886**	**52**	**0**	**4643**
9	Strontium	Outfall	-	-	39.9	39.3	50.10	43.1	52	0	37.27
		Site Total	-	-	**39.9**	**39.3**	**50.10**	**43.1**	**52**	**0**	**37.27**
9a	Uranium	Outfall	-	-	0.485	0.461	0.639	0.528	52	0	0.422
		Site Total	-	-	**0.485**	**0.461**	**0.639**	**0.528**	**52**	**0**	**0.422**

ATG	Parameter	Monitoring Point	Loadings from Previous Five Years (kg) [a]						Results for Year 2023		
			2018	2019	2020	2021	2022	Average	# Spl. [b]	NDs[c]	Load (kg)
9	Zinc	Lagoon	0	0	0	0	0.020	0.004	0	0	0
		Outfall	1.77	6.13	0.306	7.88	15.62	6.34	52	43	1.92
		Site Total	**1.77**	**6.13**	**0.306**	**7.88**	**15.64**	**6.35**	**52**	**43**	**1.92**
12	Mercury	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.001	0.001	0.0003	0.0003	0.0073	0.002	52	43	0.0005
		Site Total	**0.001**	**0.001**	**0.0003**	**0.0003**	**0.0073**	**0.002**	**52**	**43**	**0.0005**
14	Phenolics	Lagoon	0	0	0	0	0	0	0	0	0
		Outfall	0.0001	0.0003	0	0	0.21	0.042	52	46	0.16
		Site Total	**0.0001**	**0.0003**	**0**	**0**	**0.21**	**0.042**	**52**	**46**	**0.16**
16	Bromodichlo-romethane	Outfall	-	-	0.547	0	0	0.182	52	48	0.05
		Site Total	-	-	**0.547**	**0**	**0**	0.182	52	48	0.05
16	Chloroform	Outfall	-	-	31.4	8.82	8.82	16.3	52	0	7.65
		Site Total	-	-	**31.4**	**8.82**	**8.82**	**16.3**	**52**	**0**	**7.65**
25	Oil & Grease	Lagoon	0	0	0	0	2.99	0.598	0	0	0
		Outfall	124	19.1	0	188	108	87.8	52	43	1459
		Site Total	**124**	**19.1**	**0**	**188**	**111**	**88.42**	**52**	**43**	**1459**

a Averages were calculated by setting to zero results reported as "< DL."

b # Spl. is the number of samples analyzed and reported.

c NDs is the number of samples in which analyte was not detected (i.e., Code = "< DL", result = 0).

6. Environmental Monitoring Program Activities

An Environmental Monitoring Program is implemented at the WL site to meet the objectives described in Section 2.1. Cessation of a monitoring activity will occur once it can be shown that an effect has stabilized or has been reduced to a level where it is no longer considered significant by regulatory requirements or community concerns. This is also consistent with N288.4-10. Any proposals on modifications to the monitoring program will be communicated to the CNSC.

In a continuing environmental monitoring program, radioactivity is measured in a number of media at various environmental sampling points near the WL site. In addition, groundwater is monitored for several non-radiological parameters. Many of the sampling locations discussed in this report are shown in Figure 22 through Figure 27 in Appendix A. This report contains monitoring results for year 2023, including measurements of:

- radioactivity in waters of the Winnipeg River,
- radioactivity and non-radiological parameters in groundwater,
- radioactivity in flesh of fish from the Winnipeg River,
- radioactivity in cultivated (garden) vegetables,
- radioactivity in native vegetation and soils,
- radioactivity in river-bottom sediments of the Winnipeg River,
- radioactivity in deer and grouse,
- ambient gamma radiation in air,
- atmospheric deposits of radioactive material, and
- land gamma radiation.

Meteorological data are being maintained by Environment Canada for their purposes and the data are available to CNL staff, if needed.

6.1 Environmental Monitoring Results

The results of all environmental monitoring activities in 2023 are presented and discussed in this section, with the focus being on:

- the fate of **waterborne contaminants** from the source areas (e.g., process Outfall, Lagoon and waste storage areas) through the geosphere in groundwater, into and through the biosphere along surface water drainage routes, and entering the Winnipeg River and other off-site areas; and
- the fate of **airborne contaminants** from the source areas (e.g., stacks and roof vents) through the atmosphere, into and through the biosphere via deposition, reaching the boundary of the WL site and entering off-site areas.

Performance in this context was evaluated by characterizing the concentrations of contaminants of concern in groundwater, surface water, and air. Contaminant trends were reviewed and compared to historical trends, background concentrations, and benchmark values (BVs). The background concentrations and benchmarks are shown in Table 11 and Table 12. The comparison to background screening criteria serves to distinguish between “affected” and “unaffected” surface waters. The criteria consists of site-specific background concentrations that are determined by monitoring conditions at one or more reference areas that are on or near the WL site and have not been adversely affected by WMA operations. The mean plus two standard deviations (of the five (5) most recent years) was used as an upper limit of background. This method is prescribed by the Ministry of the Environment and cited in [10]. It should be noted that the locations selected to represent reference water quality data could be impacted by atmospheric releases from WL operations. This is certainly the case for tritium, which in regions remote from any reactor facility in Canada is present at concentrations of about 3 Bq/L.

Table 12 and Table 13 serve to identify anomalous conditions and areas of potential impact. Some BVs represent the level above which ecological effects could potentially occur. For radioactive contaminants, the BVs are based on a combination of generic environmental concentrations below which no effects are expected [20], and site-specific concentrations, whereas non-radioactive contaminants consist of either generic toxicological benchmarks or provincial and federal water quality guidelines [21], [22], and [23]. Exceedance of a BV does not necessarily indicate that ecological impacts would occur, but instead indicates that there is some potential for ecological impacts.

Impacts on groundwater quality are assessed by subjecting the collected data to a systematic assessment process that includes screening against groundwater quality criteria and trend analysis.

For ambient gamma radiation in air, radioactivity is expressed in units of Grays or Sieverts per time unit, as appropriate. In all other cases, gross beta and gross alpha activity are measured, and expressed in units of Becquerel per weight, volume, or area. The gross activity measurements provide a good indication of the total radioactivity, and in most cases are supplemented with spectral measurements for individual radionuclides that may be responsible for the gross activity. For example, Outfall and Lagoon samples are analyzed for total uranium (U), plutonium-239/240 (Pu-239/240), plutonium-238 (Pu-238) and americium-241 (Am-241). The gamma spectrum is scanned for artificially produced radionuclides, as well as for naturally occurring ones such as potassium-40 (K-40) and beryllium-7 (Be-7). In many instances, it is apparent that the gross activity is mainly due to the natural radionuclides. For conservative estimates of dose caused by the activity, it is usually assumed that the gross activity is entirely caused by the most radiologically toxic radionuclide (one with the most restrictive DRL) that is usually assumed that the gross activity is entirely caused by the most radiologically toxic radionuclide (one with the most restrictive DRL) that is likely to be present in significant quantities in the specimens, and contribute to the parameter being measured, for example, Strontium-90 (Sr-90) for gross beta. Tritium analysis of selected surface and ground water samples and uranium analysis of groundwater samples continued this year. Non-radiological parameters were selected based on a review of the reference hazard information and on-site effluent data.

Whiteshell Laboratories' Environmental Management group maintains a complete set of sampling procedures, field-operating procedures, equipment performance checks, quality verification procedures, and laboratory administrative procedures.

Trends have been presented, for the period 2018 to 2023, along with the average values for the past five years. For the 2023 data, uncertainties based on standard deviations are shown. The method detection limits (MDLs) based on normal sample sizes and count times for the various analyses have been included in the tables. Values lower than the associated MDL are indicated as such by the less than symbol (<) along with the associated MDL value. The MDL for a given sample may vary due to differences in sample aliquot sizes, count times, and/or detector efficiencies. The MDL value has been included in the calculation of averages.

Incremental doses that could be caused by effluents from WL have been estimated for adults and infants in the critical group outside the WL site. It is assumed that these individuals ingest Winnipeg River water, Winnipeg River fish, game animals, and vegetables irrigated with

Winnipeg River water. In 2023 the consumption of water and fish from the Winnipeg River contributed to potential dose to the critical group.

Whiteshell Laboratories site biodiversity is also discussed, as waterborne and airborne contaminants from WL operations can have an impact on Valued Ecosystem Components (VECs) health and habitat. Section 6.9 identifies potential WL VECs, projects and permit requirements.

Table 11: Environmental Monitoring Radiological Method Detection Limits (MDL), Background Values and Benchmark Values

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
Air Quality and Noise	TLDs	µGy/a	85 [19]	< 1200 145-515	[24] [25]	< 2,000 (WL Main Campus)[20] < 10,000 (WL WMA. Canister Area)	[26] BV is the geometric mean plus 3 times the standard deviation of 2012 to 2017 (perimeter fence for main campus and canister area for WMA)
	Land Gamma Survey	nSv/h	10	< 60	[26] (mean plus 2s of background of 2012 to 2017 data)	< 500	[26]
	Noise	dB	28-42	47	[27]	85	[28]
Wet/Dry Deposition[21]	Gross Alpha	Bq/m^2	1	2	BG is mean plus (n-1) times the standard deviation of 2012 to 2017 [26]	3	[26], BV - average value for this station for 2012 to 2017 plus three standard deviations.
	Gross Beta	Bq/m^2	6	14		13 (17)	[29], BV in () is average value of results for this station for 2012 to 2017 plus three

18 MDLs were calculated using background or blank values as per EPA MDL method 40 CFR Part 136 Table 37 or are from Annual Compliance Monitoring Reports normally based on sample size, count times and counting statistics or value is from Contract Lab analysis sheet.

19 Detection limit calculated using background values from 2012 to 2017.

20 The benchmark values were assessed against radiological safety zone classifications. The main campus is expected to be very low radiation hazard (< 0.5 microsievert/hour/< 4380 microgray per year) and the WMA and Canister Areas are expected to be low radiation hazard (> 0.5 but less than 10 microsievert/hour/< 87600 microgray per year)

21 The MDL is based on a rain pail (1,320 cm^2) or snow sheet sample (1,320 cm^2) resulting in 0.2 g of sample ash and counted 100 min for gross beta and strontium-90 analysis, and 400 minutes for gross alpha or 800 min for cesium-137, and potassium-40 analysis.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
							standard deviations.
	Cesium-137	Bq/m^2	0.1	0.3		3 (0.3)	
	Potassium-40	Bq/m^2	6	12		14	[26], BV - average value for this station for 2012 to 2017 plus three standard deviations.
	Strontium-90 [22]	Bq/m^2	0.5	0.7		3 (1)	[28], BV () average value for this station for 2012 to 2017 plus three standard deviations.
Surface water (not used as drinking water)[23]	Gross Alpha	Bq/L	0.30	0.3	BG is geometric mean plus two times the standard deviation of 2009 to 2017 control locations data Maxxam[24] MDL	16.2 (20)	MDL based on Control Ditch Location data 2009 to 2018 [20], [30]
	Gross Beta	Bq/L	0.30	0.3		666 (10)	
	Potassium-40	Bq/L	10	0.3		291 3 (for WMA catch/ containment tray[25])	[22]
	Cesium-137	Bq/L	1	< 1	Maxxam[24] MDL	NA	Maxxam[24] MDL NA

22 Strontium-90 analysis of atmospheric deposition samples was discontinued in 2019. Tritium analysis was considered due to emissions from WR1 (1.5E+09 Bq/wk) but discounted as the average release of tritium from the site is 9E-05 %DRL.

23 Control ditch location unaffected by WL operations. These are normally collected s 1 liters samples and are ashed before alpha, beta and gamma counting.

24 Maxxam Analytics Inc., https://www.maxxamlabs.com/

25 Alert Environmental Specialist if the cesium-137 activity in the Catch/Containment Tray exceeds 3.0 Bq/L at any time.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
	Carbon-14	Bq/L	2	< 2	Maxxam[24] MDL [26]	200	Maxxam[24] MDL [22]
	Strontium-90	Bq/L	1	< 1	[26] Maxxam[24]/PACE[26] MDL	666 (10)	Maxxam[24]/PACE[26] MDL [20], [30]
	Technetium-99	Bq/L	0.2	< 0.2		200	Maxxam[24]/PACE MDL [22]
	Americium-241	Bq/L	0.05	< 0.05	Maxxam[24] MDL [26]	16.2 (20)	Maxxam[24] MDL [20], [30]
	Tritium oxide	Bq/L	8	< 8	[26]	1.27E+07 (1E+07)	MDL based on Control Ditch Location data 2009 to 2018 [20], [30]
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	0.025 (< 10[27])	[26]	2.5 (100)	[31]
Surface Water (Sumps and Water Relocation Samples within the WMA)[28]	Gross Alpha	Bq/L	10	< 10	[32]	16.2	[20]
	Gross Beta	Bq/L	10	< 10	[32]	666	[20]
	Tritium	Bq/L	8	< 8	[32]	7000 (12.7 MBq/L)	[20], [21]
	Cesium-137	Bq/L	5	< 5	[32]	291	[20]
	Americium-241	Bq/L	10	< 10	[32]	16.2	[20]
	Potassium-40	Bq/L	100	<100	[32]	NA	NA

26 PACE Analytics, https://www.pacelabs.com/

27 Local well waters within the Canadian Shield contain naturally occurring uranium [31] at concentrations >100 ppb, the presence of uranium and its progeny are not unexpected. The reason for high uranium concentrations can be attributed to the presence of dissolved carbonate which is effective for leaching naturally occurring uranium from minerals under oxidizing conditions.

28 Normally collected as a one litre samples, gamma MDL is based on counting a 500 mL sample for 30 minutes and three 1 mL samples counted for alpha and beta. These samples include sump water, manhole water and standing water from excavations. Gross alpha is assumed to be americium-241 and gross beta is assumed to be strontium-90.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
Surface water (used as drinking water)	Cesium-137	Bq/L	0.003	0.007	BG is average plus two standard deviations of 2007 to 2017 of upstream (SFD) data [26]	10	[21]
	Gross Alpha	Bq/L	0.023	0.050		0.5	[21]
	Gross Beta	Bq/L	0.023	0.090		5	[21]
	Potassium-40	Bq/L	0.040	0.087		NA	
	Strontium-90	Bq/L	0.003	0.009		5	[21]
	Americium-241	Bq/L	0.006	< 0.002		0.7	[22]
	Total Uranium	Bq/L (ppb)	0.003 (0.1)	0.025 (<10)		0.5 (20)	[21]
	Tritium oxide	Bq/L	3	7		7,000 (5.0 background level[29])	[21]
Fish	Gross beta	Bq/kg (fresh weight)	5	200	BG is the geometric mean plus 2 times the standard deviation of 2012 to 2017 upstream data (rounded) [26]	250	BV is geometric mean plus 5 times the standard deviation of 2012 to 2017 upstream data (rounded)
	K-40		6	200		250	
	Cs-137		1	1.7		4[30]	[26]
Game, Livestock	Gross alpha	Bq/kg (fresh weight)	5	<11	[33], [14]	33	[33], [14]
	Gross beta		5	Deer – 162 Grouse – 233	BG is the geometric mean plus 2 times the standard deviation of 2001 to 2016 data (outer areas)	Deer – 193 Grouse – 294	BV is 3 times the geometric mean of 2001 to 2016 data
	Cesium-137		1	Deer - 6 Grouse – 5		Deer [31] - 33 Grouse – 45	

29 Background levels of tritium taken from Health Canada's Canadian Radiological Monitoring Network – tritium in drinking water (saved as excel file).

30 The concentration of cesium-137 in fish would have to be 1750 Bq/kg to trigger an ALARA (0.05 mSv/a) review.

31 The concentration of cesium-137 in game would have to be 240 Bq/kg to trigger an ALARA (0.050 mSv/a) review.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
	Potassium-40		100	Deer - 149 Grouse – 260		Deer - 174 Grouse – 320	
	Strontium-90 (Deer bone)		8	64		80	
Honey	Tritium (free and OBT)	Bq/kg	HTO 30 OBT 19	HTO < 40 OBT < 19	[34]	HTO 2.5E6 OBT 1.3E6	[34], [9]
Native Vegetation	Gross alpha	Bq/kg (fresh weight)	60	90	[26], BG is geometric mean plus 2 standard deviation of 2012 to 2017 data [33], for BG value in ()	130	[26], BV is 3 times the geometric mean of 2012 to 2017 data
	Gross beta	Bq/kg (fresh weight	50	822		1550[32]	
	Potassium-40	Bq/kg (fresh weight	100	960		1550	
	Cesium-137	Bq/kg (fresh weight	7	13 (4)		21	
	Americium-241	Bq/kg (fresh weight	4	< 4		NA	
	Beryllium-7	Bq/kg (fresh weight	6	NA		NA	

32 Dose to meadow grass for gross beta as strontium-90 would be 0.02 mGy/d, which is well below the benchmark values of 100 µGy/h (2.4 mGy/d) for doses to terrestrial biota [29].

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
	Strontium-90	Bq/kg (fresh weight	6	7		8	[26], BV is 3 times the geometric mean of 2012 to 2017 data
	Tritium (free and OBT)	Bq/kg (fresh weight	HTO 10 OBT 4	HTO < 10 OBT < 4	[34]	HTO 104,000 OBT 45,200	[34]
Canola	Tritium (free and OBT)	Bq/kg (fresh weight)	HTO 30 OBT 8	HTO < 40 OBT < 8	[34]	HTO [33] 104,000 OBT 45,200	[34]
Garden Crop	Gross alpha	Bq/kg (fresh weight)	4	Fruit - < 6 Root - < 6 Leaf – < 20	MDLs are from Kinetrics[34], [26], BG is geometric mean plus 2 times standard deviation of 2012 to 2017 data	Fruit - 10 Root – 10 Leaf – 20	MDLs are from Kinetrics, BV is geometric mean plus 3 times standard deviation of 2012 to 2017 data [26], or 0.05 mSv/a potential dose (trigger for ALARA review) whichever is less.
	Gross beta	Bq/kg (fresh weight	13	Fruit - 110 Root - 190 Leaf – 1200		Fruit - 130 Root - 210 Leaf – 1600	
	Potassium-40	Bq/kg (fresh weight	10	Fruit – 120 Root - 220 Leaf – 1680		Fruit – 140 Root - 250 Leaf – 2300	

33 Values from the CNSC Implementation of Recommendations from the Tritium Studies Synthesis Report. The screening level for a particular radionuclide in a particular medium (e.g., water, air, foodstuffs) represents the activity concentration that would result in a dose of 0.1 mSv per year, a dose at which no health impacts are expected.

34 Kinetrics Engineering, Testing, kinetrics.com

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
	Cesium-137	Bq/kg (fresh weight	1	Fruit - < 1 Root - < 1 Leaf – < 1		Fruit - 2 Root - 2 Leaf – 1	
	Americium-241	Bq/kg (fresh weight	4	Fruit – < 4 Root - < 4 Leaf – < 4		Fruit - 6 Root - 4 Leaf – 6	
	Beryllium-7	Bq/kg (fresh weight	8	Fruit - 24 Root - 30 Leaf – 110		Fruit - 1000 Root - 1000 Leaf – 1000	BV is based on a <0.005 mSv/a dose to a member of the public
	Strontium-90	Bq/kg (fresh weight	0.1	Fruit - 5 Root - 5 Leaf – 9		Fruit - 10 Root - 10 Leaf – 20	BV is geometric mean plus 3 times standard deviation of 2012 to 2017 data (rounded), [26]
Soil (WMA)	Gross alpha	Bq/kg	100	970	Maxxam[24] Lab MDL, BG data is mean plus 2s of non-impacted areas (B408, B409, B415, B416, B428) land clearance samples [33], for BG value for Cs-137	1E+05	Maxxam[24] Lab MDL, BVs from [30]
	Gross beta	Bq/kg	100	1800		8E+02 [35]	
	Potassium-40	Bq/kg	3	750		900[36]	
	Cesium-137	Bq/kg	10	20 to 110 Bq/kg		8E+02	
	Americium-241	Bq/kg	10	< 10		1E+05	
	Strontium-90	Bq/kg	100	< 100		2E+06	

[35] Gross beta is assessed after potassium-40 contribution and cesium-137 contributions are removed and residual is assumed to be strontium-90/yttrium-90.

[36] BV for potassium-40 is mean plus 3 standard deviations of unaffected area soils.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
Soil (Land Clearance)	Gross alpha	Bq/kg	100	970	Maxxam[24] Lab MDL, BG data is mean plus 2s of non-impacted areas (B408, B409, B415, B416, B428) land clearance samples	2436 (agriculture land use)	Maxxam[24] Lab MDL, BVs from[35][37]
	Gross beta	Bq/kg	100	1800		478[38]	
	Potassium-40	Bq/kg	3	750		900	
	Cesium-137	Bq/kg	10	< 10		478	
	Americium-241	Bq/kg	10	< 10		2436 (agriculture land use)	
	Strontium-90	Bq/kg	100	< 100		196	
Sediment	Gross alpha	Bq/kg	240	600		(1100) 2E+05 [30] 1000 [36] as natural uranium	MDL is three times the standard deviation of the 2012 to 2017 data from the upstream locations. BV in () is 3 times (rounded) the geometric mean of 2012 to 2017 data for upstream locations DOE Graded Approach to Evaluating Radiation Doses to Aquatic and Terrestrial Biota [20] NSRDR Unconditional Clearance Level [36]
	Gross beta	Bq/kg	350	900		(1900) 2E+04 [30]	
	Potassium-40	Bq/kg	420	900		(1800) 10,000 [36]	
	Cesium-137	Bq/kg	13	< 20		(28) 1E+05 [30] 100 [36]	
	Americium-241	Bq/kg	10	< 10		(1100) 2E+04 [20] 100 [36]	

[37] The soil BV is the soil activity concentration resulting in a 0.1 mSv/a dose for the residential land use identified in Table 3-2 of WL-509420-REPT-001 [35].

[38] Gross beta is assessed after potassium-40 contribution and cesium-137 contributions are removed and residual is assumed to be strontium-90/yttrium-90.

Environmental Medium	Parameter	Unit	MDL[18]	Background Value (BG)	Source	Benchmark Value (BV)	Source
	Strontium-90	Bq/kg	100	< 100		(1900) 2E+05 [20] 1000 [36]	

Table 12: Non-Radioactive Background and Benchmark Values for the Whiteshell Laboratories Site and Their Comparison to Current Laboratory Method Detection Limits (LMDL)

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
Surface Water[39]							
3	pH	pH unit	--	7.6	Maxxam[24] MDLs BG- Mean plus 2 s of the 2003 to 2017 of Control location data	6.5-9.0	[23]
6	Phosphorus (Total)	µg/L	5	230		270	BV Mean (2003 to 2017) plus 3s (ditch control location data)
7	Conductivity	µS/cm	1.0	620		740	
9	Barium, (Total)	µg/L	1.0	75	Maxxam[24] MDLs BG - Mean plus 2 s of the 2016-2018 of Control location data	1000	[21]
9	Beryllium, (Total)	µg/L	0.10	< 0.10		100	[37]
9	Boron, (Total)	µg/L	50	< 50		500	[37]
9	Cadmium, (Total)	µg/L	0.01	< 0.01		0.09	[23]
9	Chromium, hexavalent (Cs(VI))	µg/L	0.5	To be assessed	Maxxam[24] MDL	1.0	[23]
	Chromium, trivalent (Cr(III))	µg/L	1	To be assessed	Maxxam[24] MDL	8.9	[23]
9	Cobalt, (Total)	µg/L	0.2	0.8	Maxxam[24] MDLs, BG- Mean plus 2 s of the 2016-2018 of Control location data	0.9	[38]
9	Copper, (Total)	µg/L	0.5	15	BG - Mean plus 2 s of the 2003 to 2017 of Control location data Maxxam[24] MDLs,	20	BV Mean (2003 to 2017) plus 3s (ditch control location data)]
9	Lead, (Total)	µg/L	0.2	0.3		6	

39 Control Ditch Location data for comparison to ditch water, landfill dugout, catch/containment tray, sump water, manhole water and standing water from excavations.

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
9	Molybdenum, (Total)	µg/L	1.0	4	BG- Mean plus 2 s of the 2016-2018 of Control location data	25	[23]
9	Nickel, (Total)	µg/L	1.0	4.6	BG- Mean plus 2 s of the 2003 to 2017 of Control location data	7	(2003 to 2017) plus 3s (ditch control location data)
9	Selenium, (Total)	µg/L	0.10	0.24	Maxxam[24] MDLs, BG is Mean plus 2 s of the 2016-2018 of Control location data	1.0	[37]
9	Silicon, (Total)	µg/L	100	8340		9950	BV mean (Ditch Control location-2017, 2018) plus 3SD
9	Silver, (Total)	µg/L	0.020	< 0.02		0.25	[23]
9	Strontium, (Total)	µg/L	1.0	350		7000	[21]
9	Thallium, (Total)	µg/L	0.10	0.04		0.8	[23]
9	Tin, (Total)	µg/L	5.0	< 5		30	BV mean (2017, 2018) plus 3SD
9	Titanium, (Total)	µg/L	5.0	10		30	BV mean (2017, 2018) plus 3SD
9	Vanadium, (Total)	µg/L	5.0	< 5		30	BV mean (2017, 2018) plus 3SD
9	Zinc, (Total)	µg/L	5.0	18	Maxxam[24] MDLs, BG- Mean plus 2 s of the 2003 to 2017 of Control location data	1000	[37]
9	Zirconium, (Total)	µg/L	0.10	1	Maxxam[24] MDLs, BG - Mean plus 2 s of the 2016-2018 of Control location data	37	[23]
9a	Iron, (Total)	µg/L	10	840	Maxxam[24] MDLs BG - Mean plus 2 s of the 2003 to 2017 of Control location data	1000	Mean plus 3s of the 2003 to 2017 of Control location data
9a	Magnesium, (Total)	µg/L	1.0	84,000	Maxxam[24] MDLs BG- mean (2017, 2018) plus 2 s	110,000	BV - Mean plus 3s of the 2016 to 2018 of Control location data
-	Sodium, (Total)	mg/L	0.05	43,000		200,000	[21]

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
10	Arsenic, (Total)	µg/L	0.10	2.6		5	[23]
12	Mercury, (Total)	µg/L	0.0020	0.098	Maxxam[24]MDLs BG- Mean plus 2 s of the 2003 to 2017 of Control location data	0.13	Mean plus 3s of the 2003 to 2017 of Control location data
14	Phenolics (4AAP)	mg/L	0.001	0.005	Maxxam[24] MDLs, BG - Mean plus 2 s of the 2003 to 2017 of Control location data	0.007	BV - Mean plus 3s of the 2003 to 2017 of Control location data
16	Trichloroethylene (trichloroethene)	µg/L	0.5	< 0.5		21	[37]
17	Benzene, Toluene, Ethylbenzene, Xylene	µg/L µg/L µg/L µg/L	0.40 0.40 0.40 0.40	< 0.4 < 0.4 < 0.4 < 0.4	Maxxam[24] MDLs, BG – 2017, 2018 landfill dugout	370 2 90 300	[23] [23] [23] [37]
17	Acetone	µg/L	15	< 15	Maxxam[24] MDLs, BG is less than MDL	>45	BV is three times MDL
19	Extractables, Neutral di-n-butyl Phthalate (DBP) Di-2-Ethylhexyl Phthalate (DEHP),	µg/L µg/L	NA NA	To be assessed	NA	19 16	[23]
20	Extractables, Acid (Phenolics)	mg/L	0.001	0.005	BG - Mean plus 2 s of the 2003 to 2017 of Control location data	4	[23]
23	Extractables, Chlorinated (chlorobenzenes)	µg/L	0.50	< 0.5	Maxxam[24] MDLs, BG – 2017, 2018 landfill dugout	1.8	[23]

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
25	Solvent Extractables (Oil and Grease)	mg/L	1.0	2	Mean plus 2 s of the 2003 to 2017 of Control location data Maxxam[24] MDLs	2.5	Mean plus 3s of the 2003 to 2017 of Control location data
30	Chloride	mg/L	1.0	20	Maxxam[24] MDLs, BG – 2017, 2018 landfill dugout	640	[23]
30	Sulphate	mg/L	1.0	110		500	[21]
30	Nitrate (N)	mg/L	0.02	0.07		550	[23]
30	Nitrite (N)	mg/L	0.005	0.04		60	[23]
Soils[40]							
	pH	NA	NA	6 to 8	Maxxam[24] MDLs,	6 to 8	CCME [39]
9	Antimony	mg/kg	0.5	0.5	Maxxam[24] MDLs, BG – mean plus 2 s of B408, 409, 415, 416, 418 428 clearance samples	20 (agriculture)	CCME [39]
9	Barium	mg/kg	1.0	180		750 (soil, agriculture)	CCME [39]
9	Beryllium	mg/kg	0.40	1		4 (8)	CCME [39]
9	Cadmium	mg/kg	0.050	0.7		1.4 (22)	CCME [39]
9	Chromium	mg/kg	1	45		64 (87)	CCME [39]
9	Cobalt	mg/kg	0.30	20		40 (300)	CCME [39]
9	Copper	mg/kg	0.50	35	Maxxam[24] MDLs, BG – mean plus 2 s of B408, 409, 415, 416, 418 428 clearance samples	63 ((1)	CCME [39]
9	Lead	mg/kg	0.10	20		70 (600)	CCME [39]
9	Molybdenum	mg/kg	0.10	1		5 (40)	CCME [39]
9	Nickel	mg/kg	0.80	40		45 (89)	CCME [39]

[40] Soil from non-impacted areas

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
9	Selenium, (Total)	mg/kg	0.50	1.2		1 (agriculture), 6	CCME [39], BV- mean plus 3s of B408, 409, 415, 416, 418 428 clearance samples
9	Silver, (Total)	mg/kg	0.20	0.6		20 (agriculture)	CCME [39]
9	Thallium, (Total)	mg/kg	0.10	0.4	Maxxam[24] MDLs, BG – mean plus 2 s of B408, 409, 415, 416, 418 428 clearance samples	1 (agriculture)	CCME [39]
9	Tin, (Total)	mg/kg	1.0	1.1		5 (agriculture)	CCME [39]
9	Uranium, (Total)	mg/kg	0.20	1.8		23 (soil, agriculture)	CCME [39]
9	Vanadium, (Total)	mg/kg	1.0	70		130 (soil, agriculture)	CCME [39]
9	Zinc	mg/kg	1.0	100		200 (360)	CCME [39]
9a	Iron	mg/kg	50	30,000 (>3%) {30, 330}	Maxxam[24] MDLs, BG Background Level in WL region of Manitoba [40] and {BG – mean plus 2 s of B408, 409, 415, 416, 418 428 clearance samples}	30,000 (>3%)	BV Background Level in WL region of Manitoba [40]
10	Arsenic	mg/kg	0.50	8	Maxxam[24] MDLs, BG – mean plus 2 s of B408, 409, 415, 416, 418 428 clearance samples	12 (12)	CCME [39]
12	Mercury	mg/kg	0.050	< 0.07		6.6 (50)	CCME [39]
17	Benzene	mg/kg	0.0050	< 0.005	Maxxam[24] MDLs, BG- B409 clearance samples	0.0068	CCME Tier 1 Levels [41]
	Toluene	mg/kg	0.020	< 0.02		0.08	CCME Tier 1 Levels [41]
	Ethyl Benzene	mg/kg	0.010	< 0.01		0.018	CCME Tier 1 Levels [41]
	Xylene	mg/kg	0.040	< 0.04		2.4	CCME Tier 1 Levels [41]
	F1 (C6-C10)	mg/kg	10	< 10		210 (320)	CCME Tier 1 Levels [41]

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
	F2 (C10-C16)	mg/kg	20	23	Maxxam[24] MDLs, BG- B409, 416, 418 and 428 clearance samples	150 (260)	CCME Tier 1 Levels [41]
	F3 (C16-C34)	mg/kg	20	60		1300 (2500)	CCME Tier 1 Levels [41]
	F4 (C34-C50)	mg/kg	20	60		5600 (6600)	CCME Tier 1 Levels [41]
Sediments[41]							
9	Antimony, (Total)	mg/kg	0.5	To be assessed	Maxxam[24] MDLs	20 (soil, agriculture)	CCME [39]
	Barium, (Total)	mg/kg	1.0	To be assessed	Maxxam[24] MDLs	750 (soil, agriculture)	CCME [39]
9	Beryllium, (Total)	mg/kg	0.4	< 1.3	Maxxam[24] MDLs, CSR [42]	4 (soil, agriculture)	CCME [39]
9	Cadmium, (Total)	mg/kg	0.05	< 1.3		0.6	[39]
9	Chromium, (Total)	mg/kg	1.0	4.9		37.3	[39]
9	Cobalt, (Total)	mg/kg	0.50	2.4		40 (soil, agriculture)	CCME [39]
9	Copper, (Total)	mg/kg	1.0	2.4		35.7	[39]
9	Lead, (Total)	mg/kg	0.50	< 1.3		35	[39]
9	Molybdenum, (Total)	mg/kg	0.40	2.8		5 (soil, agriculture)	CCME [39]
9	Nickel, (Total)	mg/kg	1.0	4.7	Maxxam[24] MDLs, CSR [42]	45 (soil, agriculture)	CCME [39]
9	Selenium, (Total)	mg/kg	0.50	To be assessed	Maxxam[24] MDL	1 (soil, agriculture)	CCME [39]
9	Silver, (Total)	mg/kg	0.20	< 1.4	Maxxam[24] MDL, CSR [42]	20 (soil, agriculture)	CCME [39]

41 From upstream location

ATG	Parameter	Unit	LMDL	Non-Radioactive Background Value	Ref	Non-Radioactive Benchmark Value	Ref
9	Thallium, (Total)	mg/kg	0.10	To be assessed	Maxxam[24] MDL	1 (soil, agriculture)	CCME [39]
9	Tin, (Total)	mg/kg	1.0	To be assessed	Maxxam[24] MDL	5 (soil, agriculture)	CCME [39]
9	Uranium, (Total)	mg/kg	0.20	To be assessed	Maxxam[24] MDL	23 (soil, agriculture)	CCME [39]
9	Vanadium, (Total)	mg/kg	1.0	3.9	Maxxam[24] MDLs, CSR [42]	130 (soil, agriculture)	CCME [39]
9	Zinc, (Total)	mg/kg	10	10.8		123	CCME [39]
10	Arsenic, (Total)	mg/kg	0.50	To be assessed	Maxxam[24] MDL	5.9	[43]
12	Mercury, (Total)	mg/kg	0.05	0.0034	CNL MDLs, CSR [42]	0.17	[43]
-	Total Organic (as HB 40)	mg/kg	1	< 60		75	CSR [42]

6.2 Waterborne Contaminants

Figure 3 summarizes the sources of surface water contaminants and the paths taken by these contaminants to reach the Winnipeg River. Some surface waters in the WL Supervised Area are affected by past and present activities at the WMA, and are routinely monitored for radioactive contaminants as part of the Effluent Verification Monitoring Program, operational control monitoring and the Environmental Monitoring Program. The results of the effluent verification and operational control monitoring are found in the WL Annual Compliance Monitoring Report [8].

These surface waters are not used for human consumption. With the current restrictions on access, members of the public are not permitted on the WL site without authorization and direct supervision. The potential health risks to humans are therefore limited to the discharge of contaminants to the Winnipeg River and liquid effluent outfall.

This monitoring is complemented by routine groundwater monitoring. Groundwater is often the initial pathway for the migration of dissolved contaminants released from past and present activities at the WMA, and (inadvertently) from some facilities in the built-up portion of the WL site. The measurement of groundwater quality around the perimeters of such facilities and WMA provides a way to monitor the condition and behaviour of the facilities and operations. The Ground Water Monitoring Program [44] was established for this purpose. Groundwater monitoring results are discussed in Section 6.3.

Table 2 provides a summary of the monitoring schedule including a list of parameters analyzed in ground and surface waters.

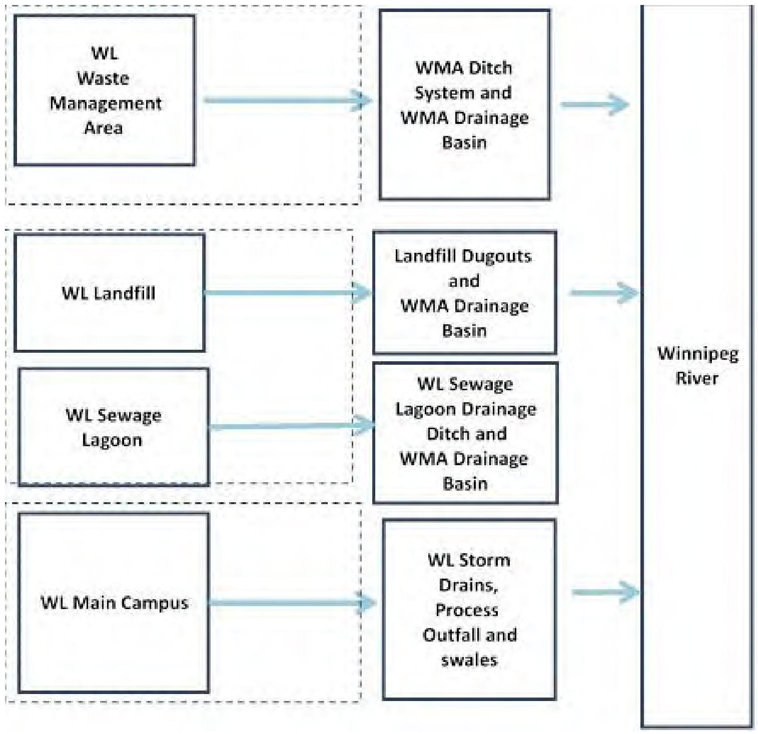

Figure 3: Whiteshell Laboratories Site Model Overview

6.3 Groundwater within the Whiteshell Laboratories Site

The viability of the borehole network is integral to demonstrating the robustness of the geological and hydrogeological barrier system. Activities undertaken as part of the ongoing assessment of the WMA, Lagoon and Landfill physical and chemical hydrogeological conditions [44], [45] and the work tasks in the EAFP have ensured on-going inspection of the existing well network. Current well locations are shown in Figure 23 and Figure 24 in Appendix A. The stratigraphic units sampled by wells in various locations include the shallow Bedrock which is overlain by the Basal unit (with sand and gravel giving higher hydraulic conductivity). The Basal unit is overlain by lower permeability Clay Till and Clay.

The Bedrock well at the WMA was installed to complete the network required to validate the conceptual model and lower boundary of groundwater flow at the WMA (see Figure 26 in Appendix A). The wells at the upland recharge area were installed to monitor the recharge conditions in the sand aquifer that contributes to discharge conditions at the WMA. The wells at the landfill were installed to verify the absence of flow from the landfill to the east. Ongoing monitoring confirms that groundwater flow is to the south and southwest, away from the Pinawa Channel.

Manual water level monitoring is conducted in the spring and fall in all 500-series wells. Evaluation of the data has determined that the groundwater flow conditions vary seasonally, and the spring and fall periods provide adequate representation of overall flow conditions needed for on-going assessment. The reduced requirement for manual measurements is offset by a recommendation for additional automated water level recording at the WMA, Lagoon and Landfill.

A review of the radiological and non-radiological source term for the facilities, and confirmation of flow conditions in the Clay, Clay Till and Basal stratigraphic units, has allowed for a refinement of the selection of wells and target parameters of potential concern. This effort is part of the WL Decommissioning Project Environmental Assessment Follow-Up Program [1], which requires that CNL refine and enhance the monitoring already in place at WL.

The routine environmental monitoring program has been, and will continue to be, modified to include the recommendations presented as part of the on-going assessment. Further discussion on the recommendations for the groundwater monitoring program and how these will improve the existing program is included in the EAFP report [7]. The complete results of the assessment will be included in the WL Decommissioning Project Environmental Assessment reports generated as part of the EAFP.

6.3.1 Radiological Monitoring of the Groundwater

Analysis of the groundwater for radiological parameters (gross beta, gross alpha, tritium and uranium) was conducted during 2023. Samples were collected from the Basal zone wells of the WMA during the spring and fall. They were also collected from selected locations in the Basal zone and water table of the Lagoon and Landfill area during the spring.

6.3.1.1 WMA

Water samples were collected from water table and deep wells in and around the WL WMA in spring and fall of 2023. The locations of all wells and piezometers are shown in Figure 23 and Figure 24 in Appendix A. Figure 26 (Appendix A) indicates the location of WL Facilities and surface drainage and layout.

The wells are in supervised areas within the WL site boundary. Discharge conditions were predominant in 2008 to 2023 although there was a very small area in the central portion of the WMA that had slight recharge conditions in 2023.

The WMA well data is reviewed based on the geologic unit it resides in as recommended in the groundwater monitoring plan [44]. This would allow for interpretation of the flow of parameters detected. Vertical flow occurs in the surficial Clay unit and in the intermediate Clay Till unit. The head gradient is upward leading the water in these layers to discharge to the surface. The surface water is monitored through the ditch network. Lateral flow occurs in the deeper Basal unit, and over the Bedrock. The low permeability of the Clay and Clay Till layers serve as a natural barrier to the groundwater as they retard the movement of potential contaminants. The facilities in the WMA reside at depths within the Clay and-Clay-Till units. The pathways that can potentially result in lateral contamination migration away from each facility area are of particular interest.

The tritium, uranium, gross beta and gross alpha results for the samples collected from the wells in the WMA during the spring and fall of 2023 are summarized in Table 41 in Appendix B.

Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurement for gross alpha and gross beta is less than 0.5 Bq/L and 1.0 Bq/L, respectively. If the level of the gross beta measurement exceeds 1 Bq/L the samples are submitted for gamma spectrometric analysis for cesium-137 and potassium-40. If the gross alpha activity exceeds 0.5 Bq/L the samples are submitted for gamma spectrometry to check for gamma emitting radionuclides, such as Am-241.

Average gross beta, gross alpha and uranium activity results are presented in Table 13. The table includes data dating back to 2013 to provide a better indication of temporal trends. The alpha activity in the basal and bedrock zones was below the screening level of 0.5 Bq/L [21]. The alpha activity was above the screening level in a few wells in the clay and clay-till zones. The well (BHS 500-140) installed during 2021 in the clay-till south of the WMA still measured the highest gross alpha (5.60 Bq/L) and uranium (261 ppb) activity, although the alpha activity was a factor 10 lower than when it was first sampled in 2022. This is higher than in any other well in the vicinity of the WMA, and is similar to the uranium concentrations and alpha activities observed in main campus wells. The high alpha is a consequence of the high uranium which is naturally present. It is natural uranium and not from the WMA for the following reasons:

- the groundwater flow direction is east to west and not north to south which would bring uranium from the WMA to this location,
- such uranium concentrations are not observed elsewhere in the WMA,
- these high uranium concentrations can be expected in the Whiteshell area, as discussed below,
- these concentrations are also observed on the main campus upstream from the WR-1 reactor.

The spatial distribution of alpha activity in the clay and clay-till zones is illustrated in Figure 28 in Appendix A. Gamma spectrometry and uranium analysis were performed on those samples above 0.5 Bq/L. As noted in previous years, the 2023 gamma spectrometry analysis indicated only the presence of naturally occurring potassium-40 and uranium progeny. Uranium and its progeny would contribute to the alpha activity in the samples. The distribution of dissolved uranium in the clay and clay-till zones is illustrated in Figure 29 (Appendix A).

Concentrations of uranium in the bedrock groundwater ranged from 0.23 to 2.31 ppb. Concentrations in the Clay zone wells ranged from 11.5 to 96.9 ppb, and in the Clay Till from 0.10 to 261 ppb (Table 41 in Appendix B). The waters from a number of wells from the Clay and Clay Till were above the Drinking Water Limit of 20 ppb (0.5 Bq/L) for uranium. Since it is known that the local well waters within the Canadian Shield contain naturally occurring uranium [46] at concentrations >100 ppb, the presence of uranium and its progeny are not unexpected. The reason for high uranium concentrations can be attributed to the presence of dissolved carbonate which is effective for leaching naturally occurring uranium from minerals under oxidizing conditions.

The beta activity levels in bedrock and the basal zone wells remained well below the drinking water screening level of 1 Bq/L. In 2023, with six exceptions, groundwater beta activities in the Clay zone and Clay Till were also below the drinking water screening level. Gamma analysis indicated the presence of naturally occurring potassium-40 and uranium progeny, both of which would contribute to the beta activity in the samples. No anthropogenic isotopes such as cesium-137 or Co-60 were detected in the samples.

Tritium was detected in samples collected from the clay-till wells BHS 79-2 (9 Bq/L), BHS 500-99 (22 Bq/L), BHS 500-102 (56 and 53 Bq/L), BHS 500-78 (15 Bq/L), and BHS 500-96 (20 Bq/L). The clay zone had detected tritium in BHS 500-103 (57 and 45 Bq/L), BHS 500-101 (8 and 10 Bq/L) and BHS 30 (25 Bq/L). Tritium was also found in the basal wells BHS 500-63 (22 Bq/L), BHS 500-71 (15 Bq/L) and BHS 86 (7 Bq/L). Tritium detection occurs in the area where transient reversals in recharge / discharge conditions have been noted in the WMA [7]. Tritium lateral distributions in the basal, clay-till and clay units are depicted in Figure 30 in Appendix A. These results are less than the Drinking Water guideline for tritium of <7000 Bq/L [21].

The WMA contains a number of trenches with varying amounts of low-level radioactive and conventional waste. Trench 7, located at the southeast end of the WMA, contains 87% of the inventory of tritium in the WMA. Some of the wells having elevated levels of tritium appear to be near or in the flow direction from Trench 7. There are unlined trenches in the north end of the WMA that also contain tritium. The contamination migration model [47] for the WMA unlined trenches proposed that tritium would be mobile and potentially present in the ground and surface water around the WMA. Contaminant migration modeling also indicated in-situ disposal provided no significant risk to human health or the environment.

The average alpha, beta and uranium activities in the WMA wells within the clay, clay-till, bedrock, and basal zone for the past five years are shown in Table 13 and displayed in Figure 4, Figure 5 and Figure 6. There is general agreement between the gross alpha and the uranium concentrations from year to year as shown in Figure 5 and Figure 6. Activity levels are fairly similar taking uncertainty into account.

The average beta activity (0.37 Bq/L) for the wells located in the basal sand is higher than the average, but remains below the drinking water screening level (1 Bq/L) [21] as noted in the years since 2011, and lower than that seen in the clay and clay-till wells. The clay (0.61 Bq/L) was higher than in 2022, while the clay-till (0.64 Bq/L) zone was lower than 2022 levels, but higher than the average for the previous five years. The average beta activity in the bedrock (0.29 Bq/L) is less than the 2022 value and higher than the average of previous five years since 2018.

The average alpha activities in the basal and bedrock zone wells (0.29 Bq/L and 0.31 Bq/L, respectively) are below the screening level (0.5 Bq/L) [21]. The values seen for the basal zone wells are lower than those in 2022 but higher than the average values for the previous five years. The average bedrock alpha activity is lower than in 2022, but higher than the five year average. The average alpha activities in the clay zone (0.67 ± 0.39 Bq/L) are higher than 2022 and less than the five year average. Alpha activities in clay-till zone (0.94 ± 1.18 Bq/L) are lower than in 2022 and the average of previous five years. The average uranium activities in the clay and clay-till (0.80 and 0.91 Bq/L, respectively) are above the screening level, which is not unexpected due to the contributions from natural uranium. Some variation in the alpha activity is noted and no persistent pattern from year to year has been observed.

The average uranium activity in the clay zone is slightly lower than the average of previous five years. The average uranium activity in the clay-till wells was higher than the past five years and remains elevated from that seen in the basal and bedrock zones. The uranium activity in the basal zone wells hovers around the detection limit for most locations.

The average overall activities in the clay and clay-till wells are higher than that noted in the basal zone wells. The activity associated with the clay zone wells has been generally the highest. However, with the addition of the new well south of WMA the average clay-till activities are the highest.

Based on the results of total beta, total alpha and uranium activity it is difficult to say whether vertical or lateral movement of radionuclides from the WMA facility has occurred, particularly since these activities were most likely from natural sources. Tritium would provide the best indication of contaminant migration from the facility. As mentioned above, there is some evidence that migration of tritium has occurred.

Table 13: Annual Mean-Gross Alpha, Gross-Beta and Uranium Radioactivity in Waste Management Area Monitoring Wells and Piezometers, 2013 to 2023

Gross Beta* (Bq/L)															
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Average(1)**	**MDL**	**2023**		
Clay	1.18	0.83	1.21	0.67	0.35	0.29	0.45	0.35	0.43	0.48	0.40	0.03	0.61	±	0.46
Clay-Till	0.72	0.55	0.86	0.54	0.36	0.25	0.29	0.31	0.45	1.23	0.51	0.03	0.64	±	0.60
Basal	0.43	0.29	0.64	0.39	0.16	0.13	0.34	0.14	0.25	0.46	0.26	0.03	0.37	±	0.10
Bedrock	0.49	0.50	0.82	0.47	0.15	0.15	0.15	0.16	0.32	0.44	0.24	0.03	0.29	±	0.04
Gross Alpha* (Bq/L)															
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Average(1)**	**MDL**	**2023**		
Clay	0.72	0.60	0.54	1.05	1.01	1.03	0.94	0.74	0.67	0.64	0.80	0.05	0.67	±	0.39
Clay-Till	0.50	0.35	0.36	0.60	0.77	0.72	0.68	0.66	0.58	3.44	1.21	0.05	0.94	±	1.18
Basal	0.19	0.16	0.20	0.18	0.10	0.12	0.22	0.13	0.19	0.32	0.20	0.05	0.29	±	0.10
Bedrock	0.35	0.55	0.38	0.33	0.17	0.25	0.12	0.35	0.42	0.50	0.33	0.05	0.31	±	0.12
Uranium (Bq/L)**															
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Average(1)**	**MDL**	**2023**		
Clay	0.93	0.81	1.01	0.86	0.90	0.88	0.92	0.83	0.82	0.76	0.84	0.001	0.80	±	0.60
Clay-Till	0.50	0.54	0.53	0.55	0.52	0.62	0.65	0.59	0.55	0.77	0.64	0.001	0.91	±	1.35
Basal	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.04	0.03	0.02	0.03	0.001	0.02	±	0.05
Bedrock	0.03	0.09	0.02	0.04	0.02	0.06	0.02	0.04	0.06	0.03	0.04	0.001	0.02	±	0.02

Notes:

1. Average of previous five years.
2. NA = not available
3. Uncertainties are expressed as the standard error of the mean for average activities measured.
4. ***Maximum Acceptable Concentration in Drinking Water for gross beta (as strontium-90) is 5.0 Bq/L, for gross alpha (as uranium) is 0.5 Bq/L, and for uranium is 0.5 Bq/L, as specified by Health Canada [21].

****Uranium concentrations were converted from µg/L to Bq/L by using the generally accepted conversion factor of 0.025 Bq/mg uranium [21].

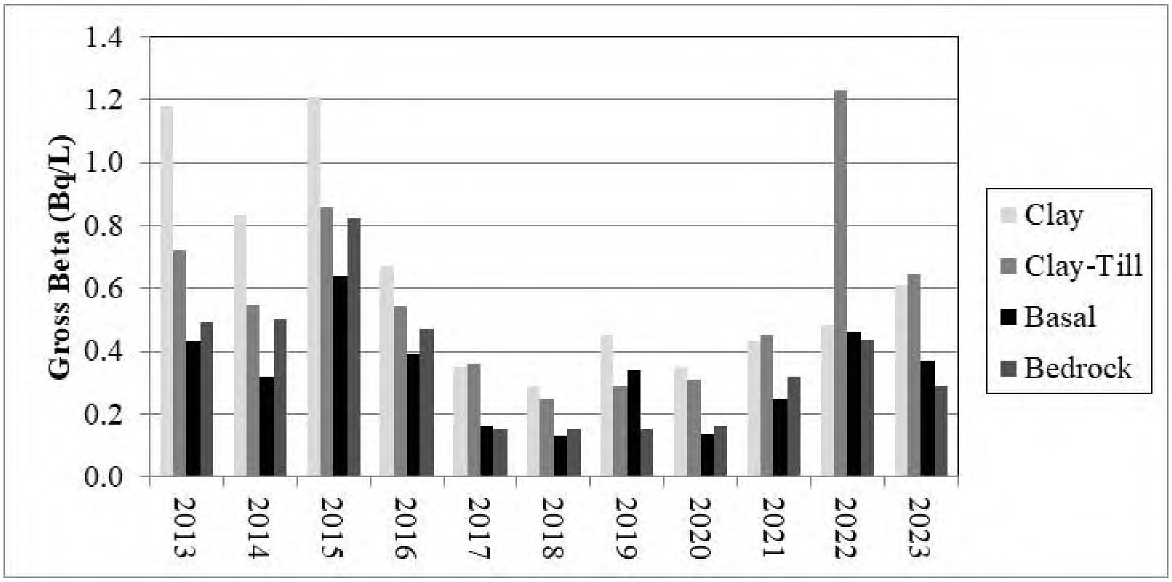

Figure 4: Gross Beta Activity in WMA Wells, 2013 to 2023

The MAC for gross beta in drinking water (as strontium-90), specified by Health Canada, is 5 Bq/L [21].

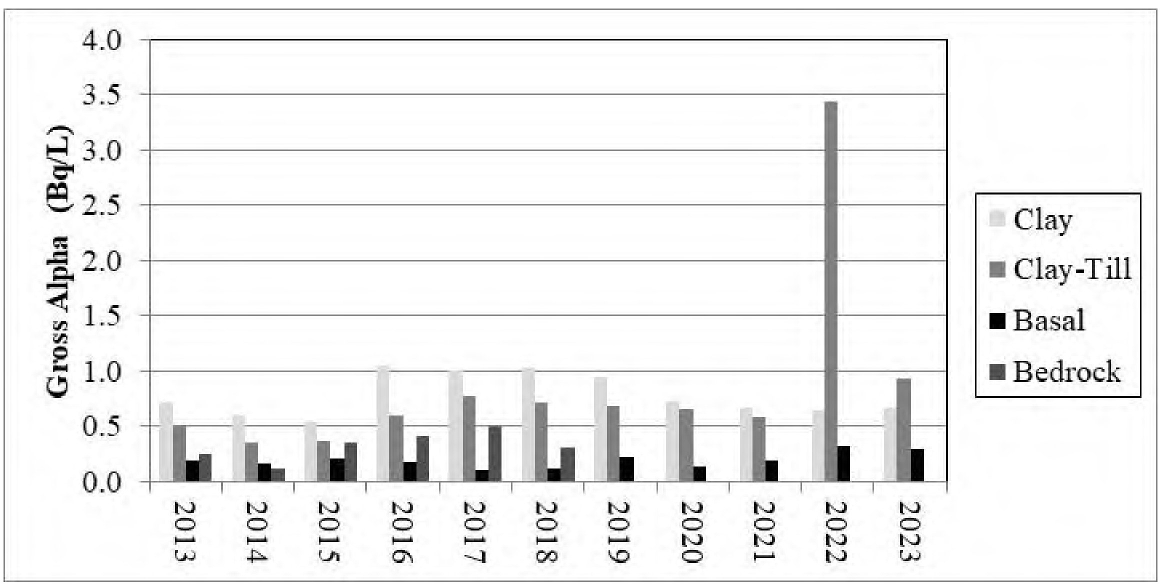

Figure 5: Gross Alpha Activity in WMA Wells, 2013 to 2023

The MAC for gross alpha in drinking water (as natural uranium) is 0.5 Bq/L [21].

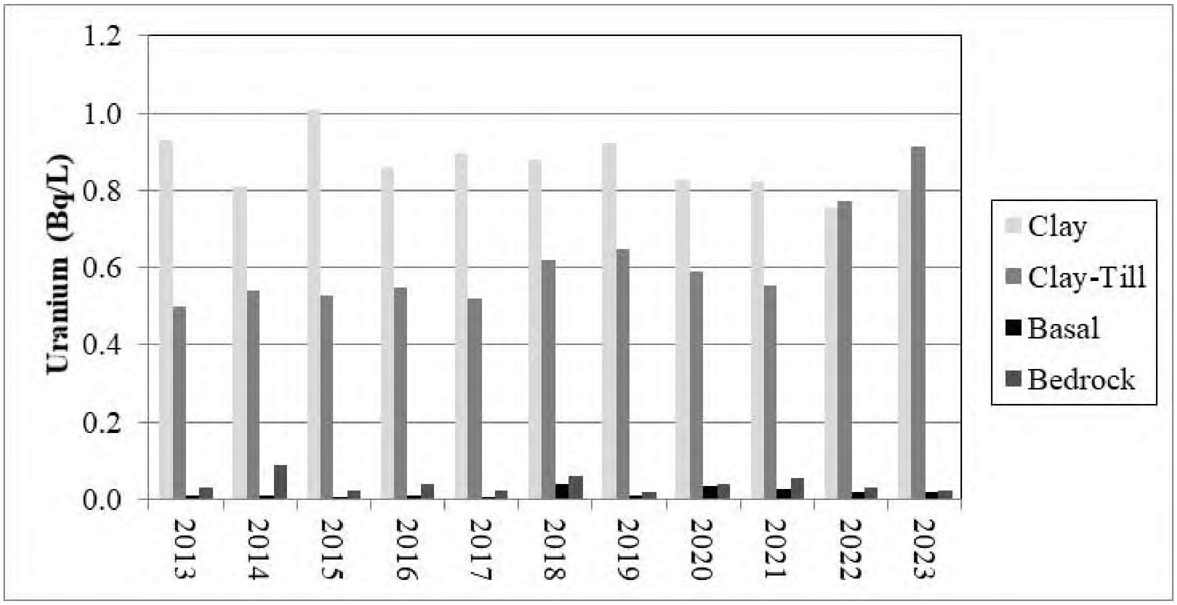

Figure 6: Uranium Activity in WMA Wells, 2013 to 2023

6.3.1.2 Lagoon and Landfill

Samples were collected from the wells in the Lagoon and Landfill areas on site during the spring of 2023. The uranium, tritium, gross alpha and gross beta results are summarized in Table 42 and Table 43 in Appendix B.

In 2023 the gross beta activities in all water table wells in the lagoon area were below the drinking water screening level (1 Bq/L). Basal unit well BHS 500-14 (1.39 Bq/L) had gross beta above the drinking screening level. Gamma spectrometry of these samples indicated the presence of naturally occurring potassium-40 and uranium progeny. This would account for the elevated gross beta. Two of the four water table wells and all basal unit wells in the lagoon area had alpha activity levels at or above the screening level of 0.5 Bq/L. Gamma analysis of the remaining wells indicated the presence of naturally occurring uranium progeny. In addition, all samples contained uranium in concentrations ranging from 11 to 158 ppb with the highest levels noted in the basal unit. Uranium and its progeny are contributors to the total alpha activity. The Drinking Water Limit for uranium is 20 ppb. Local well waters within the Canadian Shield [31], [48] contain naturally occurring uranium (>100 ppb) and therefore its presence at these levels is not unexpected.

The beta activities detected in the landfill wells were below the screening level of 1.0 Bq/L. All alpha activities in the landfill wells were below the screening level of 0.5 Bq/L. All samples were below the Drinking Water Limit for uranium (20 ppb).

Tritium in the Landfill wells was detected in wells BHS 500-4 (7.14 Bq/L), BHS 500-13 (4.2 Bq/L), and BHS 500-56 (24.92 Bq/L). All were well below the Drinking Water Limit (7000 Bq/L). The water from these wells is not used for human consumption. As discussed in the WL Annual Compliance Monitoring Report [8], low levels of tritium (212 Bq/L) were detected in 2019 in the surface water (dugout #15) near the landfill. Although this activity is well below the drinking water limit for tritium (7000 Bq/L), it is higher than expected.

The most likely source of tritium is the Landfill, based on the following arguments. The highest tritium activities found in dugouts and wells are in close proximity to the Landfill. Due to its 10 m height the Landfill has a higher hydraulic head than the local terrain and will contribute leached contaminants to the shallow groundwater system. Due to the local groundwater flow direction (toward the south and southwest) dugouts 15 and 24, and well BHS 500-56 are more likely to receive contaminants from the Landfill than the asbestos site. Furthermore, the Landfill has been in operation for a much longer time frame than the asbestos site, increasing the probability that something was placed there by mistake and providing more time for contaminants to reach dugouts and well locations. In 2021 the lack of detected tritium in wells was likely the result of lower precipitation and less leaching of tritium from the landfill. In 2022 the amount of precipitation was at record highs and likely contributed to the presence of detectable tritium in some landfill wells.

6.3.1.3 Main Campus Wells

Samples were collected from the wells in the Whiteshell Main Campus areas during the spring and fall of 2023. The uranium, tritium, gross alpha and gross beta results are summarized in Table 44 in Appendix A. It should be noted that many Main Campus wells have low permeability and do not produce very much water. Those wells which do not produce enough water for sampling are not considered in this report. The general lack of water also restricts the number of analyses that can be performed. Since 2023 had less precipitation than normal the near surface clay zone wells did not have enough water for sampling. The main purposes of these wells were to contribute in the development of a hydrogeological model for the Whiteshell site and to provide background information on radioactivity in groundwater.

In 2023 the average gross beta activities in clay-till wells (0.77 Bq/L) was below the drinking water screening level (1 Bq/L). The average gross beta in basal wells (1.12 Bq/L) was slightly higher than the screening level. All of the wells from the bedrock have gross beta activities (with an average of 5.15 Bq/L) which are above the drinking water screening level. Table 44 in Appendix A shows that the high gross beta is associated with very high uranium concentrations in bedrock wells. The beta is not attributed to dissolved K-40 or Sr-90 in the groundwater. The exact source of the beta is not known, but is likely attributed to uranium decay series isotopes released from the host rock to groundwater.

Tritium activities measured in main campus wells in 2023 were close to or below detection levels. This is expected as the main campus wells are not close to a known tritium source.

In 2023 gross alpha activities in the main campus wells were well above the screening level of 0.5 Bq/L. Average gross alpha activities were 1.28 Bq/L in clay-till and 1.04 Bq/L in the basal zone. These alpha activities can be accounted for by the presence of natural uranium, with average concentrations of 62 µg/L in clay-till and 66 µg/L in the basal. The average gross alpha activity in bedrock of 30.6 Bq/L, with low and high activities of 5.5 and 75 Bq/L were significantly higher. The average uranium concentration of 367 µg/L accounts for about half the alpha activity. The alpha activities were measured after radon has had a chance to decay away, so the most likely source for the alpha is radium-226. Groundwater samples were not analyzed for radium-226 in 2020, but were in 2021. Radium-226 accounted for 5 percent of the total alpha activity. In 2023 radium-226 accounted for 6 to 14 percent of total alpha activity. There was no evidence of americium-241 in the groundwater. The poor mass balance between total alpha and measured alpha emitters in the sampled water is likely because the water does not represent the entire system, which includes the rock that contains uranium associated with mineral phases. Alpha emitting decay products with short half-lives are released to the mobile groundwater phase captured by sampling. In 2023 the highest bedrock groundwater uranium concentrations (820 and 886 ppb) were in well nest 2 located upstream of main campus. Downstream locations in well nest 4 and 7 had significantly lower uranium concentrations of 37 to 210 ppb. This indicates that the source of uranium is not anthropogenic.

6.3.2 Non-Radiological Monitoring Groundwater

Analysis of the groundwater for non-radiological parameters (chromium, copper, iron, lead, zinc, arsenic, mercury, nitrate, nitrite, ammonia, chloride, volatile organic compounds (including but not limited to, benzene, toluene, ethylbenzene, xylene, and acetone) and HB-40[42]) were conducted in 2022[43]. Samples were collected from the basal and bedrock zone wells of the WMA during the spring and fall. Samples were also collected from selected locations in the basal zone and water table of the Lagoon and Landfill area during the spring. The non-radiological data have been evaluated in the EAFP report [7]. The following discussion presents an overview of non-radiological contaminants in groundwater.

6.3.2.1 Waste Management Area

Review of the groundwater in the clay, clay-till, basal and bedrock zones of the WMA indicated that the level of chromium was below the associated MAC in Drinking Water of 0.05 mg/L [21]. The highest chromium concentrations were in the clay and clay-till. Copper concentrations were below the associated Aesthetic Objective (AO)[44] for copper (1.0 mg/L) [21]. The highest copper concentrations (average = 0.008 ± 0.003 mg/L) were in the clay zone. The concentration of iron in the groundwater of the WMA ranges from <0.005 to 4.10 mg/L. The average iron values in groundwater from the clay (0.20 ± 0.39 mg/L) were below the AO (0.3 mg/L), while the average iron values from the clay-till (0.63 ± 0.93 mg/L), basal (0.61 ± 1.00 mg/L) and

[42] The primary coolant feedstock for the WR-1 reactor was HB-40, also known as OS-84. Both HB-40 and OS-84 are product codes coined by Monsanto Chemical Company (now Solutia Inc.), the coolant supplier. These codes refer to a complex mixture of organic compounds often described as “partially hydrogenated terphenyls”.

[43] Analysis of magnesium, calcium and sulphate was performed on selected wells in the WMA as part of the Periodic Inspection Program. This data is discussed in the EAFP report [7].

[44] An Aesthetic Objective (AO) applies to certain substances or characteristics of drinking water that can affect its acceptance by consumers or interfere with practices for supplying good water. For certain parameters, both AOs and health-related guidelines (maximum acceptable concentrations) [21] have been derived. Only where AOs are specified, the values are below those considered to constitute a health hazard. This is the case for copper, iron, zinc, chloride and sulphate.

bedrock (0.91 ± 0.96 mg/L) were significantly higher than the AO. The high dissolved iron concentrations in the clay-till, basal and bedrock indicate the presence of low redox conditions. Concentrations of iron exceeding the AO are very common in Manitoba [48].

With the exception of BHS-500-80 (0.039 ± 0.004 mg/L) in the basal, all wells had a lead concentration below the associated MAC of 0.01mg/L [21]. The concentration of zinc in the samples ranged from < 0.005 to 0.025 mg/L, which is below the AO of 5 mg/L [21]. The zinc concentration was higher in the clay and clay-till compared to the basal and bedrock. The arsenic concentrations within the WMA groundwater wells ranged from < 0.0001 to 0.0021 mg/L, which were all under the MAC of 0.01 mg/L. Most mercury concentrations were below detection levels and all well below the MAC of 0.001 mg/L.

In 2023 there was no evidence for the presence of benzene, toluene, ethylbenzene, xylene, or HB40 (a hydrocarbon oil). Chloride was below its applicable AO of 250 mg/L. The levels in the wells were below the 10 mg/L MAC for nitrate [21] in all wells.

6.3.2.2 Lagoon and Landfill

Review of the Landfill groundwater indicated that the level of chromium ranged from <0.001 to 0.0097 mg/L, and all samples were below the associated MAC of 0.05 mg/L [21]. In 2019 the chromium concentration in well BHS 500-01 was determined to be 0.124 mg/L, whereas in 2020, 2021, 2022 and 2023 it was <0.001 mg/L. This confirms that a filtration issue had affected the 2019 result.

Copper concentrations ranged from <0.0003 to 0.006 mg/L which is below the associated AO for copper (1.0 mg/L) [21]. The concentration of iron in the groundwater ranged from <0.005 to 0.405 mg/L. There was one high sample above the AO (0.3 mg/L). Most concentrations of lead were below the detection limit of the method (0.0002 mg/L) and all were below the associated MAC of 0.01 mg/L [21]. The concentration of zinc in the samples was ranged from < 0.005 mg/L to 0.025 mg/L, which is well below the AO of 5 mg/L [21].

Arsenic concentrations in landfill wells ranged from < 0.0005 to 0.0186 mg/L. Wells in which arsenic concentrations are above the MAC of 0.010 mg/L include the basal Landfill wells BHS 500-1 (0.014 mg/L) and BHS 500-60 (0.0186 mg/L). Some areas of Manitoba are known to have groundwater concentrations of arsenic (ranging from 0.001 to 0.025 mg/L) which would naturally be over the drinking water guidelines [21]. The mercury levels were below the MAC of 0.001 mg/L, with all concentrations below the detection limit of 0.000002 mg/L.

Chloride was below its applicable AO of 250 mg/L, and the values for the wells were below the MAC for nitrate (10 mg/L) [21].

Analysis of non-radiological parameters of the lagoon groundwater is limited to the basal zone. Chloride concentrations in all wells were below their AO of 250 mg/L, and the water in all the wells in this area was below the MAC for nitrate (10 mg/L) [21]. Chromium concentrations were between < 0.005 and <0.0194 mg/L and all samples were below the associated MAC of 0.05 mg/L [21]. Copper concentrations were all <0.001 and 0.007 mg/L which are below the associated AO for copper (1.0 mg/L) [21]. The basal wells in the Lagoon had an average iron concentration of 0.74 ± 0.56 mg/L. These high iron concentrations suggest that groundwater in the basal unit was from low redox conditions. All lead, and most mercury concentrations were below their respective detection limits of 0.001, and 0.000002 mg/L. The one exception was well BHS 500-43 with 0.0000025 mg/L mercury. Zinc concentrations were all < 0.005 and below the AO of 5 mg/L [21].

Arsenic concentrations ranged from <0.0005 to 0.0013 mg/L, all below the MAC of 0.010 mg/L for arsenic.

6.4 Monitoring of Surface Water

6.4.1 Winnipeg River Water

Monthly composite samples of Winnipeg River water were collected from four locations: near Pinawa, about 17 km upstream of the Outfall; 2 km downstream at the WL boundary; 10 km downstream at the Lac du Bonnet water intake; and 28 km downstream at the Great Falls generating station (see Figure 22 in Appendix A). The Pinawa location serves as the background location for this data set. In 2023, the samples were analysed for tritium, strontium-90, gross beta, and gross alpha. In addition, the samples were submitted for gamma spectrometric analysis, which provided values for cesium-137 and potassium-40. The monthly results are shown in Table 37 to Table 40 in Appendix B. Data for 2013 to 2023, along with the previous five years' average values are shown in Table 14 and in Figure 7 to Figure 9.

The gross alpha activity in the samples at all locations continues to be at or near the lower limit of detection for the method (see Table 37 to Table 40 in Appendix B) and less than the average of previous five years. The upstream value (0.012 Bq/L) is similar to the downstream locations at the K-11 (0.012 Bq/L), Lac du Bonnet (0.010 Bq/L) and Great Falls Dam (0.012 Bq/L). These are lower than the established background value (0.050 Bq/L) and benchmark value (0.5 Bq/L) shown in Table 11.

The gross beta activity in the samples includes contributions from potassium-40, cesium-137 and strontium-90. The beta activity detected in 2023 at the upstream location (0.078 Bq/L), at K11 (0.058 Bq/L), at Lac du Bonnet (0.047 Bq/L) and at Great Falls (0.033 Bq/L) are not that different from their respective 2022 activities (0.057 Bq/L, 0.069 Bq/L, 0.047 Bq/L, 0.074 Bq/L). The gross beta activities sampled upstream, at K11, at Lac du Bonnet and at Great Falls, are less than the five year averages. Variations in gross beta activities seem to be accounted for mainly by the variations in potassium-40 levels. The gross beta activities are near the background value of 0.09 Bq/L but well below the screening level (1 Bq/L) for drinking water and the benchmark value of 5 Bq/L).

Potassium 40 activity (0.133 Bq/L) found at the upstream location is less than the 2022 value (0.158 Bq/L), but greater than the previous year's average. The levels seen at K-11 location are higher than those in 2022 and the previous five year average. Potassium-40 activity detected at Lac du Bonnet was greater than that in 2022 and the five year average. The levels reported at Great Falls Dam are greater than 2022 values and the five year average. They are above the background level (0.09 Bq/L). Potassium-40 is naturally occurring and not affected by WL's operation, and would be affected by suspended solids in the samples.

The cesium-137 activity found in the 2023 samples is similar to the 2022 values (Table 14) and below the background level (0.007 Bq/L). The strontium-90 activities found upstream were higher than in 2022, and the 2023 values at K11, Lac du Bonnet and Great Falls. Most strontium-90 activities were less than background levels (0.009 Bq/L) and well below the benchmark level (5 Bq/L). The river water results for 2023, and the previous five years, are consistent with the expected minimum impact from the liquid effluents from the WL site, reported in the WL Annual Compliance Monitoring Report [8].

The upstream values for anthropogenic parameters are compared with those of downstream locations in Figure 7, Figure 8 and Figure 9. The value for cesium-137 activity at the upstream location (0.003 Bq/L) is slightly lower than that of the downstream value at Great Falls (Table 14), suggesting a small impact on cesium-137 from WL discharges in 2023. In recent years the differences in upstream and downstream cesium-137 have been small and remained very small fractions of the benchmark values (Maximum Acceptable Concentrations (MACs) in drinking water specified by Health Canada [21]). The downstream activities of strontium-90 were not higher than the upstream activity. This suggests that there was no contribution to dose to downstream recipients from strontium-90 in 2022 (Table 52 in Appendix B). All downstream values are lower than established background values and benchmark values (Table 11).

Table 14: Radioactivity in Winnipeg River Water, 2013 to 2023

Parameter	Mean Activity (Bq/L)														
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average[4]	MDL	2023		
Pinawa (upstream from WL)															
Cesium-137	0.006	0.004	0.005	0.004	0.004	0.003	0.011	0.012	0.004	0.003	0.006	0.004	0.003	±	0.002
Potassium-40	0.06	0.06	0.08	0.06	0.09	0.09	0.11	0.108	0.069	0.158	0.105	0.060	0.133	±	0.091
Strontium-90	0.007	0.009	0.007	0.006	0.006	0.006	0.010	0.010	0.006	0.006	0.008	0.001	0.019	±	0.041
Gross Beta	0.07	0.06	0.09	0.07	0.09	0.10	0.12	0.127	0.068	0.057	0.093	0.004	0.078	±	0.129
Gross Alpha	0.030	0.024	0.033	0.023	0.030	0.026	0.029	0.027	0.015	0.014	0.022	0.017	0.012	±	0.009
Tritium	3.1	3.7	4.8	6.1	3.9	3.2	3.5	4.2	4.1	6.4	4.3	3.0	4.2	±	0.3
Location K11 (2 km downstream)															
Cesium-137	0.006	0.005	0.005	0.005	0.004	0.005	0.014	0.010	0.004	0.004	0.007	0.004	0.002	±	0.001
Potassium-40	0.07	0.08	0.11	0.08	0.10	0.13	0.14	0.100	0.091	0.084	0.112	0.060	0.191	±	0.172
Strontium-90	0.007	0.009	0.007	0.007	0.006	0.006	0.012	0.010	0.006	0.007	0.008	0.001	0.006	±	0.003
Gross Beta	0.09	0.09	0.11	0.10	0.11	0.13	0.20	0.146	0.091	0.069	0.134	0.004	0.058	±	0.038
Gross Alpha	0.029	0.024	0.033	0.033	0.040	0.041	0.054	0.039	0.021	0.013	0.034	0.017	0.012	±	0.010
Tritium	3.1	3.6	3.8	3.9	4.0	3.7	3.4	4.2	4.0	4.1	3.9	3.0	4.3	±	0.5
Lac du Bonnet (10 km downstream)															
Cesium-137	0.005	0.004	0.003	0.002	0.003	0.002	0.008	0.007	0.005	0.001	0.005	0.004	0.002	±	0.001
Potassium-40	0.05	0.07	0.07	0.06	0.05	0.06	0.08	0.078	0.195	0.044	0.090	0.060	0.204	±	0.088
Strontium-90	0.008	0.010	0.006	0.006	0.006	0.006	0.008	0.007	0.004	0.005	0.006	0.001	0.008	±	0.008
Gross Beta	0.08	0.08	0.08	0.07	0.07	0.08	0.10	0.102	0.068	0.047	0.078	0.004	0.033	±	0.012
Gross Alpha	0.025	0.021	0.028	0.018	0.022	0.022	0.022	0.021	0.013	0.008	0.017	0.017	0.010	±	0.004
Tritium	3.0	3.6	3.8	3.9	4.0	3.2	3.4	4.1	3.9	4.0	3.7	3.0	4.1	±	0.4

Parameter	Mean Activity (Bq/L)														
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Average[4]	MDL	2023		
Great Falls (28 km downstream)															
Cesium-137	0.005	0.003	0.002	0.002	0.002	0.004	0.008	0.007	0.003	0.003	0.005	0.004	0.004	±	0.011
Potassium-40	0.08	0.06	0.06	0.05	0.05	0.07	0.08	0.08	0.070	0.093	0.078	0.060	0.088	±	0.071
Strontium-90	0.008	0.007	0.007	0.006	0.006	0.017	0.008	0.007	0.004	0.006	0.008	0.001	0.007	±	0.002
Gross Beta	0.07	0.08	0.07	0.07	0.06	0.09	0.10	0.10	0.074	0.048	0.083	0.004	0.038	±	0.013
Gross Alpha	0.029	0.023	0.025	0.019	0.022	0.024	0.029	0.022	0.016	0.009	0.020	0.017	0.012	±	0.007
Tritium	3.1	3.7	3.8	3.9	3.9	3.2	3.4	4.1	4.0	4.0	3.7	3.0	4.1	±	0.4

Notes:

1. Uncertainties are expressed as the standard deviation for the average activities measured per month.
2. Method Detection Limit (MDL) are given in Table 11.
3. Maximum Acceptable Concentration in drinking water for strontium-90 and gross beta (as strontium-90) is 5.0 Bq/L, for cesium-137 is 10.0 Bq/L, for tritium is 7000 Bq/L, and for gross alpha (as total uranium) is 0.5 Bq/L [21]
4. Five year average

The tritium activities detected in the river water samples this year are shown in Table 14. They were all actually based on detection limit values and the error values given in the table are standard deviations of the reported detection limits. They are below background level (7 Bq/L). The tritium activity detected upstream was not significantly different than in downstream samples. The source of the upstream tritium was likely from the atmosphere. The values are well below the Maximum Acceptable Concentration (MAC) in drinking water (7000 Bq/L) [21].

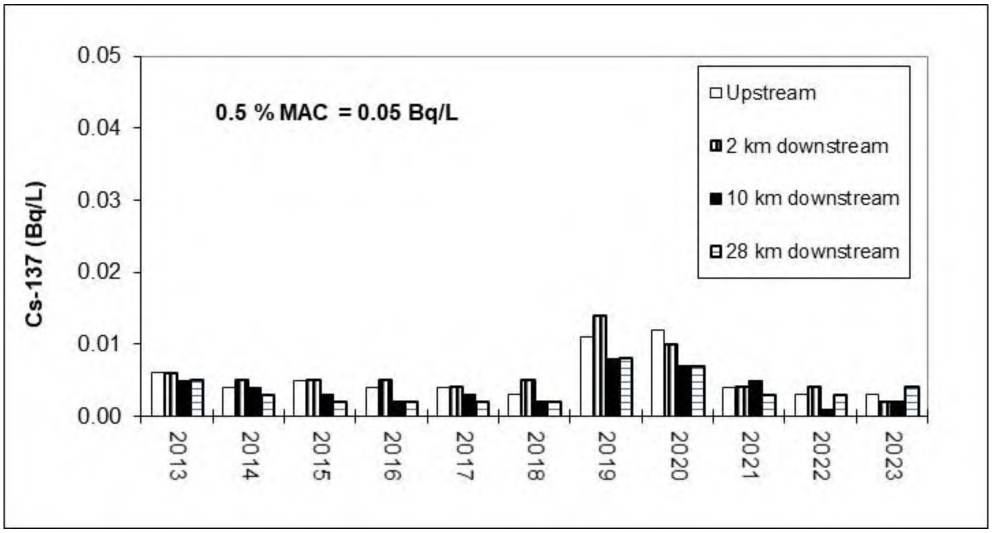

Figure 7: Cesium 137 in Winnipeg River Water, 2013 to 2023

The MAC for cesium-137 in drinking water, specified by Health Canada, is 10 Bq/L [21].

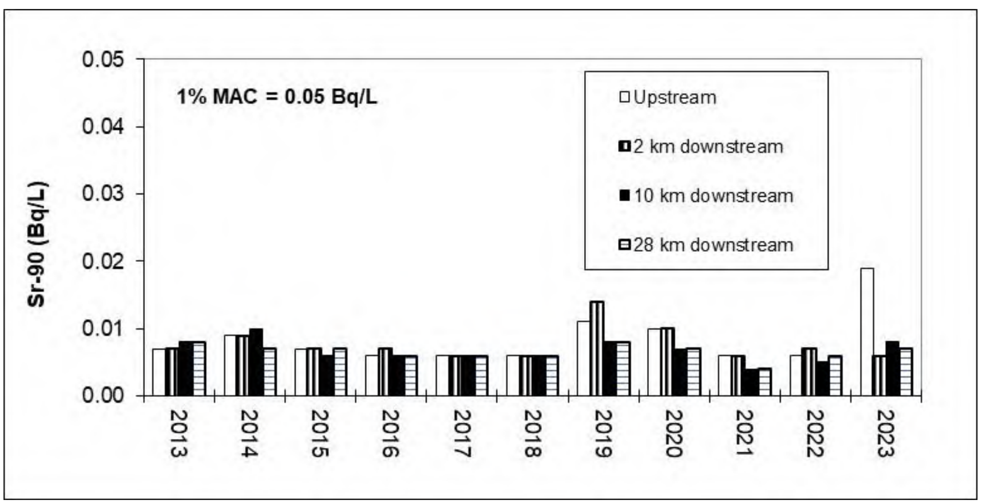

Figure 8: Strontium-90 in Winnipeg River Water, 2013 to 2023

The MAC for strontium-90 in drinking water, specified by Health Canada, is 5 Bq/L [21].

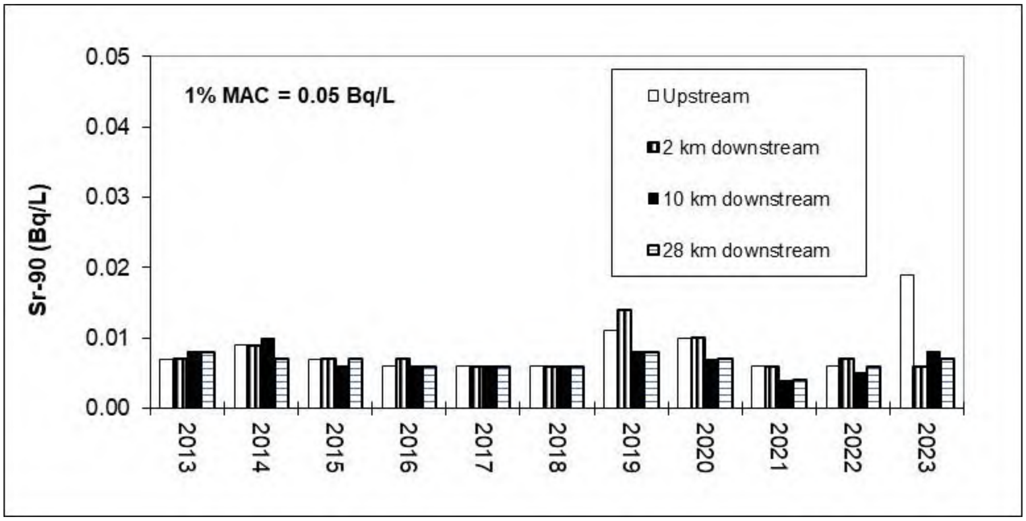

Figure 9: Gross Beta Activity in Winnipeg River Water, 2013 to 2023

The MAC for gross beta in drinking water (as strontium-90), specified by Health Canada, is 5 Bq/L [21].

Table 15 shows the mean, maximum, and minimum daily flow rates for 2013 to 2023 of the Winnipeg River, recorded by Manitoba Hydro at the Seven Sisters generating station, upstream of WL. The 2023 mean daily flow rate, at 615 m^3/s, was below the 2022 flow rate (1564 m^3/s) and the average of previous ten years (1015 m^3/s). The highest river flows in 2023 were from January through June, but then decreased to a relatively constant flow for the rest of the year, except for a small increase in December. River flow is monitored in support of the DRL model in use at WL, and a range of flow from 300 – 2500 m^3/s is typical for the area [46].

Table 15: Winnipeg River Mean Flow Rate at Seven Sisters Generating Station, 2013 to 2023

	2013	2014	2015	2016	2017	2018
HIGH **Date**	1846 28-Jun-13	2843 04-Jul-14	1567 31-Dec-15	1682 10-May-16	1480 30-Apr-17	1231 22-Nov-18
LOW **Date**	486 28-Apr-13	559 07-Nov-14	394 11-May-15	760 06-Sep-16	388 30-Apr-17	193 05-Sep-18
MEAN	1003	1398	939	1247	986	655
	2019	**2020**	**2021**	**2022**	**Average**	**2023**
HIGH **Date**	2655 30-Oct-19	1461 05-Jan-20	749 14-Feb-21	3635 01-Jun-22	1915	1084 14-Jun-23
LOW **Date**	461 13-Aug-19	237 28-Aug-20	169 04-Oct-21	577 29-Nov-22	422	155 02-Oct-23
MEAN	1185	748	422	1564	1015	615

6.5 Airborne Contaminants

6.5.1 Radioactivity in Atmospheric Deposition at Pinawa

Monitoring of total wet and dry atmospheric deposits is primarily intended to serve as a gross trend indicator since it represents an intermediate step in environmental exposure pathways. It also serves as a baseline for emergency preparedness purposes and provides confirmation of the absence of significant quantities of radioactive particulate material in airborne emissions.

Deposition of radioactive material due to atmospheric precipitation was measured at the Pinawa town yard, located about 9 km east of WL and 2 km west of Pinawa (see Figure 22 in Appendix A). Rainfall was collected in a container lined with a plastic bag and mounted 1 m above ground. Snowfall was collected on aluminum sheets at ground level or in lined rainfall containers. Samples were analyzed monthly for gross beta, gross alpha, cesium-137, and potassium-40. Strontium-90 analysis was discontinued in 2020 because strontium-90 results were always below detection levels. The monthly average deposition in units of Becquerel per square meter (Bq/m^2) is shown in Table 16 for the years 2018 to 2023, along with the average for the past five years. The yearly data for gross alpha, gross beta, strontium-90, cesium-137 and potassium-40 is shown in Table 16 and Figure 10. The level of gross beta activity seen is less than that observed in 2022 and the average of the last five years. It is less than the established background level (14 Bq/m^2) and the benchmark level of 13 Bq/m^2, but less than the benchmark value of 17 Bq/m^2) in Table 11. The gross alpha activity is less than in 2022, the average of the last five years and the background level (2 Bq/m^2). The level of potassium-40 was less than observed in 2022 and the average of the last five years. It was less than the background level (12 Bq/m^2). The primary contributor to the gross beta activity continues to be potassium-40, a naturally occurring isotope. The activity of cesium-137 was less than in 2022 and the average of the past five years. It was similar to the background level (0.3 Bq/m^2). The variations in gross alpha, gross beta and potassium-40 from year to year are likely due to dusts that may have fallen into the lined containers. The higher than normal amount of precipitation may have resulted in an increase in atmospheric deposition of radioactivity. Some values are above background values, while all values are below established benchmark values Table 11. These values are consistent with normal background values reported for southern Ontario [49].

Table 16: Monthly Average Atmospheric Deposition of Radioactivity through Precipitation at Pinawa, 2018 to 2023

Monthly Average Deposition (Bq/m^2)								
	2018	2019	2020	2021	2022	Five-Year Average	MDL*	2023
Gross Beta	11.8	15.3	16.1	10.0	15.5	13.7	0.2	9.2 ± 3.6
Gross Alpha	1.6	3.7	3.5	1.5	2.5	2.5	0.3	1.8 ± 0.9
Strontium-90	0.2	0.3	ND	ND	ND	0.3	0.3	ND
Cesium-137	0.2	0.6	0.5	0.3	0.5	0.4	0.6	0.3 ± 0.06
Potassium-40	10.1	7.8	7.3	7.6	9.8	8.5	6	9.2 ± 3.7

Notes:

1. Uncertainties are expressed as the standard deviations of the average activity of the processed samples.
2. * The MDL values are consistent with Table 11
3. Strontium-90 analyses were discontinued in 2019 March since strontium-90 is always at detection levels.

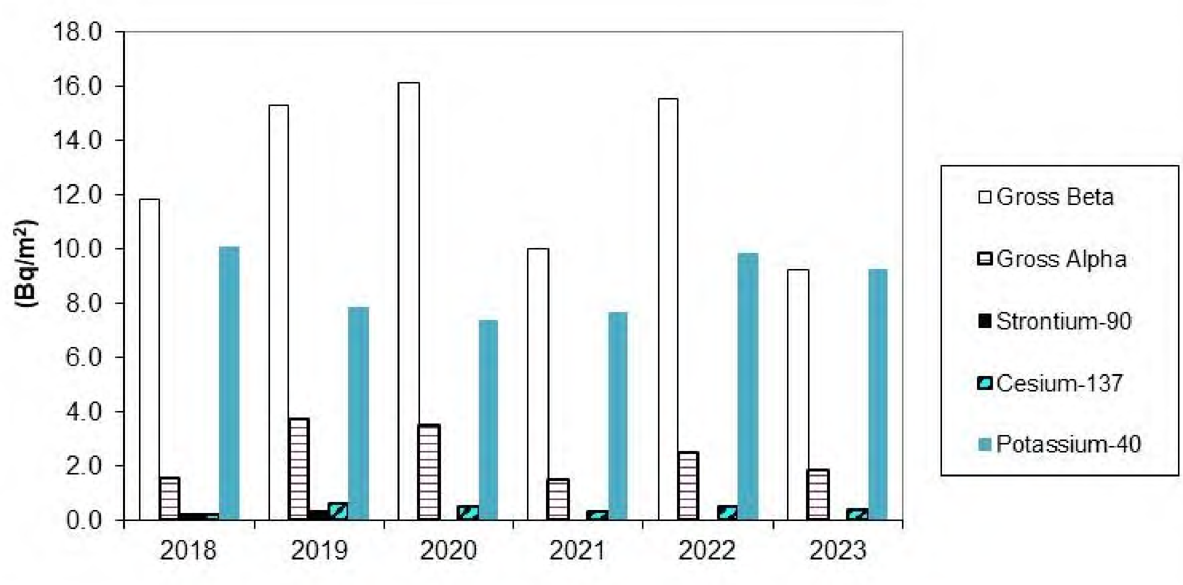

Figure 10: Monthly Average Deposition of Radioactivity through Precipitation at Pinawa, 2018 to 2023

6.5.2 Monitoring of Ambient Radiation in Air

The annual ambient gamma radiation at WL and the surrounding area is monitored by means of thermoluminescent lithium fluoride dosimeters (TLDs). The six Ambient Radiation Monitoring

Stations (ARMS) have been monitored since 1966. The locations of the ARMS are indicated on Figure 22 in Appendix A. Five of the ARMS stations are situated within 4 km of the Building 100 stack and are arranged according to the prevailing wind direction. The sixth is located near Pinawa, about 11 km to the east-southeast. Starting in 1986, TLD packages were mounted at various locations along the fence enclosing the WL site active area. Another series of TLD packages were installed in 1987 along the WMA fence, and in 1994 a series of TLDs were installed along the Canister Area fence. As mentioned in Section 1.1, this report does not cover results of environmental monitoring for operational control purposes within individual facilities. The results for the TLDs within the WL WMA and Canister area are to be included in the WL Annual Compliance Monitoring Report [8].

The TLDs are placed 1 m above the ground surface and continuously record gamma radiation over the calendar year.

These results and the average reading for the past five years, for locations along the WL controlled area fence, the WL perimeter and at Pinawa are shown in Table 17 in units of microgray per year (µGy/a). Please note that the ARMS #2 TLD location (east-southeast) is currently inaccessible. A TLD will not be deployed to that location in the future. Data from the Pinawa town yard will be used as the new east-south east location for ambient gamma radiation. Figure 11 shows the statistical means of the readings from the TLDs at the Controlled Area fence, Site Perimeter (ARMS), and Pinawa, respectively, for the years 2018 to 2023. The reported values include the gamma background caused by terrestrial and cosmic radiation. Land ambient gamma-radiation background measured as part of the preoperational environmental surveys for WL in 1964 was found to range from 2.1 to 3.6 nCi/kg h [24]. In air, this converts to 700 to 1,200 µGy/a, which is about the same as the current levels. This is as expected, since at present WL has no operating reactors or fuel processing experiments, and therefore no emissions of noble gases. Since the background and the readings are about the same, the background has not been subtracted from the readings. Levels of natural terrestrial background exposure can vary considerably at different locations at times, due to factors such as types of rock and soil, type and source of material used for building construction, building ventilation, depth of snow cover, and levels of soil moisture.

Data in Table 17 and Figure 11 show that average ambient gamma radiation at the perimeter and Pinawa locations has remained at levels below the background value of 1,200 µGy/a [50]. The locations along the fence of the controlled area have typically experienced radiation levels above preoperational levels. The TLD readings recorded for 2023 correspond to average ambient dose rates ranging from 2 to 5 µR/h[45] . These levels are a fraction of the maximum allowable level of 50 µR/h in a Radiation Zone 1 area. The 2023 results of the controlled area, Site Perimeter and Pinawa are all higher than 2022 and the average of the last five years. In 2018 the TLD outdoor packaging was modified and when the TLDs were recovered from the field it was noted that the packaging contained significant quantities of water/ice. This could have provided shielding or affected the TLDs, resulting in significantly lower gamma radiation readings, particularly for the Site Perimeter and Pinawa. In 2021, the TLDs started to be double

[45] One µR/h is equivalent to an observed dose rate in air (Air Kerma) of 10 nGy/h.

bagged and inspected twice to prevent water ingress in the TLD packaging. Sources of recorded ambient radiation are likely due to a combination of stack emissions from the facilities, and storage of nuclear material within the controlled area fence.

Table 17: Ambient Gamma Radiation in Air at WL and Vicinity, 2018 to 2023

Total Gamma Dose (µGy/a)*									
TLD Location	**2018**	**2019**	**2020**	**2021**	**2022**	**Five-Year Average**	**2023**		
Controlled Area Fence									
South Fence	524	420	587	548	528	521	550	±	12
East Fence	509	426	557	570	541	521	591	±	15
North Fence	487	447	542	585	549	522	603	±	10
West Fence	500	446	590	588	404	506	602	±	13
Fence Mean	**505**	**435**	**569**	**573**	**506**	517	587	±	25
Site Perimeter (ARMS)									
1. North	411	391	464	532	500	460	547		-
2. East-southeast	NA	NA	NA	NA	NA	NA	Not deployed		
3. South-southeast	453	421	516	570	494	491	576		-
4. West	NA	NA	NA	517	510	514	557		-
5. Northwest	339	344	429	471	427	402	484		-
Perimeter Mean	**401**	**385**	**470**	**523**	**483**	**452**	**541**	±	**40**
Pinawa									
Town Yard	455	401	503	536	475	474	478	±	133
Pinawa Golf Course	NA	NA	NA	NA	NA	NA	NA		-
Hospital	407	378	440	526	583	467	515		-
Kelsey			510	555	340	-	565		-
Pinawa Mean	**431**	**390**	**484**	**539**	**466**	**462**	**519**	±	**44**

Notes:

1. Uncertainties are based on the standard deviations of 3 TLD measurements (Controlled Area Fence).
2. Natural background, caused by cosmic and terrestrial sources, has not been subtracted.
3. NA - Data not available because of vandalism, damage of TLDs or outlier.
4. *The values presented represent dose in air.

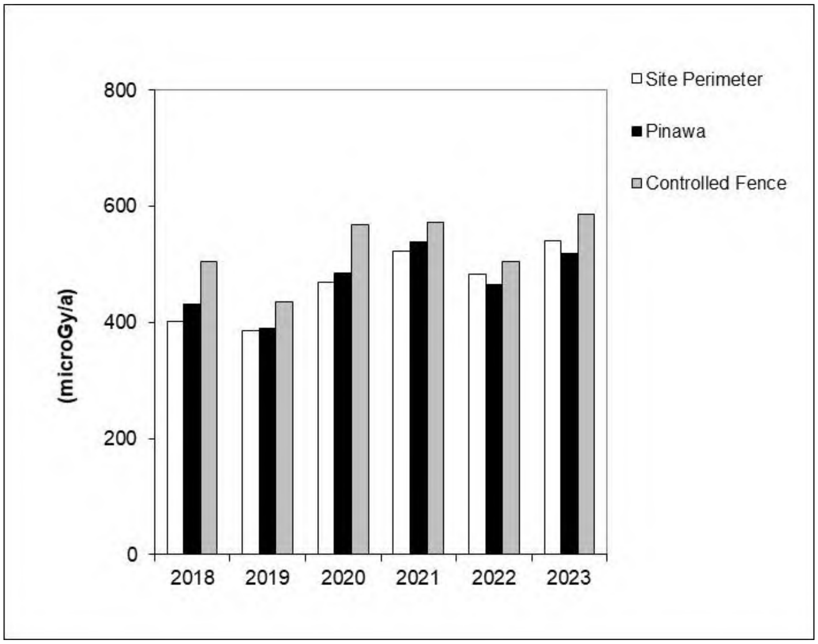

Figure 11: Ambient Gamma Radiation in Air at Whiteshell Laboratories and Vicinity, 2018 to 2023

6.5.3 Land Gamma Radiation

The dose rate due to ambient-gamma radiation was measured once in 2023 at control points on roads within a 16 km radius surrounding the WL site. The survey was done from a slowly moving vehicle, using a MicroSpec 3 gamma monitor. The survey is part of the terrestrial monitoring performed to provide verification that there has not been a build-up of radioactivity due to deposition of air emissions from the site. This monitoring serves primarily as a gross trend indicator providing, for example, baseline data for emergency preparedness and response purposes. It also provides an indication of radiation fields that may be emanating from buildings on site where radioactive materials are stored or processed. Results for 13 survey points in the off-site public area and 11 points within the WL site are shown in Table 18 . These locations are identified in Figure 22 in Appendix A. The 2023 results for off-site are slightly lower than 2022 dose rates. They were below the established background level (60 nSv/h). The higher dose rates at Building 923 were first noted in 2019 as work began involving the transfer of waste packages from Building 923. In 2021 there was an increased gamma dose on the south side of Buildings 200 and 411 due to the demolition of Building 200. This high dose was still observed in 2023 at a higher rate than in 2022.

The maximum values near operating facilities are higher than off-site locations indicating radiological activity on the ground level due to operations is localized to the site. The mean gamma dose rates are below benchmark value < 500 nSv/h and not of concern but provide useful baseline data.

Table 18: Land Gamma Radiation at Whiteshell Laboratories and Vicinity, 2018 to 2023

Mean Gamma Dose Rate (nSv/h)									
	2018	**2019**	**2020**	**2021**	**2022**	**Five-Year Average**	**2023**		
Background Readings	30	44	31	31	66	**40**	37	±	11
Public Area (16 km Route)									
Plant Road & HWY. 211	37	53	55	38	54	**47**	38	±	11
HWY. 211 & Rifle Range	41	68	61	41	54	**53**	35	±	11
Pinawa Stage 1	40	71	72	45	67	**59**	41	±	12
Pinawa Stage 2	47	71	66	50	68	**60**	39	±	12
Junction HWY. 11 & HWY. 307	39	41	54	45	60	**48**	31	±	9
Bridge to Seven Sisters	40	46	60	49	64	**52**	45	±	14
Town Circuit at Dam	29	42	63	47	72	**51**	36	±	11
Junction HWY. 214 & HWY. 11	33	36	45	43	56	**43**	32	±	10
Lac du Bonnet Circuit	35	36	46	35	48	**40**	30	±	9
West Side of LDB Bridge	31	33	43	35	55	**39**	37	±	11
Hwy. 520 at Old Pinawa	34	43	58	43	63	**48**	38	±	11
Riverland School	37	40	58	40	57	**46**	40	±	12
Road at ARMS #1	38	44	55	40	63	**48**	39	±	12
WL Site									
Bldg. 401 into Active Area	45	47	64	53	71	**56**	45	±	14
Road South side of 300	48		73	58	71	**62**	42	±	13
Road West side of 300	245	54	93	82	74	**110**	45	±	14
South side of 200 & 411	48	49	68	120	186	**94**	287	±	86
East of 100	46	48	69	55	71	**58**	44	±	13
East gate	29	27	40	48	69	**43**	33	±	10
North Road at Lagoon Road	25	31	39	39	65	**40**	21	±	6
Rd. East of Canister Area	54	52	77	46	71	**60**	25	±	8
East Rd. at WMA Gate	49	24	58	49	79	**52**	39	±	12
East Rd. at Landfill site	34	34	49	46	70	**47**	33	±	10
SMAGS (B 923)	42	116	279	45	57	**108**	33	±	10

Notes:

1. Uncertainty in measurements made using the MicroSpec 3 is estimated to be 30% (2 stdev). Values were measured in nSv/h. The detection limit for the instrument is approximately 10 nSv/h.

6.6 Monitoring of Food Stuff

6.6.1 Fish

During the fall of 2023 white sucker, walleye and pike were caught in the Winnipeg River at one location upstream of WL and two downstream locations. One Whitefish was also caught at a downstream location. The flesh was analyzed for gross beta activity and scanned by gamma spectroscopy, which provided values for cesium-137 and potassium-40. The downstream locations and the upstream Sylvia Lake location are marked on Figure 22 in Appendix A. All locations are part of the Winnipeg River system. The detailed results, including length, weight, and activity in Bq/kg fresh weight for eviscerated flesh, are given in Table 45, Table 46 and Table 47 in Appendix B. A summary of cesium-137, potassium-40, and gross beta activity in fish flesh is given in Table 19 for the years 2018 to 2023, along with the five-year average values.

The gross beta activity in all sample types collected for 2023 is mostly accounted for by potassium-40, a naturally occurring isotope. Figure 12 to Figure 15 and the values in Table 19 indicate that over the last five years, the cesium-137 activity in walleye, pike and whitefish only caught at the downstream locations was generally higher than that in upstream fish. The cesium-137 activity in white sucker collected from downstream locations tends to be similar to or less than that of upstream locations. In 2023 most cesium -137 activities are detection level values, with the exception of a walleye and a pike caught at the 5 km downstream location.

The average levels of cesium-137 in walleye (0.54 Bq/kg), white sucker (0.74 Bq/kg) and pike (0.25 Bq/kg) at the upstream location are slightly higher than those observed in 2022 and less than the five-year average for walleye (1.05 Bq/kg), sucker (0.89 Bq/kg) and pike (0.80 Bq/kg). This was because the contract lab produced better detection levels for cesium in 2022 and 2023. At the 0 to 2 km downstream location the cesium-137 activities in white sucker (0.42 Bq/kg), walleye (0.76 Bq/kg) and pike (0.29 Bq/kg) were lower than their respective five year averages (0.86, 0.99 and 1.00 Bq/kg). At the 5 km downstream location the cesium-137 activities in white sucker (0.48 Bq/kg) and walleye (0.68 Bq/kg) were lower than their respective five year averages (0.81 and 0.94 Bq/kg). The cesium-137 activity in pike (2.03 Bq/kg) was higher than the five year average (0.98 Bq/kg). In 2023 there was higher cesium-137 activity in downstream walleye and pike. White sucker had higher cesium-137 in the upstream sample.

If, for example, the level of cesium-137 activity was 1.50 Bq/kg fresh weight in fish it would result in a dose of ~ 4.4×10^{-6} mGy/d to the fish, which is well below the dose benchmark values of 400 µGy/h (9.6 mGy/d) for aquatic biota. It is also below the dose benchmark of 0.6 mGy/d recommended by the CNSC. Assessment of the maximum potential dose to members of the public from fish ingestion in 2023 indicates a small dose because there was a small difference between upstream and downstream cesium-137 in fish. Section 7 summarizes dose calculations attributed to the ingestion of food and water.

Table 19: Average Radioactivity in Flesh of Winnipeg River Fish, 2018 to 2023

Year	Radioactivity (Bq/kg fresh weight)											
	White Sucker			Walleye			Pike			Whitefish		
	Cs-137	K-40	Gross Beta	Cs-137	K-40	Gross Beta	Cs-137	K-40	Gross Beta	Cs-137	K-40	Gross Beta
Upstream of WL (J40)												
2018	<1.00	100	119	<1.30	143	121	<1.00	123	122	-	-	-
2019	1.10	115	128	1.50	138	127	-	-	-	-	-	-
2020	1.00	123	134	1.00	188	138	1.00	113	132	-	-	-
2021	1.00	130	294	1.00	105	138	1.00	110	309	-	-	-
2022	0.36	123	124	0.45	125	112	0.21	130	105	-	-	-
2023	0.74	105	94	0.54	121	106	0.25	119	89	-	-	-
Average	**0.89**	**118**	**160**	**1.05**	**140**	**127**	**0.80**	**119**	**167**	**-**	**-**	**-**
0 to 2 km Downstream of WL (K11)												
2018	<1.00	129	113	<1.30	125	106	<1.00	121	94	2.00	99	136
2019	-	-	-	-	-	-	-	-	-	-	-	-
2020	1.00	128	117	1.10	128	122	1.00	130	118	-	-	-
2021	1.00	115	169	1.00	120	338	1.00	100	135	-	-	-
2022	0.45	140	103	0.55	135	133	-	-	-	-	-	-
2023	0.42	120	97	0.76	122	94	0.29	122	86	-	-	-
Average	**0.86**	**128**	**126**	**0.99**	**127**	**175**	**1.00**	**117**	**116**	**-**	**-**	**-**
5 km Downstream of WL (K23)												
2018	<1.00	130	98	<1.00	143	115	1.50	111	112	1.40	125	132
2019	-	-	-	-	-	-	-	-	-	-	-	-
2020	1.00	140	129	1.10	173	143	1.00	117	134	1.00	115	139
2021	1.00	100	196	1.00	108	426	1.00	110	408	1.0	120	207
2022	0.25	134	146	0.65	140	125	0.41	127	109	0.3	143.0	118.0
2023	0.48	108	103	0.68	121	94	2.03	125	101	0.3	129.0	99.0
Average	**0.81**	**126**	**142**	**0.94**	**141**	**202**	**0.98**	**116**	**191**	**0.92**	**126**	**149**

Notes:

1. – No data available.
2. Average values are calculated for 2018 to 2022.
3. Trace amounts of Th-232, U-235 and Ra-226 were detected in a few of the fish flesh samples analyzed.

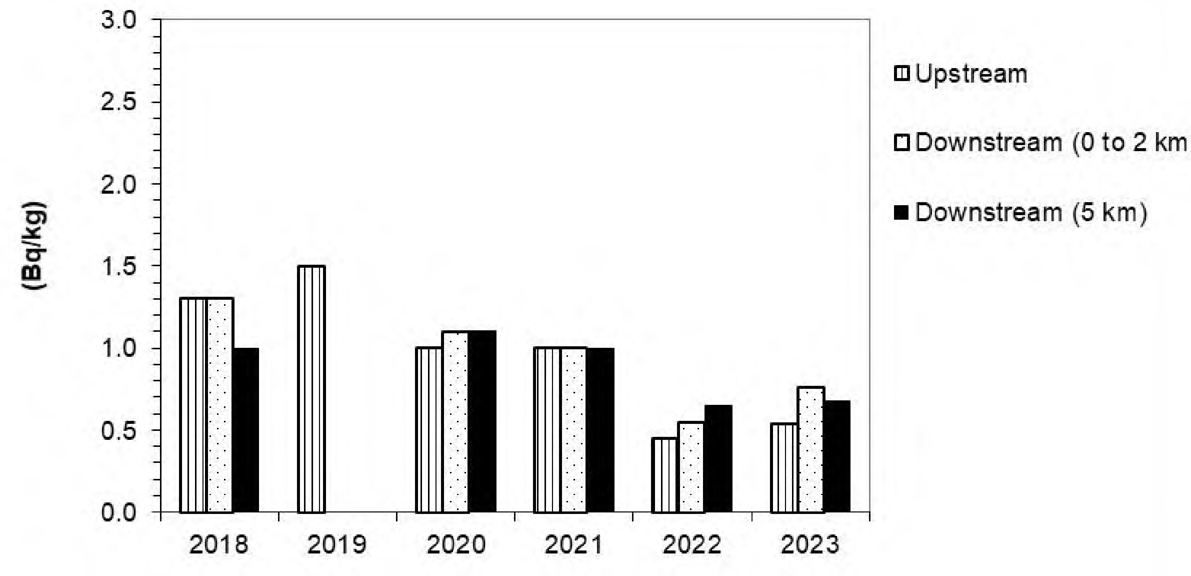

Figure 12: Cesium 137 in Walleye Flesh from Winnipeg River, 2018 to 2023

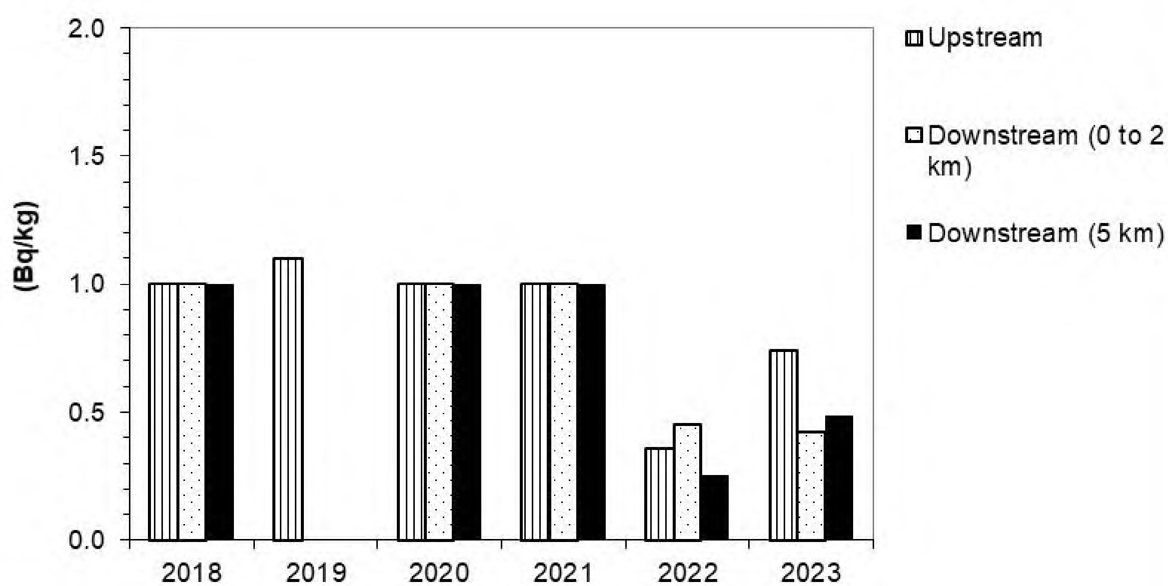

Figure 13: Cesium-137 in White Sucker Flesh from Winnipeg River, 2018 to 2023

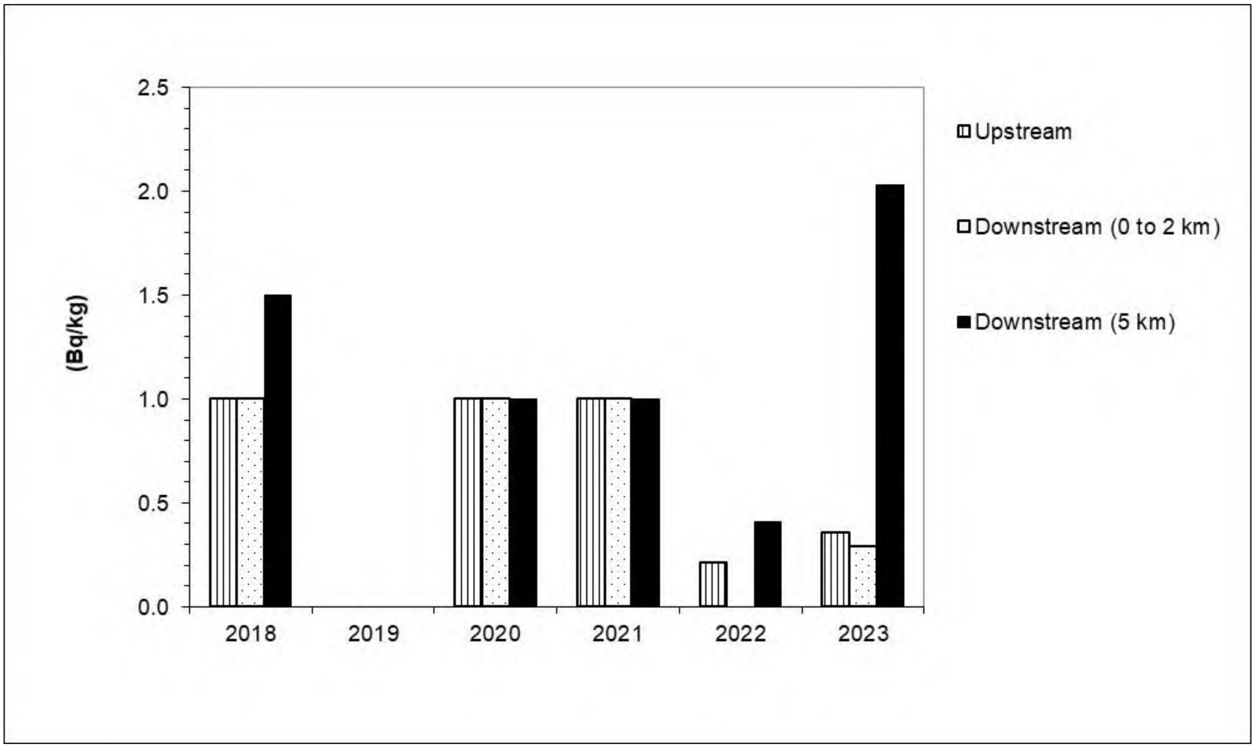

Figure 14: Cesium-137 in Northern Pike Flesh from Winnipeg River, 2018 to 2023

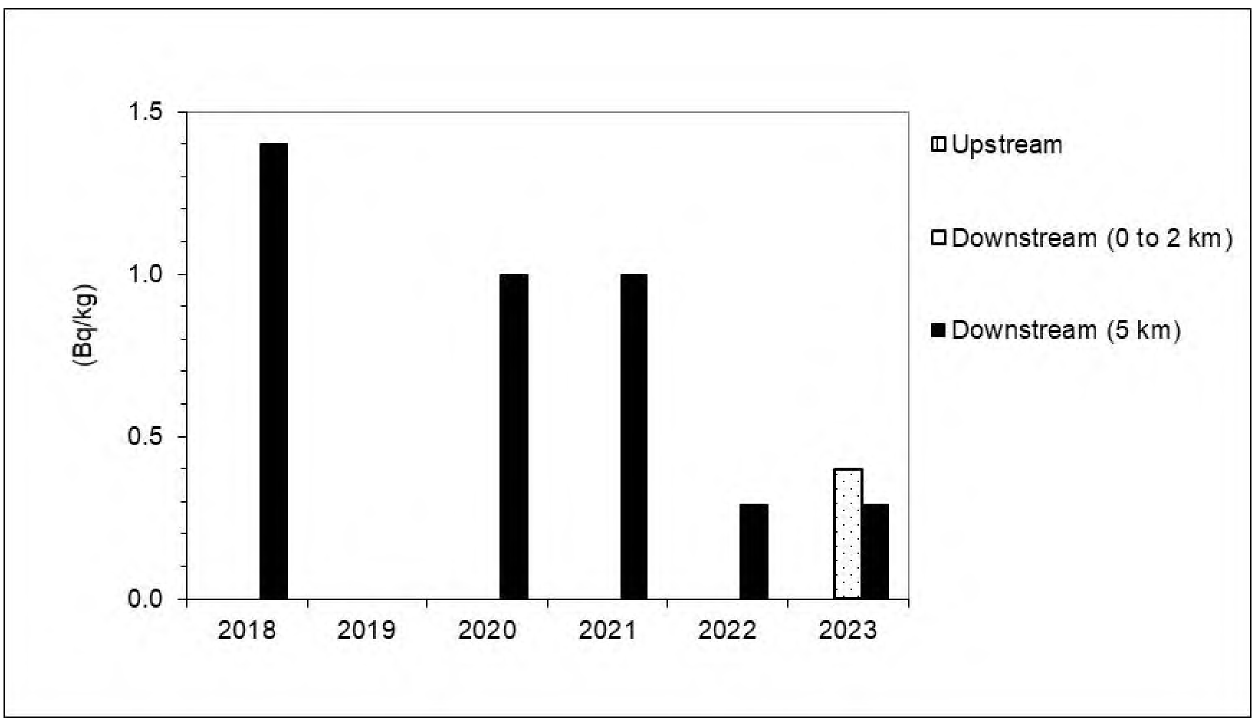

Figure 15: Cesium-137 in Whitefish Flesh from Winnipeg River, 2018 to 2023

6.6.2 Wildlife within the Ambient Radiation Monitoring Stations of Whiteshell Laboratories

Road kills in the region covered by the Ambient Radiation Monitoring Stations (ARMS) of WL are normally collected and analysed for radioactivity. Locations of ARMS can be found in Figure 22 in Appendix A. The number of animals collected is dependent on the number of dead animals that WL staff are able to respond to upon notification. The flesh portion of each animal is sent to an external ISO 17025 accredited laboratory for analysis of gross alpha, gross beta, and gamma spectroscopy to measure the activity of a number of radionuclides, such as cesium-137 and potassium-40.

In 2023, one female deer was collected on the plant road.

Analyses of deer flesh for gross beta activity, cesium-137 and potassium-40 are summarized in Table 20. The gross beta value for deer collected in 2023 (93 Bq/kg) was less than for 2022 (106 Bq/kg) and the average for the previous three years (109 Bq/kg). The beta activity can be explained by naturally occurring potassium-40. The cesium-137 activity in 2023 deer (0.19 Bq/kg) was lower than the average for the previous three years (1.2 Bq/kg), and for 2022 (0.3 Bq/kg).

The background level of cesium-137 activity in deer flesh for the region is ~6.0 Bq/kg. A benchmark value of 33 Bq/kg is used to assess the cesium-137 results for deer within the vicinity of WL. The benchmark value is three times the geometric mean of cesium-137 activity found in deer outside the vicinity of WL for the period of 2001 to 2016. The cesium-137 activity (18 Bq/kg fresh weight) found in the deer would result in an incremental dose of ~ 0.0001 mGy/d to the deer, which is well below the dose benchmark values of 100 µGy/h (2.4 mGy/d) (United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2008) for terrestrial biota. It is also below the dose benchmark of 0.6 mGy/d recommended by the Canadian Nuclear Safety Commission. Section 7 assesses the role of game ingestion on doses to the public. The assessment for 2023 considered the difference between the cesium-137 activity in the 2023 deer sample (0.19 Bq/kg) and the background activity in deer for the area (6 Bq/kg).

CNL continues to make every effort to minimize the impact of Whiteshell Laboratories operations on local wildlife. All controlled areas are surrounded by security fences which help prevent wildlife from accessing affected areas. Air emissions are kept as low as reasonably achievable which reduces the effect of aerial deposition. Liquid effluent streams are monitored at several locations to identify any potential sources of emissions. The data is evaluated and remedial measures are taken as required.

In 2019 CNL began collecting local beef for analyses for radioactivity by a contract lab. The results of beef analyses from 2019 through 2023 are shown in Table 21. In previous years the cesium-137 activity was reported at detection levels. In 2023 an improvement in detection limits showed a detected cesium-137 activity of 0.3 Bq/kg. Radioactivity in beef flesh can be compared to that of deer flesh, as is done in Table 11. The background and benchmark values in Table 21 are the values for deer flesh discussed above. Since the cesium-137 activity was less than 6 Bq/kg there is no apparent dose to the public from consumption of local beef from CNL activities.

Table 20: Radioactivity in Deer within the ARMS of WL

Deer (Bq/kg)			
Year	**Gross Beta**	**K-40**	**Cs-137**
2016	120	101	1.5
2017	-	-	-
2018	130	101	9.5
2019	133	106	3.6
2020	111	120	2.1
2021	NA	NA	NA
2022	106	239	0.3
2023	93	71	0.19
Average (2020-2022)	109	180	1.2
Average (2016 - 2022)	120	133	3.4
MDL*	5	100	1

Notes:
*MDL are consistent with Table 11.

Table 21: Radioactivity in Local Beef

Beef (Bq/kg)				
Year	**Gross Alpha**	**Gross Beta**	**K-40**	**Cs-137**
2019	< 5	113	130 ± 20	< 100
2020	< 100	100	<1000	< 100
2021 upstream	<5	106	<1000	<1
2021 upstream	<5	102	<1000	<1
2022	<6	146	114	<0.2
2023	0.7	99.3	116	0.3
Background (BG)*	< 11	162	100	6
Benchmark (BV)*	33	193	174	33
MDL*	5	5	100	1

Notes:
*MDL are consistent with Table 11

6.6.3 Cultivated Vegetables

Radioactivity was measured in root and fruit type crops obtained from local gardens, each irrigated with Winnipeg River water. Tomatoes, squash and zucchini are considered fruit. The root vegetable category is the average of carrots, beets and potatoes. Lettuce and cabbage are used to represent leafy vegetables. The gardens are located either upstream or downstream of the Outfall. Analyses have been completed for gross alpha activity, gross beta activity, strontium-90, potassium-40, cesium-137 and beryllium-7 (Table 48 in Appendix B).

Radioactivity in cultivated vegetables, for the years 2018 to 2023, along with the five year average value are detailed in Table 22. Attainable detection limits vary with the size of sample provided and the contract lab performing the analyses.

The 2023 gross beta values for both upstream and downstream samples are mostly accounted for by potassium-40, which is a naturally occurring radionuclide. The gross beta activity in fruit type vegetables in upstream and downstream samples was 79 and 67 Bq/kg, respectively. The gross beta activities for root vegetables upstream and downstream are 148 and 116 Bq/kg, respectively. The trend for root vegetable data collected from 2018 until 2023 is illustrated in Figure 16.

As a result of improved detection limits, in 2023 gross alpha was detected in all samples and strontium-90 activities were detected at low levels in two upstream samples. In previous years high detection limits had presented an obstacle for properly interpreting the results of radioactivity in vegetables. In 2021 all but the downstream root sample the reported detection limits were too high by 2 orders of magnitude. As indicated by operational experience (see Table 11 and Table 22) detection limits of <100 Bq/kg reported in 2020 and 2021 do not reflect radioactivity in cultivated vegetables. The 2022 detection limits represent a return to acceptable values. Since the high detection limits do not represent radioactivity for certain radioisotopes, detection limits of >100 Bq/kg were excluded from average calculations for gross alpha, strontium-90, and cesium-137. Detection limits of >1000 Bq/kg were excluded from average calculations for potassium-40 and beryllium-7. A detection limit of <100 Bq/kg was not considered unreasonable for potassium-40.

In 2023 strontium-90 activity in upstream fruit (<0.06 Bq/kg), root vegetables (0.05 Bq/kg), and leafy vegetables (0.1 Bq/kg) was not significantly different from their respective downstream values of <0.06, <0.04 and <0.1 Bq/kg. Strontium-90 activities have been low over the past five years, and showed no statistical difference between the upstream and downstream locations. There was no persistent trend noted for root or fruit vegetables.

In 2023 cesium-137 activity in upstream fruit (<0.21 Bq/kg), root vegetables (<0.38 Bq/kg), and leafy vegetables (<0.47 Bq/kg) was not significantly different from their respective downstream values of <0.38, <0.35 and <0.47 Bq/kg. Cesium-137 activities have been low over the past five years, and showed no statistical difference between the upstream and downstream locations. There was no persistent trend noted for root or fruit vegetables.

Since there was no difference between upstream and downstream results for garden vegetables, the potential dose to members of the public from vegetable ingestion has been assessed to be nil in Section 7.3.3.

Organically Bound Tritium (OBT) and Tritium (HTO) were added as parameters for garden crop (fruit and root) in 2017 as they were identified as a potential pathway for human exposure (ingestion) via air and liquid emissions. In 2018 the tritium activities in all vegetables were below the method detection levels, which varied from 9.3 to 11.1 Bq/kg. Organically bound tritium was also below detection limits, which varied from 2.33 to 17.1 Bq/kg. Since the tritium activity in garden crop vegetables was below detection limit levels and benchmark values for native vegetation and garden crop (Table 11), and water ingestion is the dominant dose pathway, tritium analysis of garden crop vegetables was discontinued in 2019. Tritium analyses resumed in 2023 to obtain data for a longer time frame to ensure tritium remains below detection.

The respective HTO activities in upstream fruit, root vegetables and leafy vegetables were 16.1, < 10 and 0.69 Bq/kg. In downstream vegetables the respective HTO activities in fruit, root vegetables and leafy vegetables were < 4.6, 38.6 and 29.3 Bq/kg. OBT was below detection in most samples. The respective OBT values for upstream fruit, root vegetables and leafy vegetables were <7.7, <7.0 and 7.64 Bq/kg. Downstream respective OBT values for fruit, root vegetables and leafy vegetables were <6.2, <3.9 and <6.6 Bq/kg.

6.6.4 Wild Food

In 2023, sampling and analyses were performed for wild food which included local source honey, mushrooms, blueberries and wild rice. Results are summarized in Table 23. In 2023 the local honey was obtained from River Hill's Apiary, located approximately 12 km south of the WL site. The wild rice was purchased at a local market. The mushrooms were collected from three locations within a 17 km radius of the Whiteshell Main Campus. The south east location was within the Whiteshell Provincial Park at a distance of 15 km. The north east location, at a distance of 17 km, was situated near the site of the former Underground Research Laboratory. The north west location was on Provincial Highway 214, at a distance of 5 km. The blueberries were collected at the site of the former Underground Research Laboratory with assistance from members of the Black River First Nation.

The analysis for HTO and OBT in wild foods had been discontinued because previous year's results were below detection and well below benchmark values. However, analysis for HTO and OBT resumed in 2023 to obtain data over a sufficient time period to confirm that tritium does not need to be analyzed. The honey had a gross beta activity below the detection level of <335 Bq/kg. Gross Beta activity can normally be accounted for by potassium-40 activity, but in this case the detection level of gross beta was too high to make any useful comparisons with potassium-40 activity. The gross alpha, strontium-90 and cesium-137 activities were below their respective detection limits of <141 Bq/kg, <8 Bq/kg and <0.37 Bq/kg. The wild rice had a gross alpha activity less than the detection limit. The gross beta activity in wild rice was 231 ± 45 Bq/kg. Gross alpha, and strontium -90 were below detection limits in wild rice. Cesium-137 in wild rice was 0.55 ± 1.6 Bq/kg. The OBT was 20 ± 2 Bq/kg, while the sample was too dry for an HTO measurement. Blueberries had a gross beta activity of 27.8 ± 5.6 Bq/kg and a gross alpha of 1.12 ± 0.2 Bq/kg. The gross beta activity is accounted for by postasium-40. The activity of cesium-137 was < 0.47 Bq/kg in blueberries. The activity of strontium-90 was 0.2 ± 0.04 Bq/kg. Since this was only the second year of sampling for blueberries, CNL does not have background values for radioactivity in local blueberries.

The mushroom harvest did not differentiate on species type and included all mushroom varieties present. The beryllium-7 activities in mushrooms were below detection. The gross beta activities were similar in the south-east and north-west, and lower in the north-east. Potassium-40 accounted for most of the beta activity. The respective strontium -90 activities in the south-east, north-east and north-west locations were 0.7 ± 0.2, 0.9 ± 0.2, and 0.3 ± 00, Bq/kg. Cesium-137 was about ten times higher in the north-west sample compared to the south-east and north-east samples, which had respective activities of < 0.45 and 2.03 ± 0.045 Bq/kg. In 2019 and 2021 the north-west sample also had the higher cesium-137. In 2022 the north-east samples had the highest cesium-137. The HTO activity in the south-east mushrooms was 34.5 Bq/kg. The HTO in the other locations and the OBT activities in all locations were below detection.

The Cs-137 activity in mushrooms reflects the activity in the soil organic layer, and depends on the mushroom species that were collected. In the current sampling program no attempt was made to select particular mushroom species because of the need to collect 1 kg samples. Since the samples represent a mixture of mushroom species, the variation in results could reflect the variation in mushroom species. The south east and north east locations represent typical boreal settings, while the north-west location is on Milner ridge, a sandier and drier setting that used to be a sand bar on the shore of post glacial lake Agassiz. The mushrooms collected here had a different distribution of species compared to the other two locations. The sample date within the growing season may also influence the types of mushrooms species collected. Since the mushroom samples represent a mixture of different species we do not have usable BV values at this time. It is CNL's plan to refine mushroom sampling in the future in an attempt to focus on certain mushroom species.

For most parameters, the BV value is based on 3 times the geometric mean of 2001 to 2016 data. These values are given in Table 11. The monitoring of honey and mushrooms has recently begun, and their BV have not been included in Table 11 since their monitoring period has been too short to determine BV values. For the case of tritium in honey, BV values for honey were taken from 1) CNSC, Recommendations from the Tritium Studies Synthesis Report, 2019 January [34], and 2) Derived Release Limits for CNL's Whiteshell Laboratories, WL-509211-RRD-001, 2021 [9].

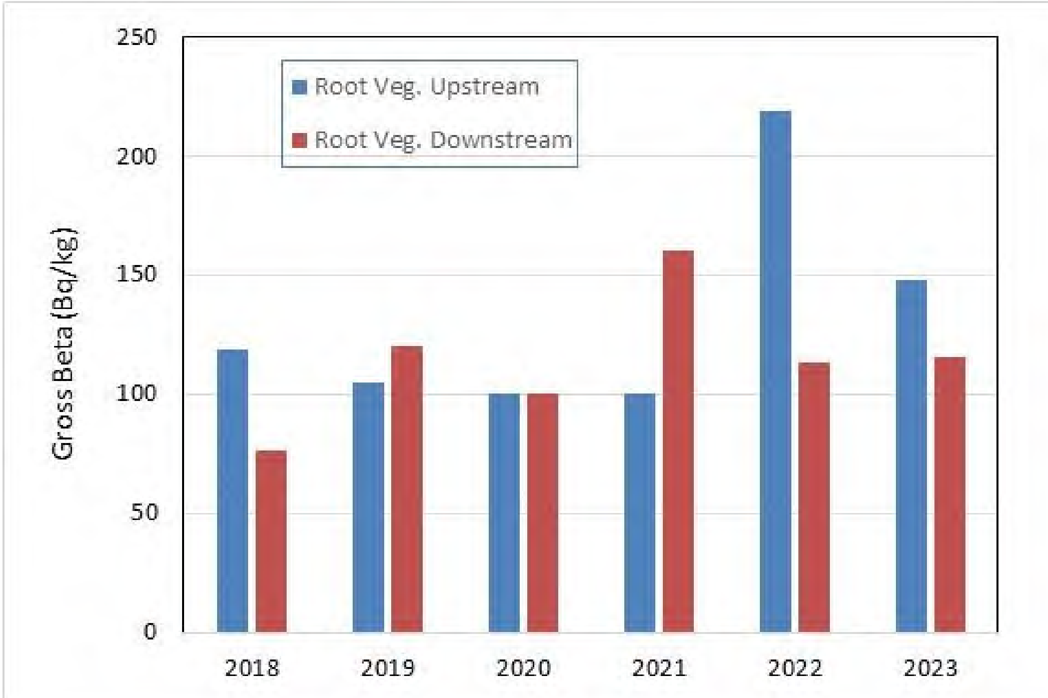

Figure 16: Gross Beta in Upstream and Downstream Root Vegetables, 2018 to 2023

Table 22: Radioactivity in Cultivated Vegetables in Vicinity of WL, 2018 to 2023

	Gross Beta (Bq/kg)							Gross Alpha (Bq/kg)							Strontium-90 (Bq/kg)						
	2018	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**	**2018**	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**	**2018**	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**
Upstream																					
Fruit	75	72	NA	<100	65	**78**	79	< 3.2	< 2.2	NA	<100	<0.45	**1.9**	0.40	< 0.1	< 0.1	NA	<5	<0.26	**1.4**	0.06
Root	119	105	100	100	219	**129**	148	< 3.8	< 2.6	<100	<100	<1.09	**2.5**	0.25	< 0.1	< 0.1	<100	<5	<0.88	**1.5**	0.05
Leafy Veg.	NA	106	NA	<100	61	**89**	51	NA	3.3	NA	<100	0.08	**1.7**	0.20	NA	< 0.2	NA	<5	<0.3	**1.8**	0.1
Downstream																					
Fruit	76	74	NA	<100	69.4	**80**	67	< 3.5	< 1.9	NA	<100	0.14	**1.8**	0.54	< 0.1	< 0.1	NA	<5	<0.7	**1.5**	0.06
Root	76	120	<100	160	113	**114**	116	< 3.9	< 2.8	<100	<1.1	0.27	**2.0**	0.43	< 0.1	< 0.1	<100	<5.7	<0.7	**1.7**	0.04
Leafy Veg.	NA	94	100	<100	56.7	**88**	57	NA	< 3.2	<100	<100	0.01	**1.6**	1.04	NA	< 0.2	<100	<5	<0.3	**1.8**	0.1
	Potassium-40 (Bq/kg)							**Cesium-137 (Bq/kg)**							**Beryllium-7 (Bq/kg)**						
	2018	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**	**2018**	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**	**2018**	**2019**	**2020**	**2021**	**2022**	**Ave**	**2023**
Upstream																					
Fruit	73	83	NA	<1000	176	**111**	81	< 0.6	< 0.3	NA	<100	<0.39	**0.4**	0.21	< 5	< 0.4	NA	<1000	<9.5	**5.0**	1.9
Root	155	86	<1000	<1000	<141	**127**	154	< 0.4	< 0.5	<100	<100	<0.31	**0.4**	0.38	< 3	< 0.6	<1000	<1000	<5.9	**3.1**	3.5
Leafy Veg.	NA	137	NA	<1000	73	**105**	64	NA	<0.34	NA	<100	<0.26	**0.3**	0.47	NA	< 0.7	NA	<1000	<5.9	**3.3**	4.5
Downstream																					
Fruit	89	119	NA	<1000	93	**100**	71	< 0.7	<0.3	NA	<100	<0.29	**0.4**	0.38	< 6	< 0.4	NA	<1000	<4.5	**3.6**	2.6
Root	67	141	<1000	225	225	**165**	130	< 0.9	<0.9	<100	<0.32	<0.32	**0.6**	0.35	< 8	< 0.7	<1000	<8	<6.7	**5.8**	4
Leafy Veg.	NA	104	100	<1000	70	**91**	65	NA	<0.41	<100	<100	<0.28	**0.3**	0.21	NA	< 0.8	<1000	<1000	<4.7	**2.8**	2

Notes:

1. Where all values were less than detected, the highest less than value is indicated in the table.
2. In the calculation of 5 year averages, unrealistic high detection limits such as <100 or <1000 were excluded.

Table 23: Radioactivity in Wild Food at Whiteshell Laboratories and Vicinity, 2023

Sample Location	Sample Date	Gross Beta (Bq/kg)	Gross Alpha (Bq/kg)	Sr-90 (Bq/kg)	K-40 (Bq/kg)	Cs-137 (Bq/kg)	Be-7 (Bq/kg)	Tritium (Bq/kg)	OBT (Bq/kg)
Local Source Honey	9-Aug-23	<335	<141	<8.0	<3.3	<0.37	<5.1	<3.6	<5.3
Mushrooms South East	12-Sept-23	146 ± 29	10.6 ± 2.1	0.7 ± 0.2	187 ± 14	<0.45	<4.9	34.5 ± 4	<6.5
Mushrooms North East	12-Sept-23	81 ± 16	12.1 ± 2.4	0.9 ± 0.2	106 ± 12	2.03 ± 0.45	<7.9	<6	<8.2
Mushrooms North West	12-Sept-23	149 ± 30	3.58 ± 0.72	0.3 ± 0.0	130 ± 11	28.1 ± 1.20	<6.8	<5.7	<8.5
Wild Rice	5-Oct-23	231 ± 45	<94.5	< 0.06	94 ± 11	0.55 ± 0.16	< 2.2	Too dry	20 ± 2
Blueberries	5-Oct-23	27.8 ± 5.6	1.12 ± 0.22	0.2 ± 0.04	31± 7	<0.47	<6.3	<8.5	<5.3

Notes:

1. Activities are reported per fresh weight.
2. For security improvement and fire control, the soil and vegetation was removed from the area just outside the WMA fence and replaced with gravel.

LLD = Lower Limit of Detection.
NR = Not Reported by contract lab.
NA = Not Available

6.7 Monitoring of Native Vegetation and Soil

6.7.1 Native Vegetation

Terrestrial vegetation samples consisting of mixed grasses, weeds, and clover are collected at a mature growth stage in the fall. The vegetation from an area of several m^2 are processed. The resulting ash is submitted for gross beta and gross alpha counting, as well as gamma spectroscopy. The vegetation is cut to ensure that soil and root material are not included in the sample. The results for native vegetation for 2023 are provided in Table 49 in Appendix B. Figure 22 in Appendix A shows the locations of the ARMS stations, and Figure 23 (Appendix A) shows the sample locations near the WMA. The data for the period of 2018 to 2023 along with the five-year average values are shown in Table 24.

As stated in previous reports, no trends are evident at the ARMS sampling locations. The gross beta activity[46] is mostly accounted for by the potassium-40. In all cases gross beta results for 2023 are lower than in 2022 and the 5 year averages. As mentioned previously potassium-40 is a naturally occurring isotope and is present in all soil and vegetation samples.

The alpha activities for most samples were lower than in 2022 and the averages of the previous five years. The one exception is the sample from location WMA#1.

With the exception of ARMS#8 (0.8 Bq/kg) the cesium-137 activity in all locations was below the detection limit, which varied from 0.2 to 0.8 Bq/kg. The background level for cesium-137 is 4.0 Bq/kg [51], [52] for this part of Manitoba. The cesium-137 results for 2023 are lower than previous years due to improved detection limits, and well below the benchmark value of 21 Bq/kg.

Low activities of strontium-90 were detected in most ARMS samples. In WMA#1 and WMA#7 strontium-90 was less than in 2022 and the average of the previous five years. Potassium-40 was less than the average of the previous five years. The gross beta was also lower than the average of the previous five years for all locations, which is expected since potassium-40 accounts for gross beta.

The presence of any low levels of strontium-90 activity in the native vegetation at the ARMS locations are likely the result of aerial deposition from current and historical site structures.

Analysis for OBT and HTO resumed in 2023. The HTO activities varied from <3 to 14 Bq/kg. The OBT activities varied from <6 to 23 Bq/kg. The highest OBT was from location ARMS#4.

As mentioned in Section 1.1, this report does not cover results of environmental monitoring for operational control purposes within individual facilities. The results for additional vegetation sampling within the WL WMA are included in the WL Annual Compliance Monitoring Report [8].

[46] In 2015 potassium-40 was once again used to establish the beta efficiency of the detectors.

Table 24: Radioactivity in Native Vegetation at Whiteshell Laboratories and Vicinity, 2018 to 2023

Radioactivity (Bq/kg fresh weight)							
	2018	**2019**	**2020**	**2021**	**2022**	**Five-Year Average***	**2023**
ARMS #1							
Cs-137	< 1.6	<1	<1.1	<0.8	<2.16	1.4	<0.2
Sr-90	<1.9	<2	<10.1	<6.7	0.57	4.3	<1.75
K-40	132	361	153	180	162	198	38
Gross Beta	160	490	129	210	158	229	41
Gross Alpha	23	16	<6.5	3.67	38.8	18	3.05
Tritium		2	<20	ND	NA		11
Tritium - OBT		51	<20	ND	NA		15
ARMS #3							
Cs-137	< 4.4	<1	<1.1	<0.8	<1.17	1.7	<0.3
Sr-90	<5.3	<2	<8.1	<1.8	0.59	3.6	<0.97
K-40	293	267	205	181	99	209	25
Gross Beta	320	410	219	130	75.8	247	33
Gross Alpha	33	5	<11	2.59	38.5	18	3.75
Tritium		2	<20	ND	NA		<3
Tritium - OBT		16	43	ND	NA		<10
ARMS #4							
Cs-137	< 3.5	<0.5	<0.44	<1.1	<0.90	1.3	<0.2
Sr-90	<5.0	<2	<7.8	<4.9	0.07	4.0	<1.11
K-40	269	160	210	192	150	196	38
Gross Beta	290	219	218	158	122	201	48
Gross Alpha	64	2	<8.4	2.97	28.9	21	6.03
Tritium		10	<20	ND	NA		10
Tritium - OBT		6	67	ND	NA		23
ARMS #5							
Cs-137	< 5.7	< 0.69	<0.82	<1.9	<2.16	2.2	0.8
Sr-90	<8.2	<2	<6.4	<2.0	<0.10	4.0	<0.78
K-40	535	157	262	166	190	262	35
Gross Beta	527	150	247	148	129	240	51
Gross Alpha	20	<9.5	<5.4	1.28	31.9	13.6	5.80
Tritium		7	<20	ND	NA		14
Tritium - OBT		19	61	ND	NA		<6

Radioactivity (Bq/kg fresh weight)							
	2018	**2019**	**2020**	**2021**	**2022**	**Five-Year Average***	**2023**
West of WMA and North of Canister Area (WMA#1)							
Cs-137	< 2.4	< 0.7	<0.81	<1.5	<1.87	1.5	<0.4
Sr-90	<3.2	17.4	<9.6	<5.1	0.19	7.1	<0.9
K-40	138	170	183	217	107	163	53
Gross Beta	187	210	162	171	102	166	58
Gross Alpha	41	27	<6	5.69	40.5	24	7.67
Tritium		58	183	ND	NA		9
Tritium - OBT		4	35	ND	NA		22
****East of WMA near Incinerator (WMA#7)**							
Cs-137	< 1.7	< 0.7	<1.2	<1.7	<0.87	1.2	<0.2
Sr-90	<2.7	1.5	<9.1	<5.5	0.6	4.0	<1.0
K-40	136	130	149	141	105	132	52
Gross Beta	195	202	152	130	106	157	59
Gross Alpha	38	25	<7	7.34	30.1	21	4.0
Tritium		7	<20	ND	NA		<7
Tritium - OBT		61	<20	ND	NA		<9

Notes:

* The average value was calculated based on the maximum of the stated range for the year,

** WMA#7: New location added to EM sampling program.

6.7.2 Soil

A summary of the radioactivity found in the surface soils collected in 2023 at the perimeter locations [53] of Standpipe Rows E, F, and G in the WMA are given in Table 50 in Appendix B.

The alpha activities observed in the 2023 samples ranged from 0.07 to 0.22 Bq/g, and in all cases were well below the benchmark for WMA soils (100 Bq/g). There was no indication of the presence of americium-241 or plutonium isotopes. The alpha activity is most likely from naturally occurring alpha emitters such as uranium and thorium present in the soil. All samples were below the Nuclear Substance and Radiation Devices Regulation (NSRDR) Clearance Level of 1.0 Bq/g [54] for radionuclides of natural origin. Except for one sample at Location E (1.77 Bq/g), the strontium-90 activities for the surface soils at the perimeter locations were below the NSRDR Clearance Level of 1.0 Bq/g [54], and well below the benchmark of 2000 Bq/g. Cesium 137 activity at the perimeter locations (0.001-0.051 Bq/g) are similar to the normal background levels for cesium-137 (0.02 to 0.11 Bq/g [40] for this part of Manitoba, and at the NSRDR Clearance Level of 0.1 Bq/g [54]. The activity is well below the benchmark value of 0.8 Bq/g. Radioactivity assaying of groundwater (from routine environmental monitoring), and the soil assays from this study indicate there is no significant radioactive migration from the waste management facilities.

Remediation of the soil near the standpipes will be conducted in accordance with the Comprehensive Study Report [55] in which it was stated that management plans for the contaminated soils near the standpipes will be prepared and documented as part of the Detailed Decommissioning Plan. Progress on this work is reported in the WL Annual Compliance Monitoring Report [8].

6.8 Monitoring of River Sediment

River bottom sediments were collected from 12 locations along the Winnipeg River, ranging from 0.8 km upstream to 13.1 km downstream of the Outfall (see Figure 22 in Appendix A). Three samples, each consisting of the top centimeter of the sediment were collected using a coring tool at each location, and the average and standard deviation of the three readings for each location have been recorded. The core diameters were 2.8 cm, giving a sampled river bottom area of 6.2 cm^2. Table 25, Table 26, Table 27 and Table 28 show the gross alpha, gross beta, potassium-40, and cesium-137 activities (in Bq/kg dry weight) of the river-bottom sediments from the 12 locations along the Winnipeg River for the years 2018 to 2023, along with the corresponding five-year average. Table 51 in Appendix B shows the distance from shore, the depth of water at each sampling site, and the weights of each of the three samples collected at every site.

In 2023, the gross alpha activity detected in the samples ranged from 180 Bq/kg to 677 Bq/kg. The alpha activity in these samples is due to naturally occurring isotopes such as U-238 or Th-232 and their progeny, as both upstream and downstream samples contain similar levels. In addition, gamma spectrometry of the samples confirmed the presence of uranium and thorium progeny. All samples are below the NSRDR Clearance Level of 1,000 Bq/kg [54] for sediments of natural origin. The background value for gross alpha is 600 Bq/kg and the benchmark value for gross alpha is 2E+05 Bq/kg, or 1000 Bq/kg as natural uranium (Table 11).

The gross beta activity in the sediment includes contributions from naturally occurring potassium-40 and from cesium-137. The majority of the beta activity for all locations is most likely from naturally occurring potassium-40. The gross beta activities measured in 2023 ranged from 413 to 1697 Bq/kg and for 8 out 12 cases were higher than observed in 2022 and the averages of the previous 5 years, with no trends being observed. The sum of cesium-137 and potassium-40 activities were equivalent with gross beta activities, taking into account the sum of the uncertainties of the cesium-137 and potassium-40 values. Any beta activity in excess of cesium-137 and potassium-40 activities would be assumed to be strontium-90/Y-90. Most gross beta activities were below the natural background of 900 Bq/kg and all well below the benchmark value of 2E+04 Bq/kg (Table 11).

All cesium-137 activity levels were below the lower limit of detection of 10 Bq/kg and below the five year average values. All samples collected in 2023 were below the NSRDR Clearance Level of 100 Bq/kg [54] and well below the benchmark value of 1E+05 Bq/kg (Table 11). The activity at the OFL location has historically varied from < 5 Bq/kg to 75500 Bq/kg [55]. Variation of activity is not unexpected for all samples due to the highly localized and spotty nature of the contamination in the river sediments. This year to year variability can be seen for OFL, K01, K03 and K05 in Table 28 . Sample collection is difficult as the river bottom has a rocky bottom exposed at the sampling locations due to the erosion created by the river current. The results from the sampling location are plotted in Figure 17. An attempt will be made in 2024 to lower the detection limits of cesium-137 and potassium-40 by collecting larger amounts of sediment. On-going evaluation of the river sediments is covered by the Environmental Assessment Follow-up Program [1] for the Whiteshell Site. Dose estimates to critical group members were not calculated for exposure to river bottom sediments since it is highly unlikely that a person would be exposed through this route.

Table 25: Gross Alpha Activity in Winnipeg River Sediments, 2018 to 2023

Location Code and Distance from Outfall (km)		Gross Alpha (Bq/kg dry weight)								
		2018	2019	2020	2021	2022	Five-Year Average	2023		
J04	-0.76 (upstream)	224	467	467	333	127	324	310	±	89
J02	-0.37 (upstream)	303	533	350	233	163	316	180	±	98
OFL	0 (Outfall)	534	167	267	233	320	304	307	±	111
K01	0.15 (downstream)	326	533	267	517	327	394	223	±	49
K03	0.52 (downstream)	297	567	667	767	327	525	633	±	58
K05	0.79 (downstream)	334	167	400	400	273	315	263	±	45
K14	2.56 (downstream)	289	467	300	533	350	388	393	±	55
K19	3.48 (downstream)	393	367	233	700	290	397	437	±	127
K22	4.63 (downstream)	338	633	767	400	357	499	677	±	137
K23	4.78 (downstream)	421	333	533	433	233	391	310	±	147
K24	4.93 (downstream)	406	300	800	353	543	480	507	±	94
K30	13.06 (downstream)	416	567	1067	300	430	556	467	±	85

Notes:

1. Uncertainties of results are based on the variability of results of the three samples collected from each area.
2. The NSRDR Clearance Level for naturally occurring such as U 238 and Th 232 is 1,000 Bq/kg and 100 Bq/kg for Am 241 [54].

Table 26: Gross Beta Activity in Winnipeg River Sediments, 2018 to 2023

Location Code and Distance from Outfall (km)		Gross Beta (Bq/kg dry weight)								
		2018	2019	2020	2021	2022	Five-Year Average	2023		
J04	-0.76 (upstream)	400	733	967	800	457	671	763	±	38
J02	-0.37 (upstream)	283	1100	433	533	430	556	413	±	40
OFL	0 (Outfall)	583	633	767	567	773	665	743	±	61
K01	0.15 (downstream)	590	967	700	900	843	800	503	±	148
K03	0.52 (downstream)	557	1133	867	1000	763	864	1107	±	45

K05 0.79 (downstream)	594	333	767	800	680	635	840	±	191
K14 2.56 (downstream)	545	700	767	917	877	761	857	±	67
K19 3.48 (downstream)	467	933	700	1067	797	793	1100	±	151
K22 4.63 (downstream)	588	1067	867	733	680	787	1197	±	84
K23 4.78 (downstream)	590	567	1067	867	557	730	790	±	69
K24 4.93 (downstream)	800	733	1900	1133	1400	1193	1697	±	152
K30 13.06 (downstream)	695	700	1433	567	970	873	1010	±	95

Notes:

1. Uncertainties of results are based on the variability of results of the three samples collected from each area.
2. The NSRDR Clearance Level for naturally occurring potassium-40 is 10,000 Bq/kg [54].

Table 27: Potassium-40 in Winnipeg River Sediments, 2018 to 2023

Location Code and Distance from Outfall (km)	Potassium-40 Activity (Bq/kg dry weight)								
	2018	2019	2020	2021	2022	Five-Year Average	2023		
J04 -0.76 (upstream)	361	700	290	<1000	600	590	1000		DLL
J02 -0.37 (upstream)	288	867	285	<1000	400	568	1000		DLL
OFL 0 (Outfall)	569	733	328	<1000	567	639	1000		DLL
K01 0.15 (downstream)	567	800	259	<1000	567	639	1000		DLL
K03 0.52 (downstream)	552	767	295	<1000	633	649	1000		DLL
K05 0.79 (downstream)	514	323	307	<1000	600	549	1000		DLL
K14 2.56 (downstream)	429	780	286	<1000	633	626	1000		DLL
K19 3.48 (downstream)	417	733	224	<1000	767	628	1000		DLL
K22 4.63 (downstream)	635	1033	262	<1000	633	713	1000		DLL
K23 4.78 (downstream)	657	833	284	<1000	600	675	1000		DLL
K24 4.93 (downstream)	848	700	448	<1000	833	766	1000		DLL
K30 13.06 (downstream)	727	767	352	<1000	767	723	1000		DLL

Notes:

1. Uncertainties of results are based on the variability of results for the three samples collected from each area.
2. The NSRDR Clearance Level for naturally occurring potassium-40 is 10,000 Bq/kg [54].

Table 28: Cesium-137 Activity in Winnipeg River Sediments, 2018 to 2023

Location Code and Distance from Outfall (km)	Cesium-137 (Bq/kg dry weight)								
	2018	2019	2020	2021	2022	Five-Year Average	2023		
J04 -0.76 (upstream)	9	< 20	11	< 10	< 10	12	10		DLL
J02 -0.37 (upstream)	7	< 20	10	< 10	< 10	12	10		DLL
OFL 0 (Outfall)	12	< 20	8	< 10	< 10	12	10		DLL
K01 0.15 (downstream)	13	< 20	8	< 10	< 10	12	10		DLL

K03 0.52 (downstream)	13	< 20	10	< 10	< 10	13	10		DLL
K05 0.79 (downstream)	10	< 20	7	< 10	< 10	11	10		DLL
K14 2.56 (downstream)	37	< 20	10	< 10	< 10	17	10		DLL
K19 3.48 (downstream)	11	20	8	< 10	< 10	12	10		DLL
K22 4.63 (downstream)	17	< 22	10	< 10	< 10	14	10		DLL
K23 4.78 (downstream)	10	53	9	< 10	< 10	18	10		DLL
K24 4.93 (downstream)	12	< 20	9	< 10	< 10	12	10		DLL
K30 13.06 (downstream)	23	23	13	< 10	< 10	16	10		DLL

Notes:

1. Uncertainties of results are based on the variability of the results for the three samples collected from each area.
2. LLD = Lower Limit of Detection as determined by contract lab.
3. The NSRDR Clearance Level for cesium-137 is 100 Bq/kg [54]
4. The radiation screening level for cesium-137 is 1E+5 Bq/kg.

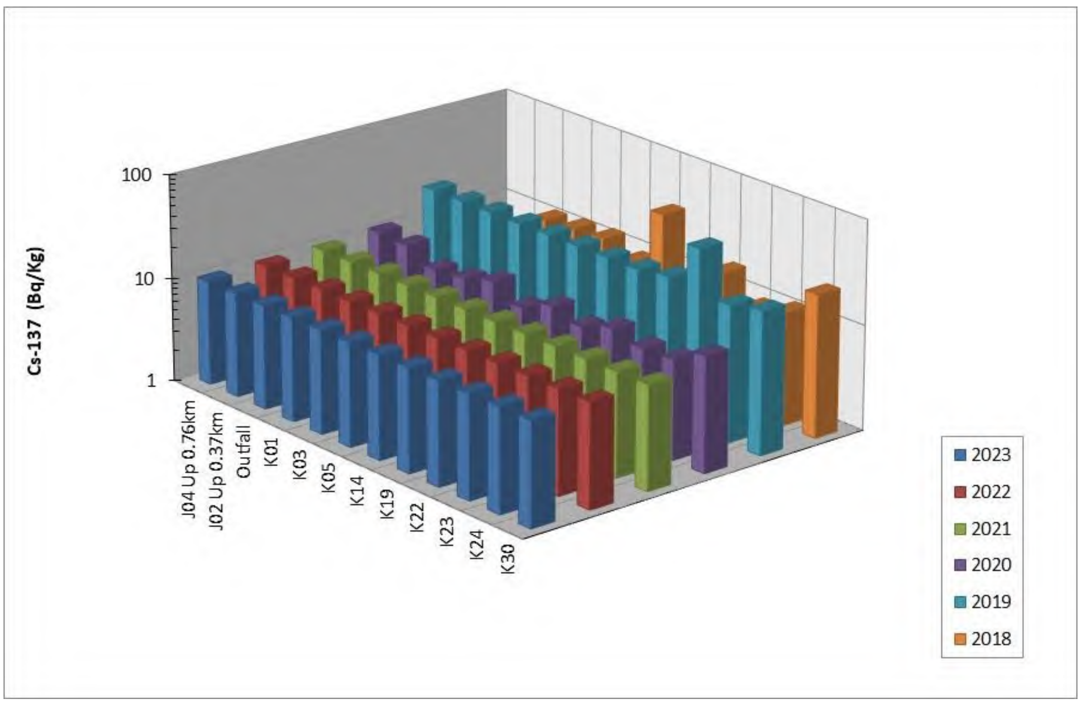

Figure 17: Cesium-137 Activity (Bq/kg) in Winnipeg River Sediments, 2018 to 2023

6.9 Biodiversity

As a federal land owner, CNL is committed, and has legal obligations, to protect the environment and maintain the goal of sustainable development. CNL has the obligation to conduct environmental reviews of the impact of its operations with special consideration given to a sub-set of environmental values that have been identified as sensitive and important to the scientific and local communities, also known as valued ecosystem components (VECs). Among the list of VECs present at WL, species at risk and their habitat, along with other not-at-risk species have been identified as important. In order to fulfill legal and operational requirements, CNL continues to monitor species at risk in an effort to understand species distribution and abundance throughout the site.

In 2023, monitoring included identifying all nesting bird species on WL buildings, site infrastructure and lands. Much of the work completed in 2023 was done to increase knowledge of biodiversity and support the proposed WR-1 project. In addition, knowledge gained enhances the Species at Risk awareness program and supports compliance related to decommissioning activities on the site. During 2023, there was one wildlife mortality, a White-tailed deer, on the plant road. There were no mortalities of species at risk.

Nest Identification Survey

In the summer of 2023, avian management took place during the migratory bird breeding window from the beginning of April to the end of August. Nesting Birds were documented in the wildlife tracking spreadsheet. The following information was gathered: the observation date; the status, number of and type of species occupying the nest; the location and status of the nest; the surroundings of the nest; and if eggs, hatchlings or fledglings were present. A notification e-mail would be sent to the building/area owner and a barricade would be erected with signage to notify staff of the active nest.

During the bird breeding season, one species at risk (Barn swallow) and several migratory bird species were found nesting on the Whiteshell site - Eastern phoebe, American robin, Killdeer, Cliff swallow, Tree swallow and Sandhill Cranes.

Bat Surveys

In 2014, Canada released an emergency order for the listing of small bodied bat species that hibernate in caves to Schedule 1 of the Species at Risk Act (SARA). At that time, these bat populations began to see a dramatic decline due to White Nose Syndrome (WNS). Manitoba is home to 6 different bat species, two of which are listed as ‘endangered’ on Schedule 1 of SARA: Little Brown Myotis (*Myotis lucifugus*) and Northern Myotis (*Myotis septentrionalis*).

As defined in the SARA, individual bats are protected under sub-section 32 and it is prohibited to damage or destroy their residence as per sub-section 33. A residence is defined by the Act as a dwelling-place that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding or hibernating. For bats species, both roosting and overwinter habitat are considered a residence and afforded protection under sub-section 33 of SARA.

Due to the listing of these bats, CNL conducted an assessment to determine if any of its operations would have an impact on these species. It was concluded that buildings such as the WR-1 reactor building that are scheduled for decommissioning should be assessed to determine if their removal would impact any bat species that could be using the facility.

Monitoring for bat roosting at WR-1 is an important commitment of the Environmental Impact Statement (EIS) for the proposed in-situ decommission of WR-1. If bats are confirmed to be using the WR-1 structure as habitat through pre-disturbance surveys, offsetting potential habitat loss in the form of bat boxes may be required when WR-1 is decommissioned.

In 2023, two exit surveys in July and August were conducted around WR-1. No bats were observed exiting the WR-1 Building. However, some bird species were noted to be using core holes into building 100. The holes were made to execute work for the islanding project, and personnel were contacted to ensure that the holes were capped on the inside to prevent wildlife from obtaining a pathway into the building.

Bats were detected and recorded on the outdoor passive and active acoustic recorders in July and August. The data was analyzed using Kaleidoscope Pro Analysis software. The software analyses the recorded echolocations and automatically identifies the bat species present. In July and August three species were identified: the Hoary, Silver Haired and Big Brown Bats. These are migratory species of bats. No bats that are protected by the Species at Risk Act were detected during the studies.

Over two summers of exit surveys in which a total of four exit surveys were conducted, no bats were observed exiting the facility, including no species at risk bats However, if the building was being used as a maternity roost or roosting location for a large number of bats it would be more easily observed. Due to the lack of visual confirmation of bats exiting the facility and the timing and frequency of the calls recorded, it is believed that the WR-1 building is not currently being used as roosting habitat. In addition, a 2023 inspection was planned to be conducted to investigate internal spaces of WR-1. However, this work was not completed due to a safety stand down. This work will need to be planned in 2024.

Turtle Study

The two turtle species at the WL site and surrounding forested areas are the snapping turtle (*C. serpentina*) and the western painted turtle (*C. marginata bellii*). In the summer of 2023, a turtle search was performed on site once a week from May 16th to August 31st by driving along both sides of the Waste Management Area access road, Landfill road, Lagoon loop, Plant road and the road to B902. The road to B902 was added this year due to its proximity to the Winnipeg River and potential for nesting. The original four roads were selected due to their high volume of traffic. All five roads were surveyed each time the survey was performed. If a turtle was found during the survey, the following information was gathered: the species of turtle, its location, general condition, and activity. No turtle mortalities were found on any of the surveyed roads.

Both species of turtles were found on the Whiteshell grounds in 2023 either through road surveys or chance observations. There is a likelihood for these turtles to cross the road as there are dugouts' on either side of the road.

6.9.1 Site Permits

A Scientific Collection Permit: 67580134 was obtained for Fish collection activities. A Wildlife Scientific Permit: WB26588 for roadkill collection, valid from 2023 through 2028 was also obtained. A beaver dam removal and wildlife kill permit (beaver) were obtained to clear beaver activity from the main drainage ditch discharging to the river (near ditch sample location 9).

6.10 Incorporation of Culturally Important Plants

Canadian Nuclear Laboratories is committed to the incorporation of culturally important plants as a Valued Component (VC) into the Environmental Monitoring Program. Culturally important VCs include medicines and foods consisting of plants and fungus. To make this happen CNL needs to understand which plants and fungus are of cultural interest, where should they be sampled and can they be found in sufficient quantity (~2 kg) to be suitable for analyses.

To this end a walk down of areas of the WL site was previously performed in 2022 September with Indigenous elders to identify the presence of plants that are of interest for providing a source of traditional medicine and food. This knowledge is intended to help CNL's understanding of the value of the WL site as a potential source of traditional plants. In addition it will be used to enhance WL's Environmental Monitoring program by including selected plants to determine whether traditional plants harvested from the WL site are safe to eat, and to quantify the limit of any contamination that might have spread from the site.

Due to the safety stand down, no follow up walk downs were performed in 2023.

7. Assessment of Doses to the Public

7.1 General

Section 7.2 examines and assesses the radiation doses for 2023, due to emissions from the WL site. The doses calculated are to the most exposed off site members of the public (i.e., critical groups) as identified in the WL DRL document [9] for the site. Critical groups are an identifiable, relatively homogeneous group of members of the public who, as a result of their location, age, diet and habits, are representative of those people expected to receive the highest radiation doses as a result of emissions of a given radionuclide from a given source. The potential critical groups which have been identified for the WL site are shown in Table 29 and Figure 18.

Table 29: Potential Critical Groups for Whiteshell Laboratories

Air Effluent Critical Groups	Liquid Effluent Critical Groups
Farms A, D, F	Farm A
Farm E	

Dose calculations are performed for a hypothetical adult and 3-month old infant, using the results of environmental monitoring at and around critical group locations, for air effluent and liquid effluent exposure pathways. The characteristics assigned to these individuals are conservative such that the doses calculated are expected to be higher than the maximum dose that might be measured for any actual individual.

The dose assessments are based on the results of environmental monitoring of the dominant environmental pathways leading to critical group dose, where the monitoring indicates an actual or potential contribution from CNL above normal background.

Dose conversion factors for calculating effective dose from ingestion, or exposure to surfaces contaminated by radionuclides are consistent with the WL DRL document [9].

For comparison with the dose estimates below, the current regulatory limit of effective dose to members of the public from human activities involving ionizing radiation (excluding medical diagnostic or treatment procedures) is 1 mSv/a. Average values for annual background doses to adults from natural sources of radiation and from medical diagnostic procedures, reported by the National Council on Radiation Protection and Measurement (NCRP) [50] and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) [52] are given in Table 30. Actual background doses can vary considerably at different locations and different countries (one or more orders of magnitude) depending on various factors such as elevation above sea level, local geology, and housing construction.

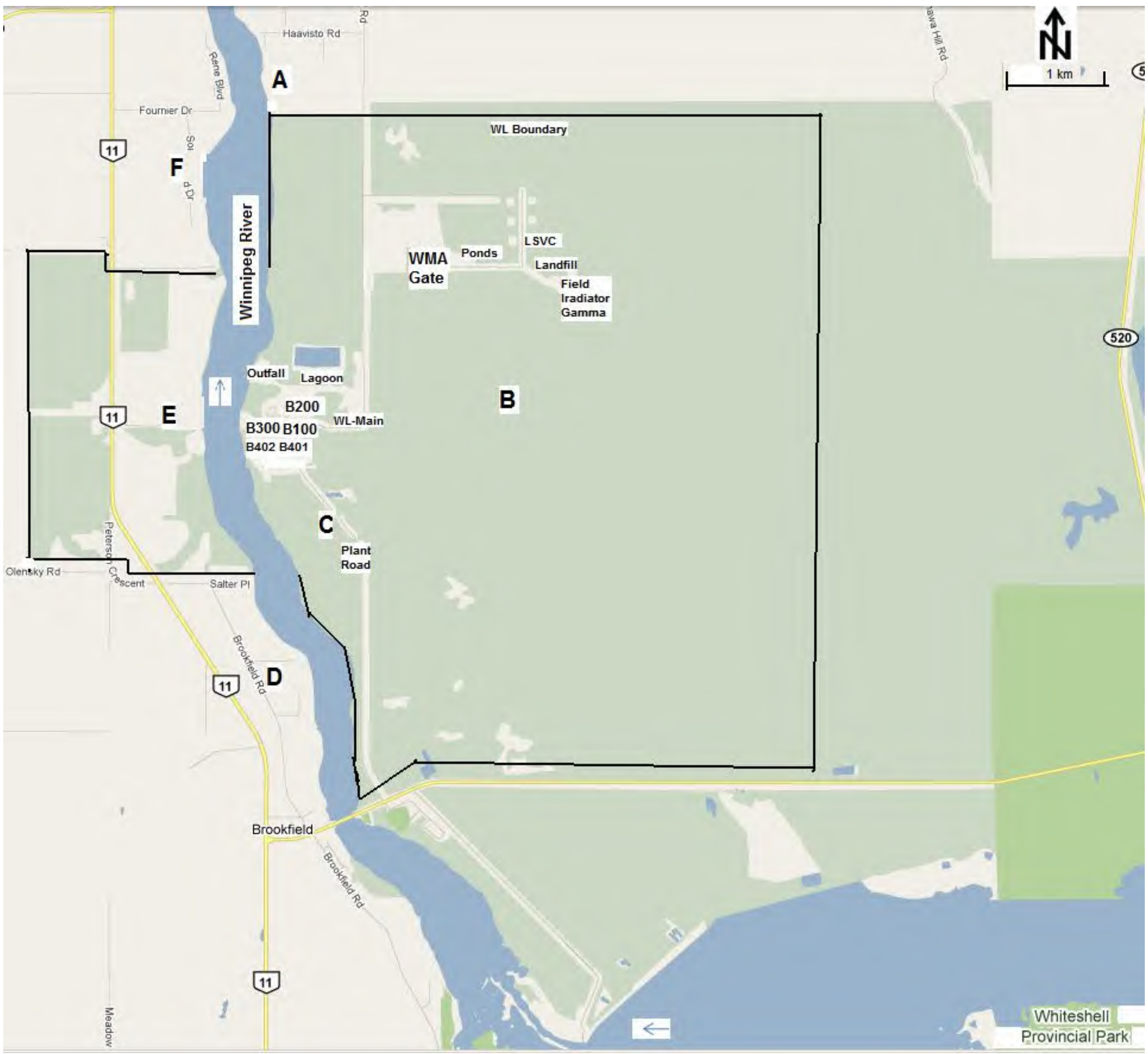

Figure 18: Map of WL Site Showing Location of Farm A, D, E and F

Table 30: Typical Annual Average Doses from Natural Background, Medical Diagnostics, and Consumer Products

Source of Exposure	Annual Average Effective Dose (mSv)
Natural Sources:	
• Cosmic Radiation (Canada) [56]	0.39
• Terrestrial Gamma Radiation (Canada) [56]	0.23
• Radionuclides in the Body (Except Radon) (Worldwide) [56]	0.30
• Radon and its Decay Products (Worldwide) [56]	1.30
Consumer Products and Services (Worldwide) [57]	0.025 to 0.095
Medical Diagnostic Procedures (Industrialized Countries) [57]	1.1
Total Dose (Natural Sources Plus Medical Procedures Plus Consumer Products and Services)	**3.3**

The general equation used for calculating dose due to nuclide n is;

Equation 1:

$$Dose\left(nuclide\ \ n\right) \;=\; C(n)\cdot DCF\ \cdot I\cdot G$$

where:

C(n) = incremental concentration of nuclide n (Bq/L or Bq/kg),

DCF = dose conversion factor,

I = consumption rate (L/a or kg/a), and

G = fraction from local sources (unitless).

Units vary according to the case being considered. Ingestion DCFs are consistent with those used in the WL DRL document [9]. These can also be found in International Commission on Radiological Protection (ICRP) 72 [57] and the Health Canada publication [58], respectively. Dose calculations are described in the following sections, and the calculation steps are shown in Table 52 in Appendix B.

Another factor that can be considered is an adjustment factor to take into account for the effects of food processing. Equation 1 was modified by adding a unitless food processing factor (*ρ)* to make Equation 2 below.

Equation 2:

$$Dose\left(nuclide\ \ n\right) \;=\; C(n)\cdot \rho\cdot DCF\ \cdot I\cdot G$$

where:

ρ = adjustment factor for food processing (unitless)

7.2 Whiteshell Laboratories Air Effluent Exposure Pathways

7.2.1 Air Effluents Exposure Pathways

The DRL model for WL identifies four potential critical groups for airborne effluents [9]. Farms A, D and F have year-round occupants and raise livestock. Farm E has limited occupancy and raises canola.

Dose for all air emissions pathways was estimated by multiplying the WL total air release (Table 6), as a fraction of the DRL, by 1 mSv. This value, along with those calculated for 2017 to 2022, are included in Table 1.

The pathways included in the dose assessment for airborne effluents (Figure 19) are those that have the potential to contribute significantly to dose from exposure to the radionuclides above background levels. They include ingestion of game animal meat. Other radionuclides and exposure pathways that may result in negligible doses to members of the public were not included in the dose assessment.

7.2.2 Ingestion of Game Animal (Deer, Grouse) Meat

The ingestion of game animal meat is a dominant pathway for airborne effluent scenarios [9] for exposure to cesium-137 (part of gross beta) which is potentially present in WL effluent. The annual dose to critical groups was estimated from the average measured radioactivity in game animal meat (e.g., deer, grouse) obtained from within about 25 km of the WL site, including animals from the site itself. The values used in the dose calculations represent averages of samples collected during the past three years. Since there are few samples obtained in one year, using a three-year average provides a larger data set from which a more realistic dose estimate can be calculated. The contributions from WL were obtained by subtracting the average concentrations in large game animals collected from locations greater than 25 km away from the WL site, from the average concentrations in animals collected from within 25 km of the site.

The annual effective dose to members of the Farm A critical groups from ingestion of large game animal meat was estimated using Equation 2 above, and the total dose is presented in Table 31. A deer meat consumption rate of 34 kg per year for adults and 6.1 kg per year for 3-month old infants was used in dose calculations [9]. The calculated dose is based on the assumption that 100% of the deer meat consumed by members of the critical group is contaminated, and that the effect of food processing on radioactivity in the meat is negligible. In 2023 the calculated dose from the ingestion of large game animals is nil because the difference in background concentrations in animals close to the WL site and further away is zero and therefore no dose is expected due to WL operations.

7.2.3 Ingestion of Garden Produce

The determination of dose received from the ingestion of garden produce in 2023 and previous years has focused on the dose received from waterborne effluents. The calculated dose was based on comparing the radioactivity in vegetables grown downstream from that in vegetables grown upstream. This does not address any doses received from airborne effluents. To address doses from airborne effluents one needs to compare the activity in local vegetables with that in vegetables grown at a distance of more than 50 km from the Whiteshell site.

As part of an investigative study, in 2024 vegetables will be obtained from one or more locations that are more than 50 km from the Whiteshell site. The activity from these vegetables will serve as the basis for establishing background radioactivity that has not been influenced by airborne effluents from Whiteshell. The results of this study will be reported in Section 7.2.3 of the WL Environmental Monitoring Report for 2024.

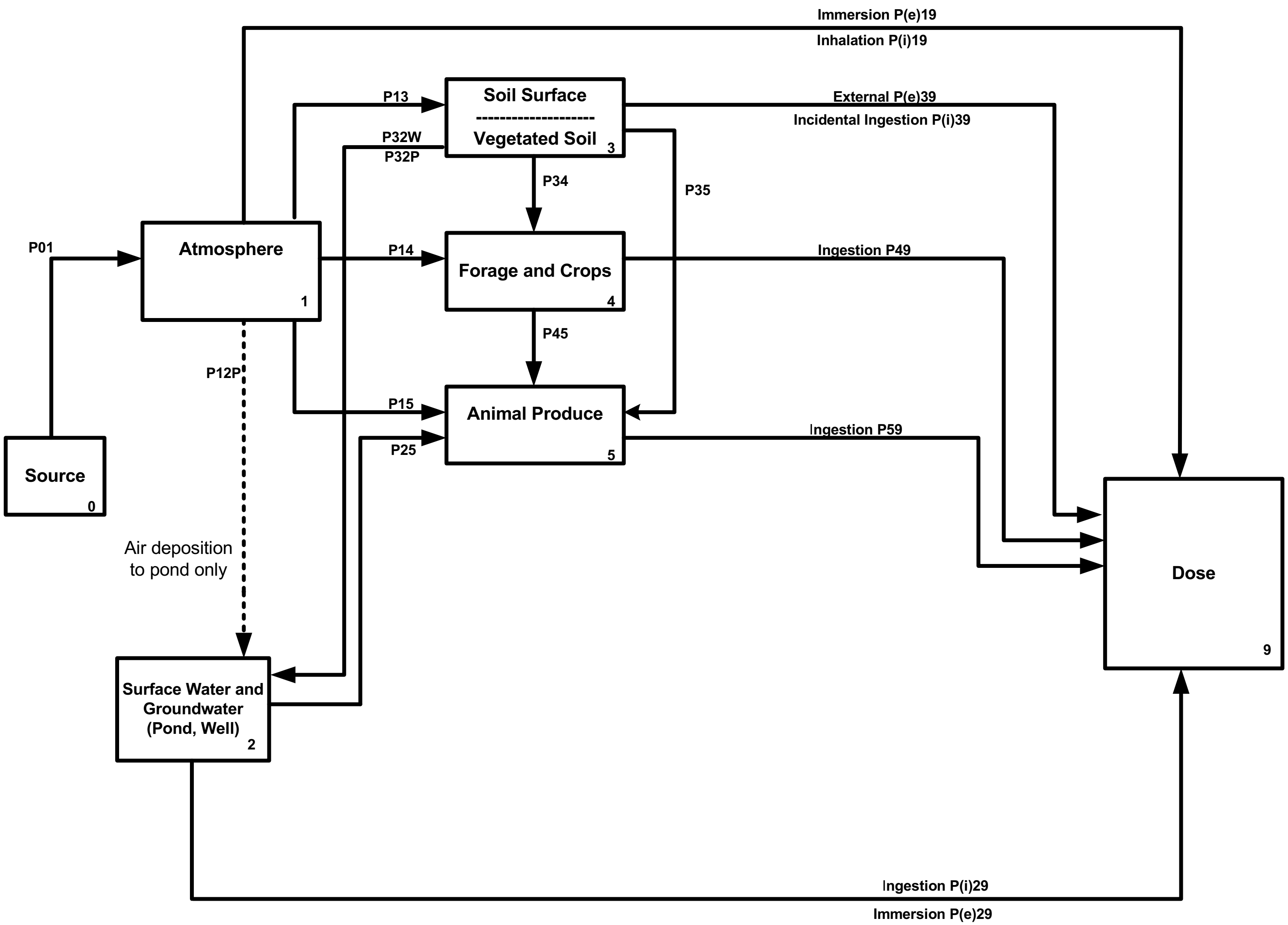

Figure 19: Environmental Transfer Model for Airborne Effluent Modelling

Table 31: Dose to Critical Group at Farm A from Ingestion of Large Game Animal Meat

Radionuclide	Concentration in Game Animal Meat above Background (Bq/kg fresh weight)	Dose Coefficient for Ingestion (Sv/Bq)		Effective Dose (mSv/a)	
		Adult	Infant	Adult	Infant
^{137}Cesium	0.0	1.3E-08	1.2E-08	nil	nil
^{90}Strontium (bone)	0.0	2.8E-08	7.3E-08	nil	nil
			Total Dose	nil	nil

7.3 Liquid Effluent Exposure Pathways

The DRL model for WL identifies one potential critical group for liquid effluents including residential group at Farm A [9]. The radionuclides included in the dose assessment for liquid effluents were those that were known or expected to be released from the WL site in 2023, and were detectable at the critical group locations or have the potential to contribute significantly to the dose to any critical group.

The pathways included in the dose assessment for liquid effluents are those that have the potential to contribute significantly to the dose from exposure to the radionuclides above. They include ingestion of water and consumption of fish. Ingestion of garden vegetables has been included although not identified as a dominant dose pathway. Other radionuclides and environmental exposure pathways that may result in negligible doses to members of the public were not included in the dose assessment because the radionuclides were not detected above background and/or above detection limits.

Dose estimates for beach sediments based on the river bottom sediment data were not considered since it is highly unlikely (less than 1%) that a person would be exposed through this route.

Figure 20 represents the environmental transfer model of liquid effluent exposure pathways to human receptors used for public dose calculation at Whiteshell, including the dose contribution from each pathway in 2023.

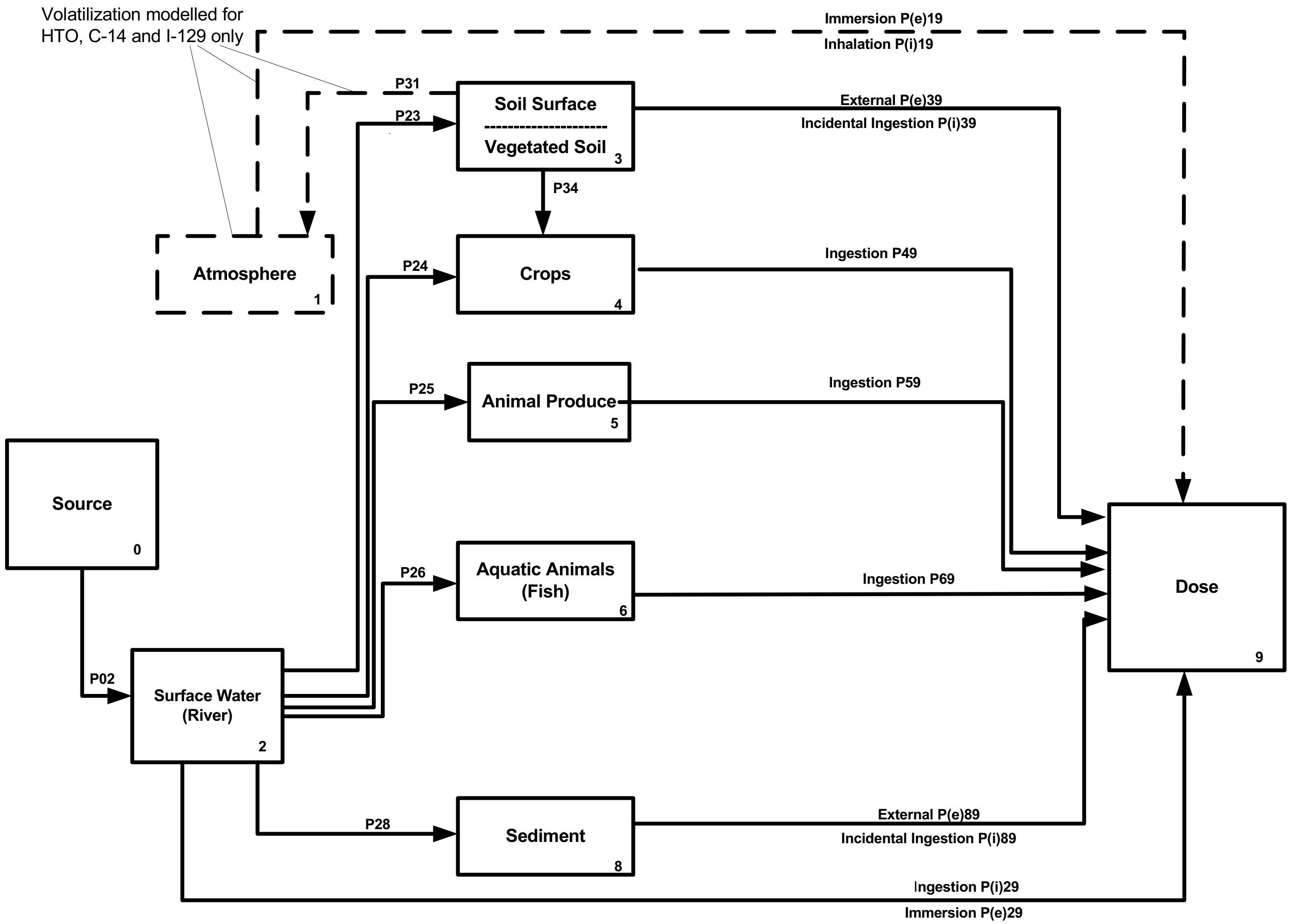

Figure 20: Environmental Transfer Model for Liquid Effluent Modelling

7.3.1 Water Ingestion

Water ingestion is identified in the DRL model as a dominant pathway for exposure to americium-241, plutonium-238, plutonium-239, plutonium-240, uranium (all part of gross alpha), technecium-99, strontium-90, cesium-137 (part of gross beta) and tritium, which are potentially present in WL effluent. The gross alpha activity continues to be at or near the lower limit of detection for the method and within the range of previous years. These are all lower than the established background value (0.050 Bq/L). This shows that in 2023, emissions from WL did not contribute to the dose from exposure to alpha emitting radionuclides in Winnipeg River drinking water. Tritium also was not found above background levels in river water and therefore does not contribute to dose. Other radionuclides present in WL effluent (cesium-137, and strontium-90) were included in the dose calculations as verification that their contribution to dose is negligible. The dose contribution from WL was obtained by subtracting the measured concentrations at Pinawa, which is located upstream of the WL site, from the highest concentration found at one of the three downstream locations at K-11, Lac du Bonnet or Great Falls. Using the concentrations at Pinawa for background correction was considered to provide more realistic dose estimates.

The annual effective dose from ingestion of water was estimated using Equation 1 and the total dose is presented in Table 32. A water intake rate of 840 L per year for adults and 347 L per year for three month old formula-drinking infants was used in dose calculations. The calculated dose is based on the assumption that 100% of the drinking water for the residential critical groups at Farm A is supplied by a water system that draws water from the Winnipeg River, and that the drinking water does not undergo any filtration or other pre-treatment processes prior to consumption.

In 2023 the cesium-137 activity detected in downstream river water samples was 0.0010 Bq/L higher than in upstream samples. The strontium-90 activity in downstream samples was the same as in the upstream, providing no dose. Therefore, in 2023 only the ingestion of cesium-137 through drinking water is considered to give doses to adults and children. As shown in Table 32 and Table 52 in Appendix B, the total incremental doses for adults and infants due to drinking water were 1.09×10^{-5} mSv/a and 4.16×10^{-6} mSv/a, respectively.

Table 32: Dose to Critical Groups at Farm A from Ingestion of Water

Radionuclide	Concentration in Drinking Water above Background (Bq/L)	Dose Coefficient for Ingestion (Sv/Bq)		Effective Dose (mSv/a)	
		Adult	Infant	Adult	Infant
Cesium-137	0.0010	1.3E-08	1.2E-08	1.09E-05	4.16E-06
Strontium-90	0.0000	2.8E-08	7.3E-08	nil	nil
			Total Dose	1.09E-05	4.16E-06

7.3.2 Fish Ingestion

Fish ingestion is identified in the DRL model as a dominant pathway for exposure to cesium-137. Other radionuclides (Cs-134 and Zn-65) were identified but are not present in WL effluent. The annual dose to residents of Farm A due to cesium-137 in walleye were estimated. Concentration data were used from samples from Pinawa (Sylvia Lake) and the locations 2 km and 5 km downstream of the Outfall. Assumed consumption rates were 7.41 kg/year for adults and 0.31 kg/a for three month old infants [9]. It is assumed that the fraction of fish locally consumed is 0.3 (the G parameter in equation 1). In 2023 downstream Pike samples had cesium-137 activity that was higher than upstream pike by 1.67 Bq/kg. This results in incremental doses due to fish ingestion of 4.83E-05 mSv/a for adults and 1.86E-06 mS/a for infants, as indicated in Table 33.

Table 33: Dose to Critical Group from Ingestion of Fish

Radionuclide	Concentration in Fish above Background (Bq/kg)	Dose Coefficient for Ingestion (Sv/Bq)		Effective Dose (mSv/a)	
		Adult	Infant	Adult	Infant
^{137}Cesium	1.67	1.3×10^{-8}	1.2×10^{-8}	4.83E-05	1.86E-06
			Total Dose	4.83E-05	1.86E-06

7.3.3 Ingestion of Garden Produce

The DRL model for the WL site identifies Farm A as the bounding critical group for dose from ingestion of garden produce [9]. This is considered an airborne and liquid effluent pathway, although the contribution of radioactivity to soil and plant tissue from irrigation is usually minor compared to the contribution from direct atmospheric deposition. Contaminant uptake in garden produce is primarily via roots and foliar deposition. Although ingestion of produce irrigated with potentially contaminated water was included in modelling of dose to the potential critical groups for liquid effluents in the DRL model, it was not identified as being a significant exposure pathway [9]. It is identified as a dominant dose pathway for cerium-144 (air deposition) which is not present in WL effluent. If cerium-144 were present it would be detected by gamma spectrometry and included in gross beta result.

The annual effective dose to Farm A residents from consumption of garden produce was estimated using the measured concentrations of tritium, cesium-137, and gross beta activity (corrected for potassium-40 contribution) in produce grown downstream of the Process Outfall. The contribution from WL was obtained by subtracting the measured concentrations in produce grown at the upstream reference location from the measured concentrations in downstream produce. This background correction was applied in an effort to provide more realistic dose estimates.

The annual effective dose to residents of Farm A from ingestion of garden produce are estimated using Equation 2. The model used to calculate the derived release limits, provided different intake rates for all three produce types. The intake rates are now applied to the individual produce types listed in Table 34 for adults and three-month old infants.

Table 34: Intake Rates of Vegetables

Food Categories and Items	Infant	Adult
Fruit and berries (kg/a)	66	174
Above ground vegetables + mushrooms (kg/a)	44	236
Root type vegetables (kg/a)	23	104

It was assumed that 15% of fruit, 25% of above ground vegetables and 100% of root type vegetables consumed during the year was grown locally (i.e., was potentially from a contaminated source) [9]. The effect of food processing on radioactivity in garden produce was assumed to be negligible.

As mentioned in Section 6.3.3, the contract lab used to analyze vegetables produced acceptable detection limits, which had not been the case in 2020 and 2021. In 2023 the cesium-137 and strontium-90 activities in fruit, leafy vegetables and root vegetables were at or below detection limits and showed no statistical difference between vegetables in upstream and downstream locations. Therefore, the potential dose to members of the public from fruit and root vegetable ingestion is nil (Table 35). Cerium-144 was not detected in the gamma spectrometric analysis of upstream and downstream vegetables. The gross beta results when corrected for potassium-40 contributions is nil therefore dose from Ce-144 is assumed to be nil.

Table 35: Dose from Liquid borne Effluents to Critical Group at Farm A from Ingestion of Garden Produce

Radionuclide	Concentration in Garden Produce above Background (Bq/kg fresh weight)	Dose Coefficient for Ingestion (Sv/Bq)		Effective Dose (mSv/a)	
		Adult	Infant	Adult	Infant
^{137}Cesium	0.00	1.3E-08	1.2E-08	nil	nil
^{90}Strontium	0.00	2.8E-08	7.3E-08	nil	nil
			Total Dose	nil	nil

7.4 Total Estimated Dose to Critical Groups

It can be noted from Figure 21 and Table 36 that the total incremental doses due to water, fish game and vegetable ingestion for adults and infants, are 5.9 x 10^{-5} mSv/a and 6.02 x 10^{-6} mSv/a, respectively. This can also be expressed as 5.9 x 10^{-3} % and 6.02 x 10^{-4} %, respectively of the annual regulatory limit of 1 mSv/a. Figure 21 is a plot of the doses estimated in the above sections.

Table 36 shows the dose estimates for 2018 to 2023 along with the five year average. The 2023 data for water ingestion was less than for 2022 for adults and infants. However, the dose from fish ingestion was higher than in 2022. The total estimated dose to exposed members of the public due to radioactivity in WL effluents in 2023 is higher for adults and lower for infants compared to the average of the last five years.

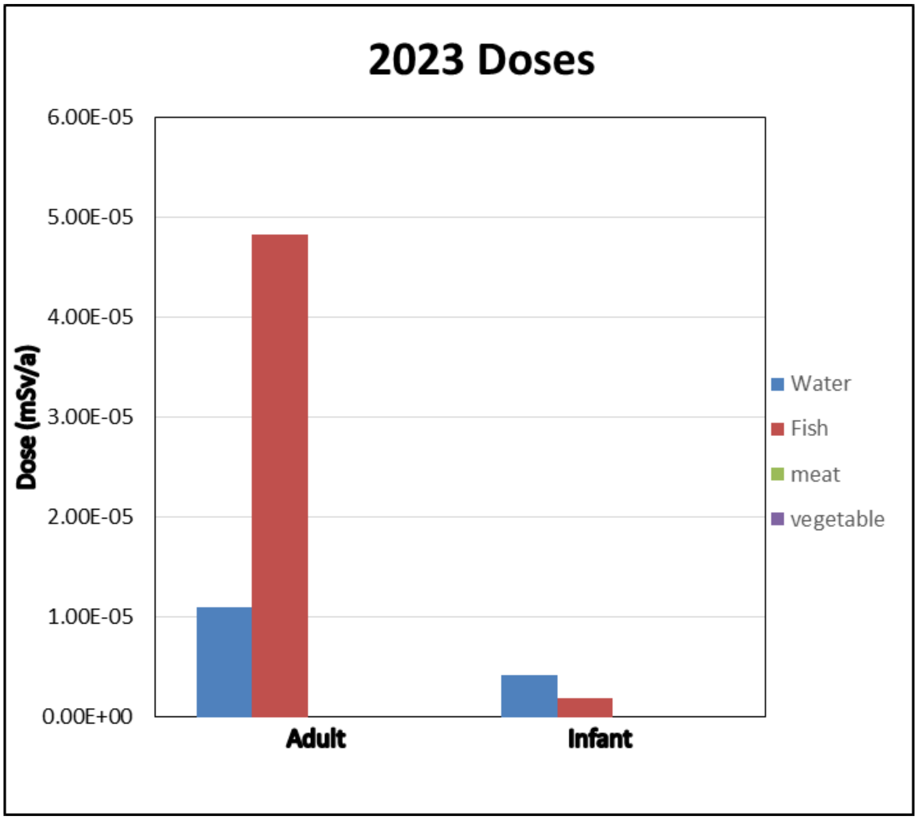

Figure 21: Estimates of Incremental Doses Due to Effluents from Whiteshell Laboratories, 2023

Table 36: Estimated Dose from WL Effluents, 2018 to 2023

	2018	2019	2020	2021	2022	Five-Year Average	2023
Dose to Adult (mSv/a)							
Water Ingestion	2.2E-05	8.0E-05	nil	4.5E-05	1.52E-05	3.2E-05	1.09E-05
Fish Ingestion	1.4E-05	6.9E-06	2.9E-06	nil	5.78E-06	7.4E-06	4.83E-05
Game Meat Ingest.	nil	nil	nil	nil	nil	nil	nil
Vegetable Ingestion	nil	nil	nil	nil	nil	nil	nil
Total	3.6E-05	8.7E-05	2.9E-06	4.5E-05	2.10E-05	4.0E-05	5.9E-05
Dose to Infant (mSv/a)							
Water Ingestion	8.3E-06	6.3E-05	nil	4.2E-06	8.41E-06	1.7E-05	4.16E-06
Fish Ingestion	5.6E-07	2.7E-07	1.1E-07	nil	2.23E-07	2.9E-07	1.86E-06

Game Meat Ingest.	nil	nil	nil	nil	nil	nil	nil
Vegetable Ingestion	nil	nil	nil	nil	nil	nil	nil
Total	8.9E-06	6.3E-05	1.1E-07	4.2E-06	8.64E-06	1.7E-05	6.02E-06

nil – no statistical difference between upstream and downstream data.

N/A- No samples were collected.

8. Investigative Studies

A review of non-radiological parameters measured in WL's Intake and Outfall waters for the years 2012 to 2017 was undertaken. The results of the parameters analyzed indicated that there is no degradation of the Winnipeg River water quality as a result of CNL operations and no need to expand the environmental monitoring program to include non-radiological parameter analysis of river water.

9. WL Environmental Assessment

The WL environmental assessment was conducted in accordance with the Canadian Environmental Assessment Act [42]. As part of the environmental assessment process the CNSC identified the need for a follow-up program. Accordingly, the Comprehensive Study Report submitted to the CNSC and ultimately to the Canadian Environmental Assessment Agency included a description of the planned follow-up program [1]. In his decision, the Minister also recommended that the mitigation measures and commitment to enhanced monitoring be implemented. Monitoring implemented as part of the Environmental Assessment Follow-Up Program (EAFP) will follow the requirements in CSA N288.4 [12], N288.5 [11] and N288.7 [59] series of standards.

The annual progress report on the EAFP [1] continues to assess the environmental performance of the site against the EAFP objectives, and identifies the need for modifications to the effluent, environmental, and groundwater monitoring programs. Progress on the work tasks associated with the EAFP are reported in the annual EAFP report [7].

In 2021, an Environmental Risk Assessment for the Landfill and Lagoon was completed and the report was sent to the CNSC for information. This document was prepared in support of the Landfill and Lagoon closures. A site-wide Environmental Risk Assessment was completed in 2023, in accordance with per CSA N288.6-12 [60], and was submitted to CNSC for review.

The identification and mitigation of environmental risks associated with routine and non-routine activities within CNL operated sites is a significant element of the CNL Environmental Management System (EMS). The environmental reviews of routine and non-routine work provide the processes and requirements for assessing environmental risks of project specific work. Significant Environmental Aspects (SEA) are identified and documented and where applicable, operational controls are put in place.

10. Conclusions

Monitoring of potential atmospheric effluent exposure pathways did not indicate any significant dose contributions from WL operations. This is consistent with effluent monitoring results, which indicated that airborne emissions were very small (1.5 x 10^{-6} mSv/a). Monitoring of potential liquid effluent exposure pathways has indicated that in 2023 the contributors to liquid effluent exposure was the consumption of water and fish. In 2023, the cesium-137 activity was higher in downstream river water compared to upstream samples. Therefore, in 2023 the ingestion of cesium-137 through drinking water is considered to give a dose of 1.09 x 10^{-5} mSv/a to adults and 4.16 x 10^{-6} mSv/a to infants. One deer was sampled in 2023. The average cesium-137 activity in the sampled deer was below background, resulting in no dose for adults and infants. The incremental doses due to fish ingestion were 4.83 x 10^{-5} mSv/a for adults and 1.86 x 10^{-6} mSv/a for infants. Dose rates from consuming vegetables were nil in 2023. Radioactive contaminants in Winnipeg River water remained very small fractions of allowable levels defined in the Canadian Drinking Water Standard [21].

The groundwater monitoring program has demonstrated there is no significant radioactive migration from the waste management facilities.

Participation in laboratory proficiency tests and internal quality verification tests were both used to assess the performance of analytical methods used to produce the data included in this report. The results were satisfactory. Findings from program audits and assessments were minor in nature and are being addressed. There were no findings that resulted in requiring changes to the Environmental Monitoring Program.

Monitoring results for the calendar year 2023 confirmed that levels of radioactivity in the environment outside the WL site boundary due to work conducted at the site, as well as the resulting radiation doses to members of the public, were well below regulatory limits[47] and guidelines.

10.1 Overall Environmental Performance

The combined operation of the radiological environmental monitoring program, the non-radiological environmental monitoring program, and the groundwater monitoring comprises contaminant pathway monitoring, results of which are discussed in an integrated manner in this report. This contaminant pathways monitoring enables the tracking of contaminants throughout the different compartments of the geosphere and biosphere, allowing conclusions to be drawn on the overall environmental impact of WL site operations and decommissioning activities.

Overall, the environmental impact can be characterized as low risk, in that the potential for human or ecological impacts is low because measured concentrations are well below benchmark values, and overall trending indicates stable performance.

[47] The regulatory limit for non-occupational effective radiation dose to members of the public from operations and products involving ionizing radiation (excluding medical procedures) is 1 mSv per year.

11. Acronyms and Terms

11.1 Acronyms

AECL	Atomic Energy of Canada Limited
ALWTC	Active Liquid Waste Treatment Centre
AO	Aesthetic Objective
ARMS	Ambient Radiation Monitoring Station
BV	Background Value
CAC	Criteria Air Contaminants
CALA	Canadian Association for Laboratory Accreditation Inc.
CNL	Canadian Nuclear Laboratories
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
CSR	Comprehensive Study Report
DCF	Dose Conversion Factor
DRL	Derived Release Limit
EA	Environmental Assessment
EAFP	Environmental Assessment Follow-up Program
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ERA	Environmental Risk Assessment
EVMP	Effluent Verification Monitoring Program
GHG	Greenhouse Gas
Gspec	Gamma Spectrometry
GWMP	Groundwater Monitoring Program
GWP	Global Warming Potential
ICRP	International Commission on Radiological Protection
ISO	International Organization for Standardization
LLD	Lower Limit of Detection
LMDL	Laboratory Method Detection Limit

LSC	Liquid Scintillation Counter
MAC	Maximum Acceptable Concentration
MDL	Method Detection Limit
NCRP	National Council on Radiation Protection and Measurements
NPRI	National Pollutant Release Inventory
NSRDR	Nuclear Substance and Radiation Devices Regulation
OFL	Outfall at Whiteshell
PM	Particulate Matter
QA	Quality Assurance
SEA	Significant Environmental Aspects
SMO	Sample Management Office
TLD	Thermoluminescent Lithium Fluoride Dosimeters
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VEC	Valued Ecosystem Component
WL	Whiteshell Laboratories
WMA	Waste Management Area (WL)
WR-1	Whiteshell Reactor 1

11.2 Terms

Action Level	Action Level for radioactive emissions is a quantity or rate of radioactive emissions that, if reached, may represent a loss of control of performance of a facility's environmental protection program or emission control systems, and triggers a requirement for specific actions to be taken.
Anthropogenic	Man-made
Biosphere	The regions of the surface and atmosphere of the Earth where living organisms exist.

12. References

[1] Health Canada, Guidelines for Canadian Drinking Water Quality – Summary Table, 2017 February.

[2] Whiteshell Laboratories Annual Compliance Monitoring Report for 2023 Under Licence NRTEDL-W5-8.00/2024, WL-514300-ACMR-2023, Revision 0, 2024 April.

[3] Canadian Standards Association, Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills, CAN/CSA-N288.4-10, 2010 May (Reaffirmed in 2015).

[4] The Canada Gazette, Nuclear Safety and Control Act, S.C. 1997, c. 9, 2015 Feb. 26.

[5] Canadian Nuclear Safety Commission, Nuclear Research and Test Establishment Decommissioning Licence, Whiteshell Laboratories, Licence No. NRTEDL W5-8.00/2024. Expiry Date: 2024 December 31.

[6] Environmental Assessment Follow-Up Program for Whiteshell Laboratories, 03704-001, Revision 1, 2002 June.

[7] 2023 Progress Report on the Environmental Assessment Follow-Up Program for Whiteshell Laboratories, WL-509246-ACMR-2023, Revision 0, 2024 June.

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Appendix A Maps

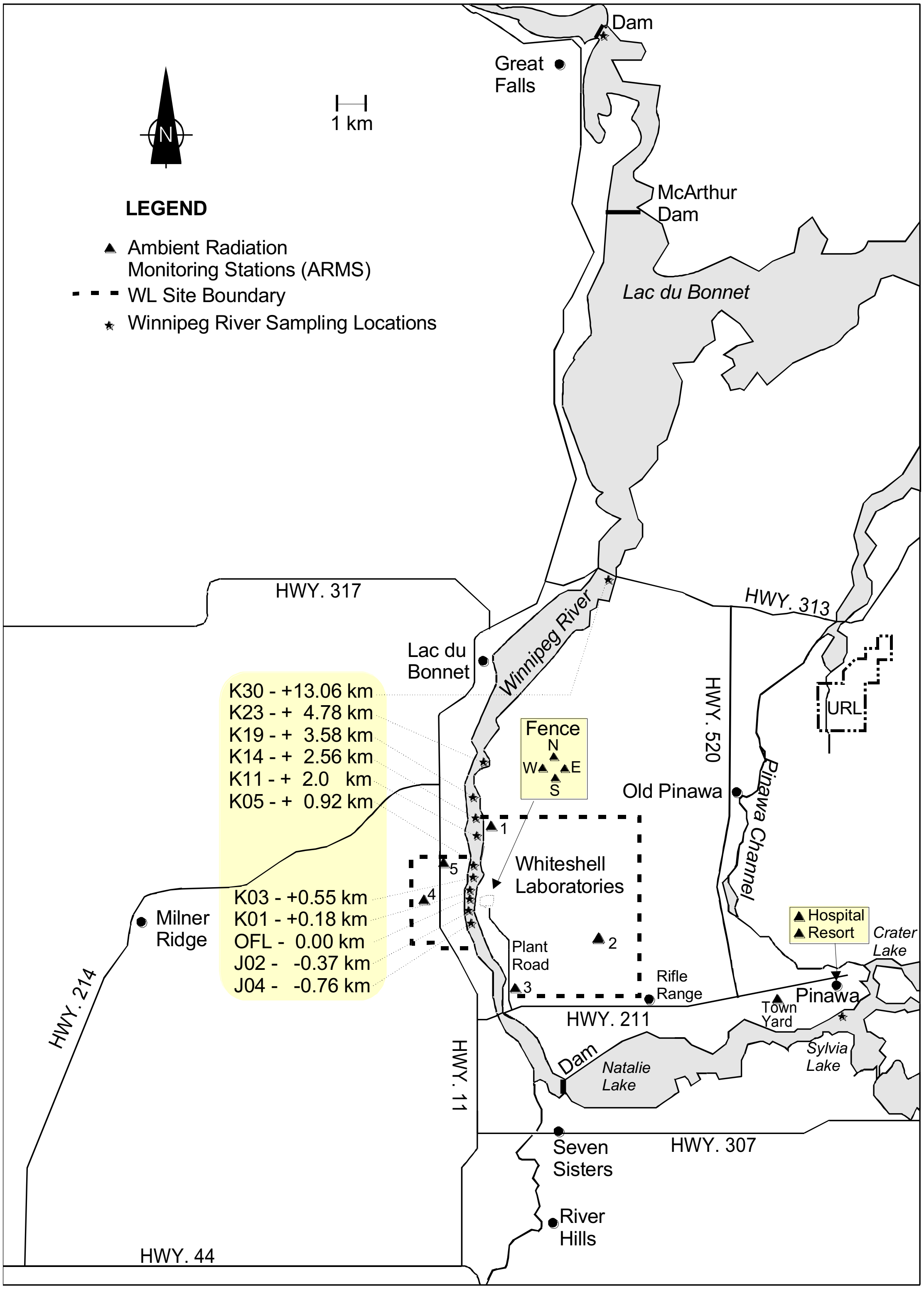

Figure 22: Whiteshell Laboratories and Surrounding Area

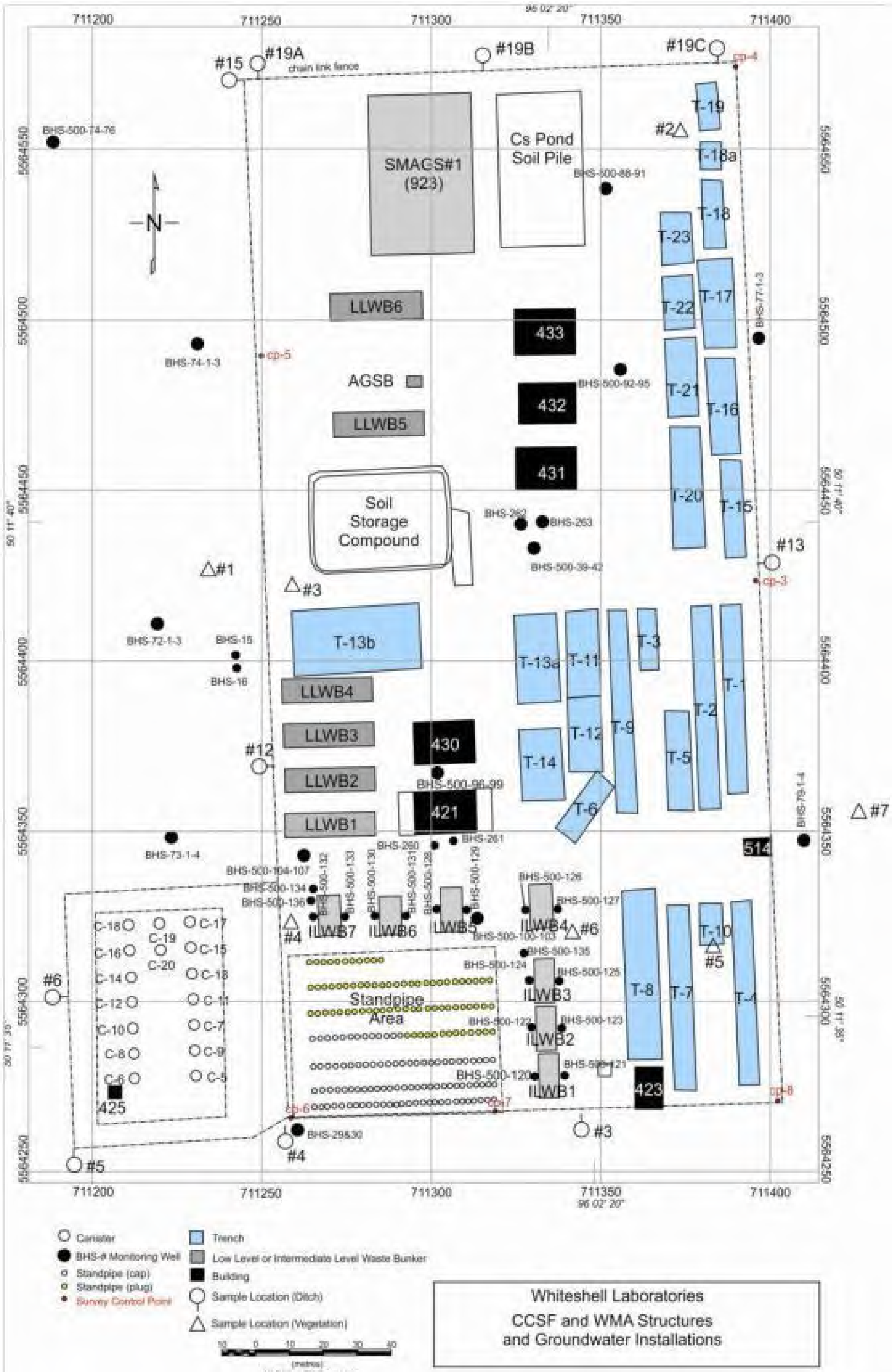

Figure 23: Whiteshell Laboratories Waste Management Area Well and Piezometer Sampling Location

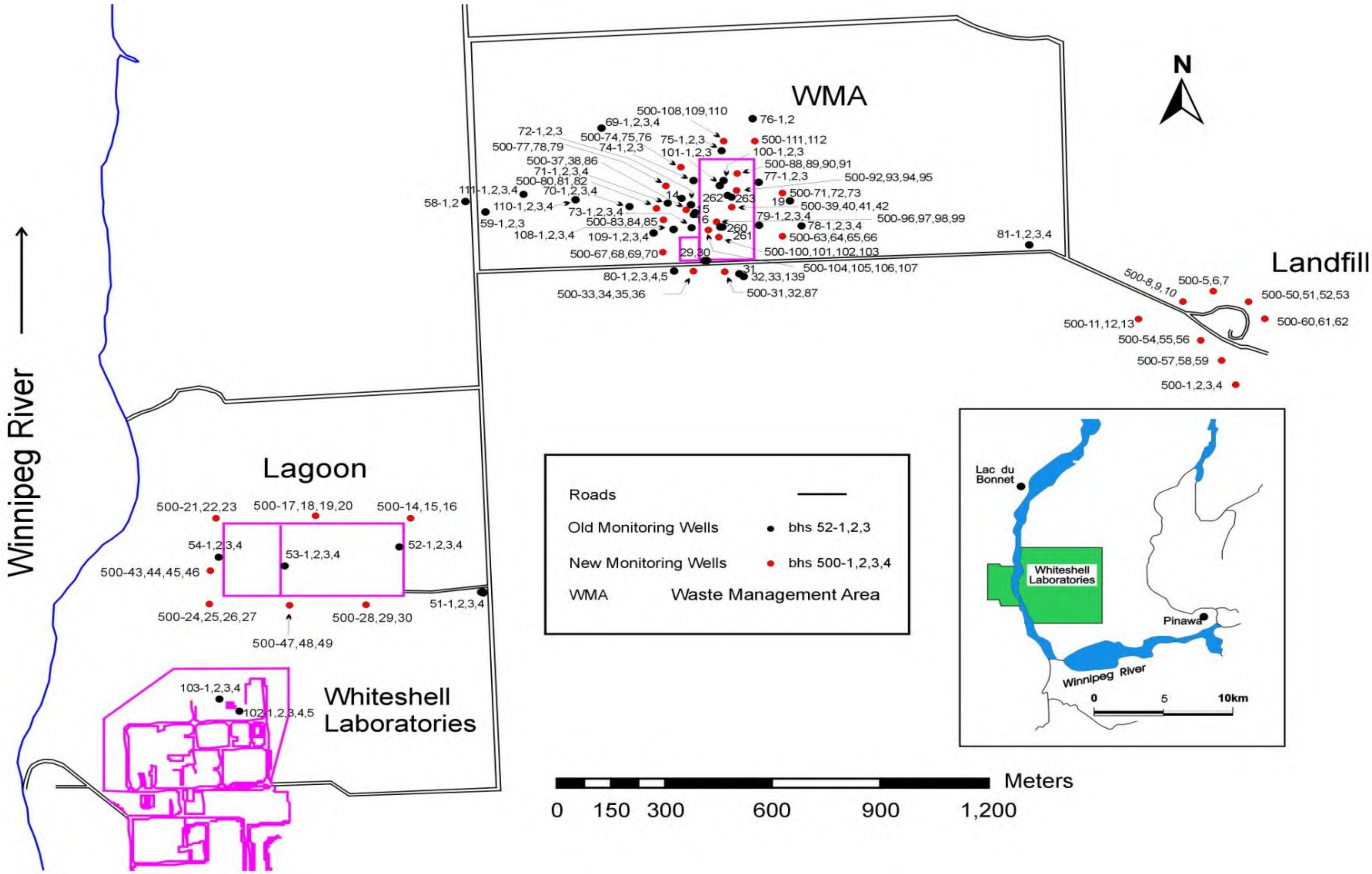

Figure 24: Well and Piezometer Sampling Locations in the Vicinity of the Whiteshell Laboratories Waste Management Area

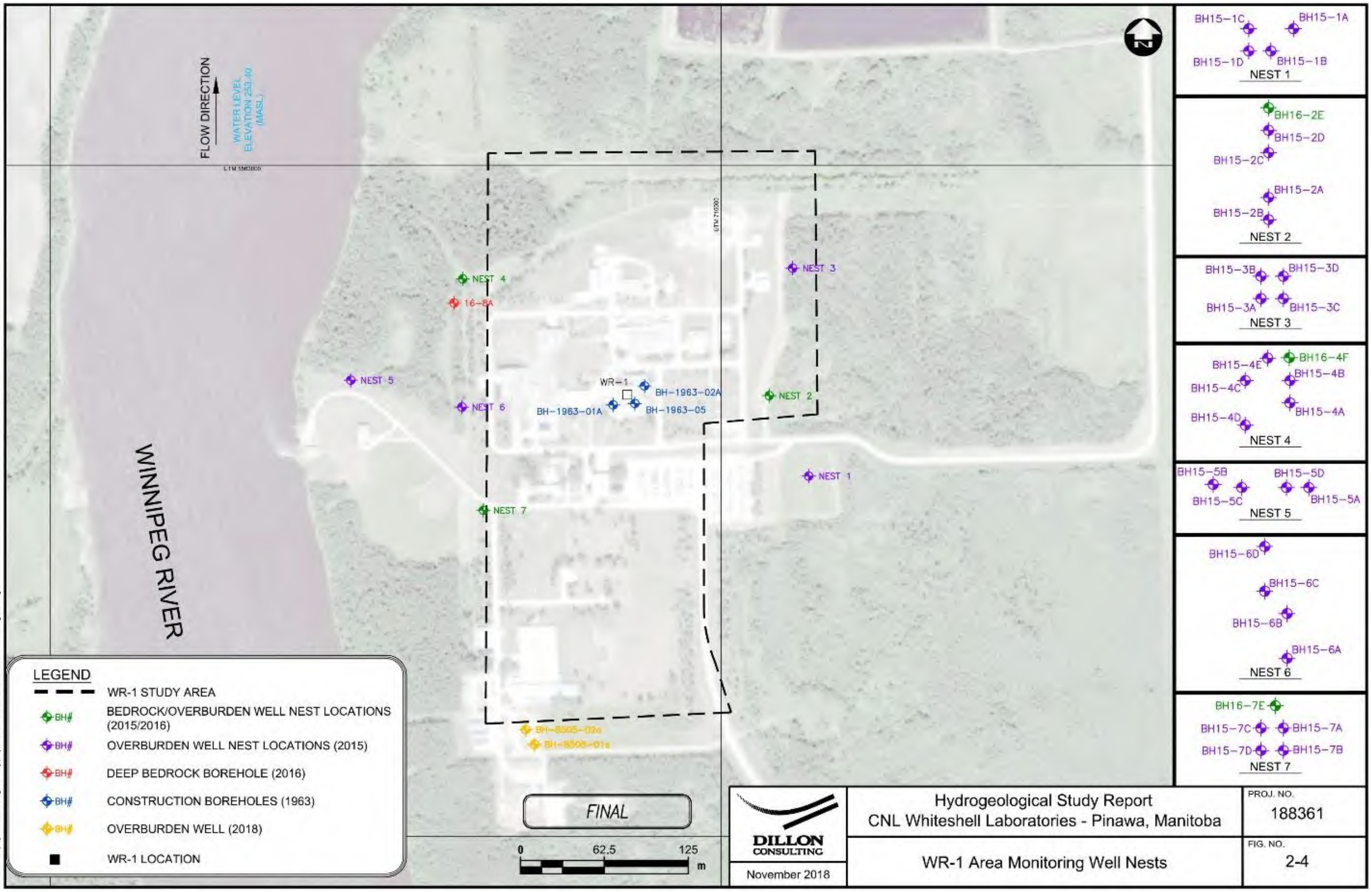

Figure 25: Main Campus Well Nests

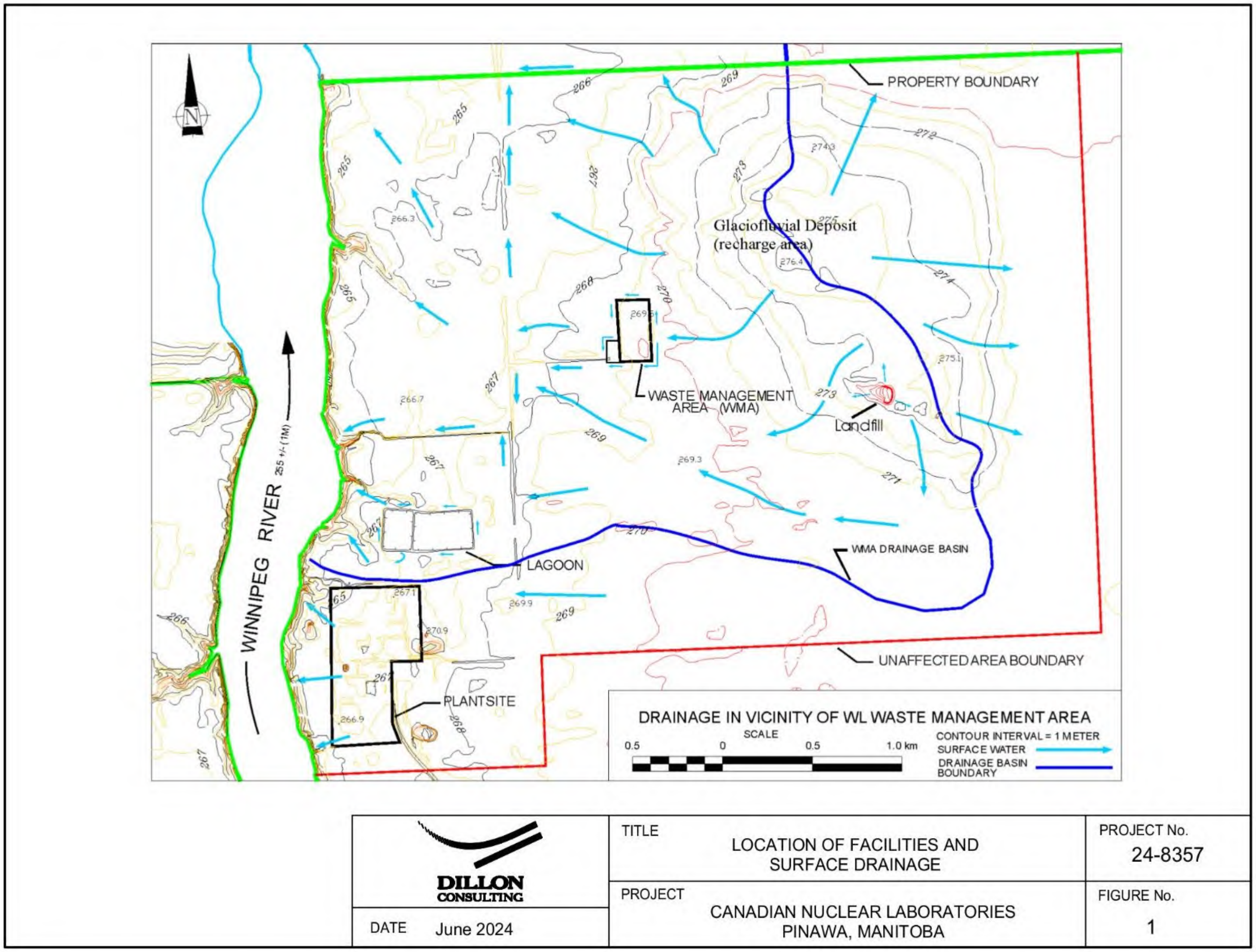

Figure 26: Location of WL Facilities and Surface Drainage and Layout

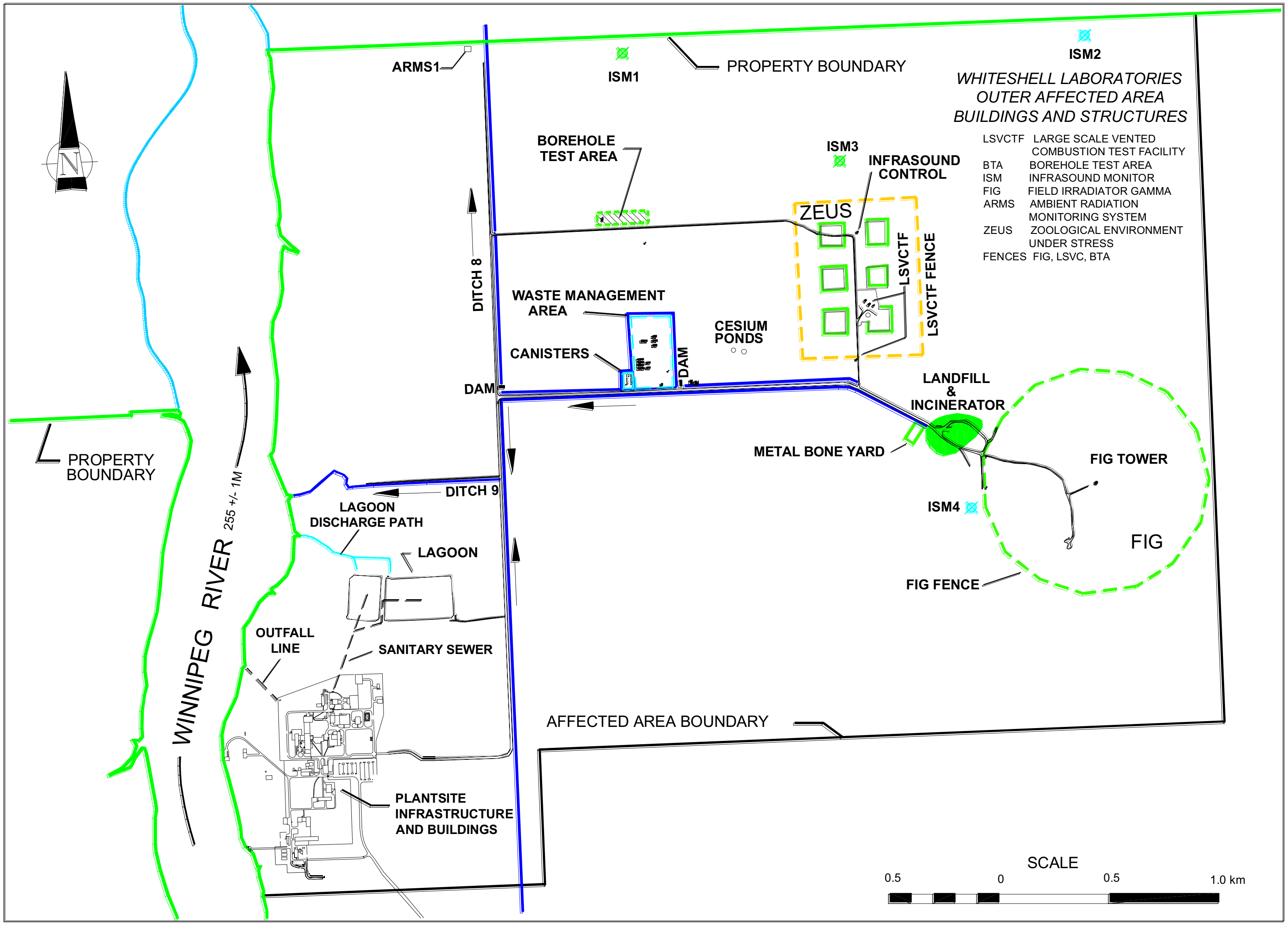

Figure 27: Whiteshell Laboratories Site Showing ZEUS and FIG Areas

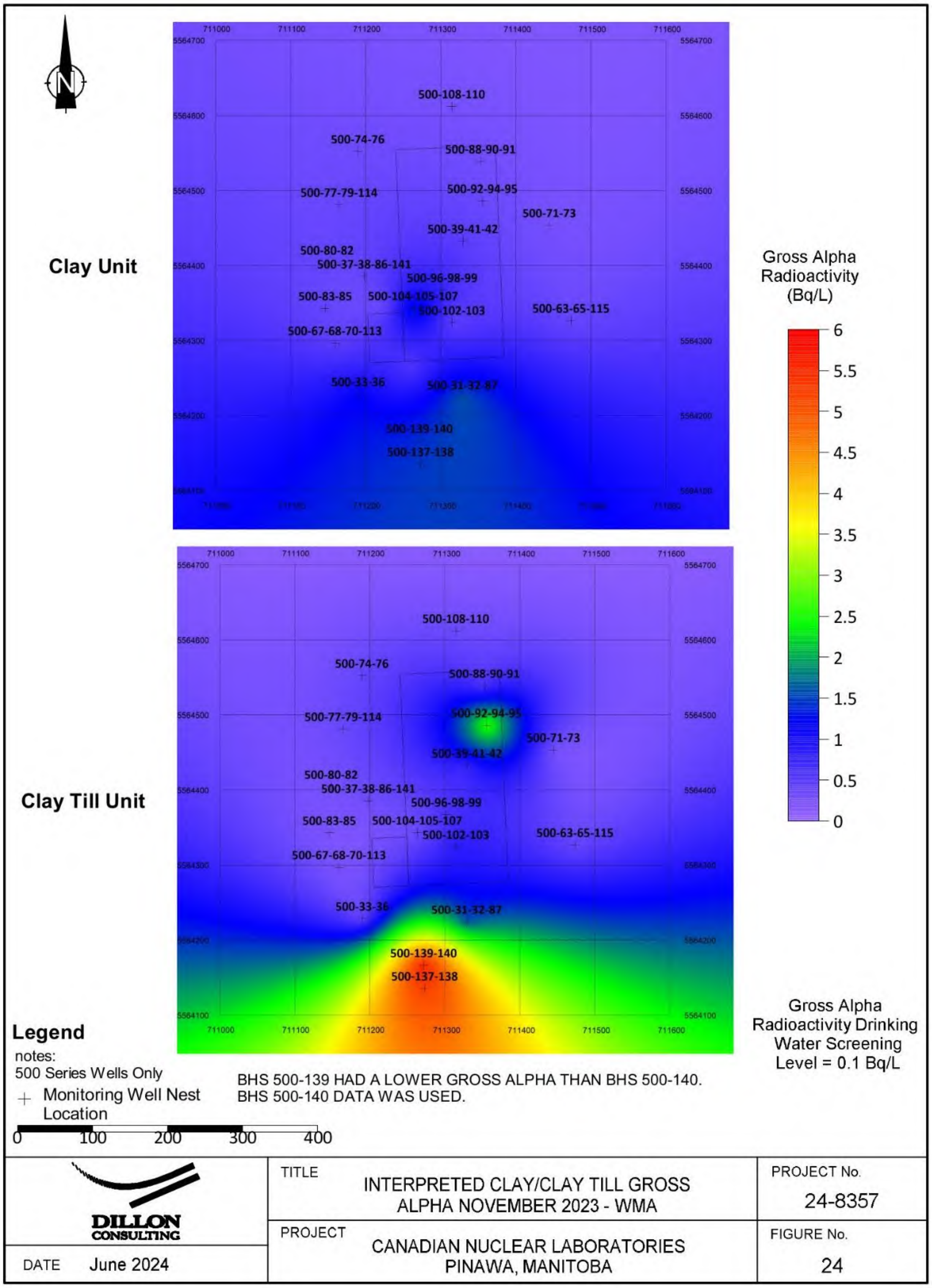

Figure 28: Interpreted Clay and Clay Till Aquifer Gross Alpha Radioactivity (2023 – WMA)

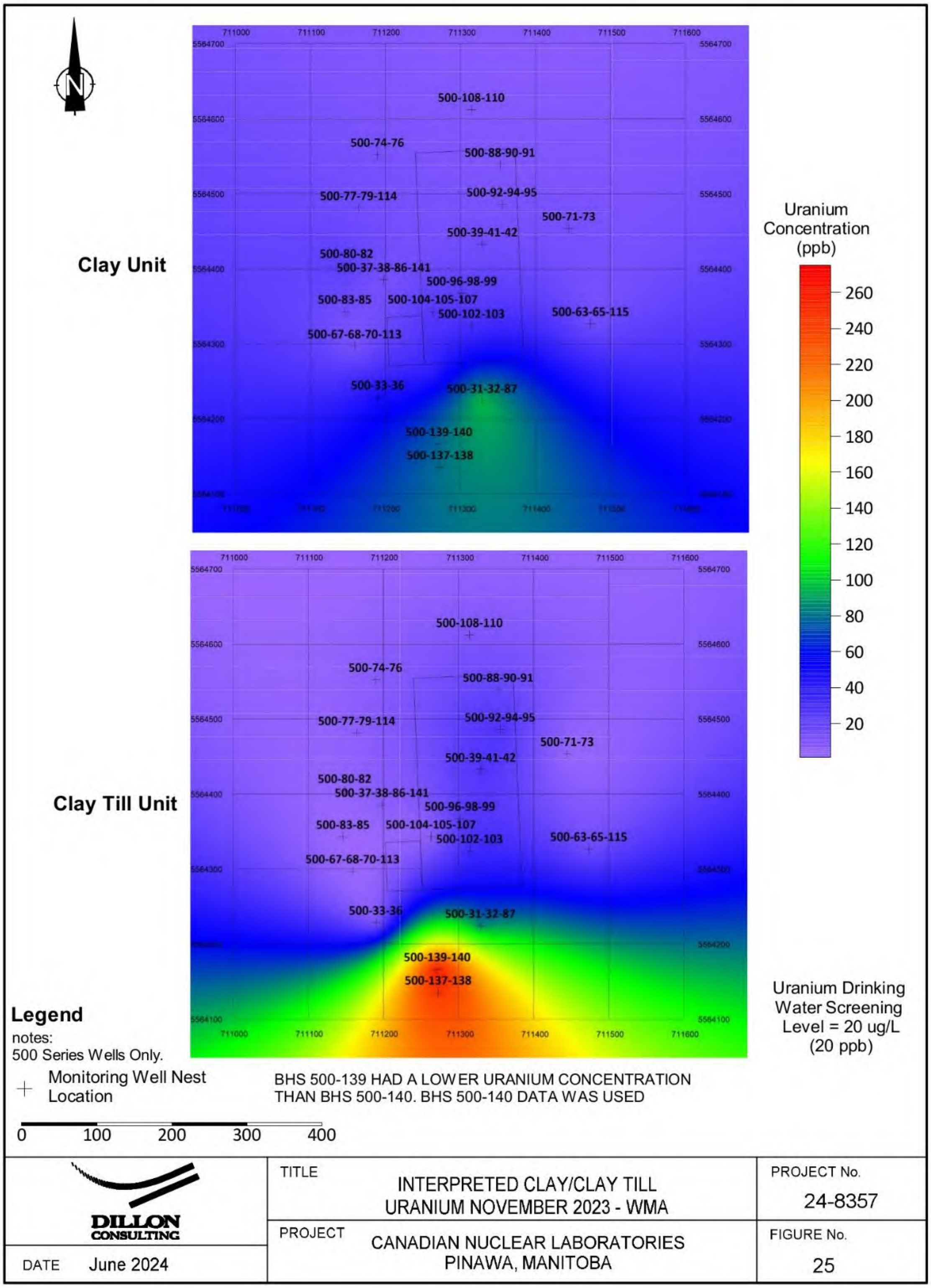

Figure 29: Interpreted Clay and Clay Till Dissolved Uranium Concentration (2023 – WMA)

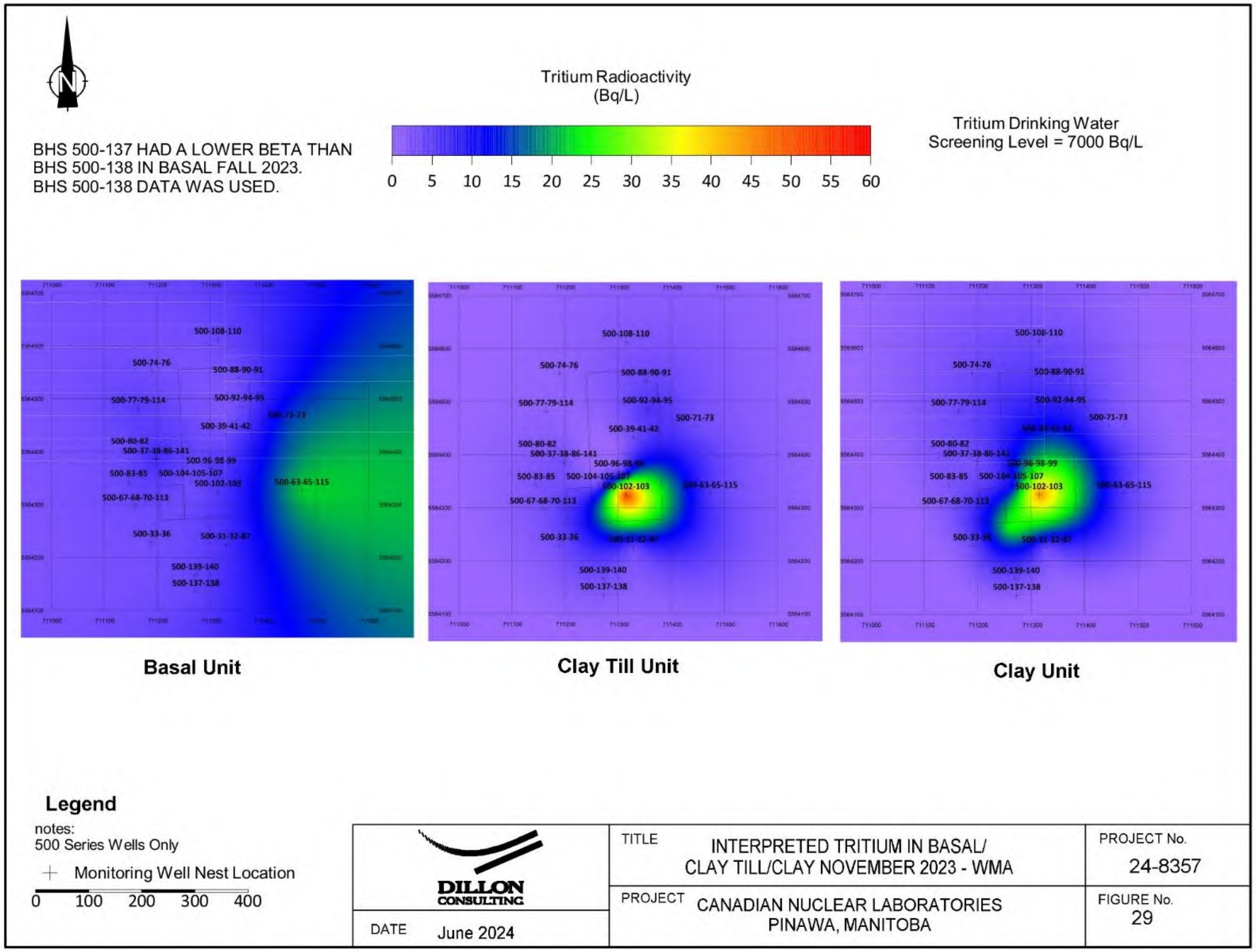

Figure 30: Interpreted Tritium Radioactivity in Basal/ Clay-Till / Clay (2023 – WMA)

Appendix B Whiteshell Laboratories Environmental Monitoring Data for 2023

Table 37: Radioactivity in Monthly Water Samples Collected Upstream from Whiteshell Laboratories, 2023

Month	Gross Alpha[1] (Bq/L)			Gross Beta[2] (Bq/L)			Strontium-90 (Bq/L)			Cesium-137 (Bq/L)			Tritium (Bq/L)			Potassium-40 (Bq/L)		
January	0.037		LLD	0.076		LLD	0.146	±	0.032	0.002		LLD	4.8		LLD	0.281	±	0.043
February	0.006		LLD	0.018	±	0.004	0.005		LLD	0.003		LLD	4.5		LLD	0.214	±	0.045
March	0.003		LLD	0.018	±	0.004	0.002		LLD	0.006		LLD	4.6		LLD	0.170		LLD
April	0.006		LLD	0.045	±	0.009	0.004	±	0.001	0.001		LLD	4.2		LLD	0.040	±	0.019
May	0.005		LLD	0.034	±	0.007	0.003	±	0.001	0.002		LLD	3.9		LLD	0.158	±	0.033
June	0.009	±	0.002	0.035	±	0.007	0.008		LLD	0.001		LLD	4.0		LLD	0.190	±	0.023
July	0.006		LLD	0.006		LLD	0.003		LLD	0.002		LLD	4.0		LLD	0.034		LLD
August	0.018		LLD	0.039	±	0.008	0.003		LLD	0.002		LLD	3.7		LLD	0.061	±	0.026
September	0.011		LLD	0.478	±	0.008	0.008		LLD	0.002		LLD	4.1		LLD	0.100	±	0.027
October	0.013		LLD	0.031	±	0.006	0.009		LLD	0.002		LLD	4.1		LLD	0.048	±	0.027
November	0.013	±	0.003	0.042	±	0.009	0.008		LLD	0.004		LLD	4.4		LLD	0.258	±	0.054
December	0.014	±	0.003	0.118	±	0.024	0.030	±	0.007	0.010	±	0.002	3.7		LLD	0.039	±	0.019
Average	0.012	±	0.009	0.078	±	0.129	0.019	±	0.041	0.003	±	0.002	4.2	±	0.3	0.133	±	0.091
Minimum	0.003			0.006			0.002			0.001			3.680			0.034		
Maximum	0.037			0.478			0.146			0.010			4.780			0.281		
MDL	0.023			0.023			0.003			0.003			3.0			0.040		
Drinking Water MAC	0.2			10			5			10			7000			NA		

Notes:

1. Gross Alpha releases are conservatively assumed to consist of total uranium, the radionuclide with the most restrictive MAC and likely to be present.
2. Gross Beta releases are conservatively assumed to consist of strontium-90, the radionuclide with the most restrictive MAC and likely to be present.
3. The MDL is based on a 40 L sample resulting in 1 g of sample ash, and counted 400 min for gross alpha, 100 min for gross beta and strontium-90 analysis, or counted 800 min for potassium-40 and cesium-137 analysis.
4. NA = not available.
5. Uncertainties of individual results are expressed as ± two standard deviations based on counting statistics; uncertainties of the average are expressed as the standard deviation of the population group.
6. LLD = Lower Limit of Detection.

Table 38: Radioactivity in Monthly Water Samples Collected from Location K-11, 2023 (2 km downstream from the Whiteshell Laboratories Process Outfall)

Month	Gross Alpha[1] (Bq/L)			Gross Beta[2] (Bq/L)			Strontium-90 (Bq/L)			Cesium-137 (Bq/L)			Tritium (Bq/L)			Potassium-40 (Bq/L)		
January	0.005		LLD	0.023	±	0.005	0.002	±	0.001	0.000		LLD	4.8		LLD	0.193		LLD
February	0.006		LLD	0.019	±	0.004	0.002		LLD	0.002		LLD	4.9	±	4.6	0.161		LLD
March	0.010		LLD	0.098	±	0.020	0.004	±	0.001	0.002		LLD	4.7		LLD	0.040		LLD
April	0.011	±	0.002	0.150	±	0.030	0.004		LLD	0.003		LLD	4.0		LLD	0.470	±	0.072
May	0.010		LLD	0.059	±	0.012	0.005	±	0.001	0.003		LLD	4.2		LLD	0.503	±	0.080
June	0.002		LLD	0.054	±	0.011	0.007		LLD	0.002		LLD	4.0		LLD	0.057	±	0.030
July	0.011		LLD	0.047	±	0.027	0.009		LLD	0.002		LLD	4.2		LLD	0.302	±	0.110
August	0.007		LLD	0.060	±	0.012	0.007		LLD	0.001		LLD	3.5		LLD	0.027	±	0.008
September	0.037	±	0.007	0.064	±	0.013	0.011		LLD	0.002		LLD	4.4		LLD	0.239		LLD
October	0.022	±	0.004	0.026	±	0.005	0.007		LLD	0.002		LLD	3.8		LLD	0.053		LLD
November	0.011		LLD	0.041	±	0.008	0.007		LLD	0.003		LLD	4.5		LLD	0.052	±	0.035
December	NS			NS			NS			NS			NS			NS		
Average	0.012	±	0.010	0.058	±	0.038	0.006	±	0.003	0.002	±	0.001	4.3	±	0.5	0.191	±	0.172
Minimum	0.002			0.019			0.002			0.000			3.5			0.027		
Maximum	0.037			0.150			0.011			0.003			4.9			0.503		
MDL	0.023			0.023			0.003			0.003			3.0			0.040		
Drinking Water MAC	0.2			10			5			10			7000			NA		

Notes:

1. Gross Alpha releases are conservatively assumed to consist of total uranium, the radionuclide with the most restrictive MAC and likely to be present.
2. Gross Beta releases are conservatively assumed to consist of strontium-90, the radionuclide with the most restrictive MAC and likely to be present.
3. The MDL is based on a 40 L sample resulting in 1 g of sample ash, and counted 400 min for gross alpha, 100 min for gross beta and strontium-90 analysis, or counted 800 min for potassium-40 and cesium-137 analysis.
4. Uncertainties of individual results are expressed as ± two standard deviations based on counting statistics; uncertainties of the average are expressed as the standard deviation of the population group.
5. LLD = Lower Limit of Detection, NS = No Sample due to river ice conditions.

Table 39: Radioactivity in Monthly Water Samples Collected from Lac du Bonnet, 2023 (10 km downstream from the Whiteshell Laboratories Process Outfall)

Month	Gross Alpha(1) (Bq/L)			Gross Beta(2) (Bq/L)			Strontium-90 (Bq/L)			Cesium-137 (Bq/L)			Tritium (Bq/L)			Potassium-40 (Bq/L)		
January	0.006		LLD	0.023	±	0.005	0.035		LLD	0.001		LLD	5.1		LLD	0.225	±	0.015
February	0.005		LLD	0.014	±	0.003	0.003		LLD	0.002		LLD	4.2	±	4.5	0.244	±	0.040
March	0.007		LLD	0.026	±	0.005	0.004		LLD	0.002		LLD	4.6		LLD	0.143	±	0.034
April	0.006		LLD	0.041	±	0.008	0.005	±	0.001	0.002		LLD	4.2		LLD	0.213	±	0.022
May	0.007		LLD	0.058	±	0.012	0.004	±	0.001	0.002		LLD	4.0		LLD	0.211	±	0.037
June	0.014	±	0.003	0.042	±	0.009	0.007		LLD	0.002		LLD	3.8		LLD	0.225	±	0.022
July	0.014	±	0.003	0.042	±	0.009	0.007		LLD	0.002		LLD	4.1		LLD	0.226	±	0.022
August	0.013		LLD	0.023	±	0.005	0.008		LLD	0.002		LLD	3.4		LLD	0.347	±	0.052
September	0.012	±	0.003	0.029	±	0.006	0.007		LLD	0.001		LLD	4.2		LLD	0.269	±	0.029
October	0.012	±	0.002	0.025	±	0.005	0.007		LLD	0.002		LLD	3.8		LLD	0.041	±	0.029
November	0.013	±	0.003	0.042	±	0.009	0.008		LLD	0.004		LLD	4.6		LLD	0.258	±	0.054
December	0.010		LLD	0.036	±	0.007	0.007		LLD	0.002		LLD	3.8		LLD	0.045	±	0.030
Average	0.010	±	0.004	0.033	±	0.012	0.008	±	0.008	0.002	±	0.001	4.1	±	0.5	0.204	±	0.088
Minimum	0.005			0.014			0.003			0.001			3.4			0.041		
Maximum	0.014			0.058			0.035			0.004			5.1			0.347		
MDL	0.023			0.023			0.003			0.003			3.0			0.040		
Drinking Water MAC	0.2			10			5			10			7000			NA		

Notes:

1. Gross Alpha releases are conservatively assumed to consist of total uranium, the radionuclide with the most restrictive MAC and likely to be present.
2. Gross Beta releases are conservatively assumed to consist of strontium-90, the radionuclide with the most restrictive MAC and likely to be present.
3. The MDL is based on a 40 L sample resulting in 1 g of sample ash, and counted 400 min for gross alpha, 100 min for gross beta and strontium-90 analysis, or counted 800 min for potassium-40 and cesium-137 analysis.
4. Uncertainties of individual results are expressed as ± two standard deviations based on counting statistics; uncertainties of the average are expressed as the standard deviation of the population group.

LLD = Lower Limit of Detection, NA = Not Applicable.

Table 40: Radioactivity in Monthly Water Samples Collected from Great Falls Dam, 2023 (28 km downstream from the Whiteshell Laboratories Process Outfall)

Month	Gross Alpha[1] (Bq/L)			Gross Beta[2] (Bq/L)			Strontium-90 (Bq/L)			Cesium-137 (Bq/L)			Tritium (Bq/L)			Potassium-40 (Bq/L)		
January	0.006		LLD	0.016	±	0.003	0.005	±	0.001	0.001		LLD	5.0		LLD	0.195		LLD
February	0.031		LLD	0.044	±	0.009	0.005	±	0.001	0.001		LLD	4.4		LLD	0.141		LLD
March	0.005		LLD	0.049	±	0.010	0.009		LLD	0.038	±	0.004	4.7		LLD	0.012		LLD
April	0.006		LLD	0.043	±	0.009	0.003	±	0.001	0.002		LLD	3.9	±	4.2	0.071	±	0.013
May	0.009	±	0.002	0.059	±	0.012	0.004	±	0.001	0.001		LLD	3.9		LLD	0.032	±	0.013
June	0.013	±	0.003	0.041	±	0.008	0.007		LLD	0.001		LLD	4.0		LLD	0.247	±	0.013
July	0.018	±	0.004	0.047	±	0.009	0.009		LLD	0.002		LLD	4.0		LLD	0.057		LLD
August	0.009	±	0.002	0.044		LLD	0.007		LLD	0.001		LLD	3.6		LLD	0.051	±	0.013
September	0.011		LLD	0.018	±	0.004	0.008		LLD	0.001		LLD	4.2		LLD	0.063		LLD
October	0.012		LLD	0.027	±	0.005	0.009		LLD	0.001		LLD	4.1		LLD	0.063		LLD
November	0.015	±	0.003	0.033	±	0.007	0.008		LLD	0.002		LLD	4.3		LLD	0.082	±	0.013
December	0.010		LLD	0.037	±	0.007	0.007		LLD	0.001		LLD	3.6	±	LLD	0.036	±	0.013
Average	0.012	±	0.007	0.038	±	0.013	0.007	±	0.002	0.004	±	0.011	4.1	±	0.4	0.088	±	0.071
Minimum	0.005			0.016			0.003			0.001			3.6			0.012		
Maximum	0.031			0.059			0.009			0.038			5.0			0.247		
MDL	0.023			0.023			0.003			0.003			3.0			0.040		
Drinking Water MAC	0.2			10			5			10			7000			NA		

Notes:

1. Gross Alpha releases are conservatively assumed to consist of total uranium, the radionuclide with the most restrictive MAC and likely to be present.
2. Gross Beta releases are conservatively assumed to consist of strontium-90, the radionuclide with the most restrictive MAC and likely to be present.
3. The MDL is based on a 40 L sample resulting in 1 g of sample ash, and counted 400 min for gross alpha, 100 min for gross beta and strontium-90 analysis, or counted 800 min for potassium-40 and cesium-137 analysis.
4. Uncertainties of individual results are expressed as ± two standard deviations based on counting statistics; uncertainties of the average are expressed as the standard deviation of the population group.
5. LLD = Lower Limit of Detection, NA = Not Available.

Table 41: Gross Beta, Gross Alpha, Tritium and Uranium Radioactivity in Monitoring Wells and Piezometers in and around Whiteshell Laboratories – Waste Management Area, 2023

Radioactivity (Bq/L)												
	Gross Beta			Gross Alpha			Tritium			Uranium (ppb)		
Sample Dates	2023 July 19 to September 13											
Basal Unit												
BHS 500-33	0.42		LLD	0.18		LLD	3		LLD	0.10		LLD
BHS 500-34	0.35		LLD	0.45	±	0.27	3		LLD	1.03	±	0.15
BHS 500-39	0.30		LLD	0.38		LLD	3		LLD	0.10		LLD
BHS 500-40	0.28		LLD	0.19		LLD	5		3.70	0.25	±	0.10
BHS 500-63	0.47	±	0.24	0.30		0.21	3		LLD	0.16	±	0.10
BHS 500-67			LLD			LLD			LLD	0.81	±	0.11
BHS 500-71	0.35	±	0.21	0.31		LLD	3		LLD	0.57	±	0.10
BHS 500-74	0.43		LLD	0.34		LLD	5		LLD	0.10		LLD
BHS 500-77	0.31	±	0.17	0.37	±	0.22	4		LLD	0.10		LLD
BHS 500-80	0.33		LLD	0.24	±	0.19	4		LLD	0.81	±	0.11
BHS 500-86	0.38		LLD	0.22		LLD	5	±	5.01	0.18	±	0.10
BHS 500-87	0.39	±	0.23	0.34		LLD	3		LLD	0.21	±	0.10
BHS 500-88	0.29		LLD	0.20		LLD	3		LLD	0.14		0.10
BHS 500-92	0.38	±	0.21	0.26		LLD	9		4.67	0.10		LLD
BHS 500-96	0.29		LLD	0.36		LLD	3		LLD	0.31	±	0.10
BHS 500-101	0.30		LLD	0.22		LLD	3		LLD	0.56	±	0.10
BHS 500-104	0.39		0.19	0.35		LLD	3		LLD	0.18	±	0.10
BHS 500-108	0.40		LLD	0.27		LLD	3	±	5.22	0.10		LLD
BHS 500-137	0.36		LLD	0.26		LLD	3		LLD	0.28	±	0.10
BHS 500-138	0.39		LLD	0.48		LLD	3.00		LLD	0.14	±	0.10
Average	**0.36**	±	**0.05**	**0.30**	±	**0.09**	**4**			**0.31**	±	**0.28**

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Radioactivity (Bq/L)												
	Gross Beta			Gross Alpha			Tritium			Uranium (ppb)		
Sample Dates	2023 Nov 8 to Nov 29											
Basal Unit												
BHS 500-33	0.27		LLD	0.23		LLD	3		LLD	0.10	±	0.10
BHS 500-33 D01	0.66		0.25	0.27		LLD	3		LLD	0.10	±	0.10
BHS 500-34	0.26		LLD	0.23		LLD	3		LLD	0.86	±	0.12
BHS 500-39	0.33		LLD	0.24		LLD	3		LLD	0.19	±	0.10
BHS 500-40	0.29		LLD	0.22		LLD	3		LLD	0.44	±	0.10
BHS 500-63	0.29		LLD	0.21		LLD	22	±	5.51	0.18	±	0.10
BHS 500-67	0.28		LLD	0.22		LLD	4	±	4.78	0.62	±	0.10
BHS 500-71	0.27		LLD	0.24		LLD	15	±	4.83	0.59	±	0.10
BHS 500-74	0.40		0.20	0.23		LLD	3		LLD	0.10		LLD
BHS 500-77	0.39		0.19	0.23		LLD	5	±	4.46	0.10		LLD
BHS 500-80	0.32	±	0.20	0.24		LLD	3.5.	±	4.79	0.12	±	0.10
BHS 500-86	0.33	±	0.20	0.24		LLD	7	±	4.90	0.17	±	0.10
BHS 500-87	0.52	±	0.22	0.27		LLD	6	±	4.60	4.63	±	0.65
BHS 500-88	0.77	±	0.26	0.70	±	0.27	3		LLD	0.10		LLD
BHS 500-92	0.31		LLD	0.22		LLD	3		LLD	0.10		LLD
BHS 500-96	0.44		LLD	0.34		LLD	3	±	4.02	0.79	±	0.11
BHS 500-97	0.44		LLD	0.44		LLD	5	±	4.15	11.20	±	1.57
BHS 500-100	Dry, no sample											
BHS 500-101	0.31		LLD	0.26		LLD	5	±	4.79	0.80	±	0.11
BHS 500-104	0.41		LLD	0.37		LLD	3		LLD	0.52	±	0.10
BHS 500-108	0.36		LLD	0.28		LLD	4		LLD	0.10		LLD
BHS 500-137	0.40	±	0.19	0.24		LLD	3	±	4.53	0.28	±	0.10
BHS 500-138	0.25		LLD	0.26		LLD	4	±	4.93	0.33	±	0.10
Average	**0.38**	**±**	**0.13**	**0.28**	**±**	**0.11**	**5**	**±**	**4.59**	**1.02**	**±**	**2.46**

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	Radioactivity (Bq/L)											
	Gross Beta			Gross Alpha			Tritium			Uranium (ppb)		
Sampling Dates	**2023 July 19 to July 26**											
Bedrock Unit BHS-500-113	0.29		LLD	0.26		LLD	3		LLD	0.58	±	0.10
BHS 500-114	0.22		LLD	0.27		LLD	4	±	4.9	0.50	±	0.10
BHS 500-115	0.35		LLD	0.42	±	0.24	3		LLD	2.28	±	0.32
BHS 500-141	0.24		LLD	0.26		LLD	5	±	5.0	0.23	±	0.10
Sampling Dates	**2023 Nov 14 to Nov 15**											
BHS 500-113	0.30		LLD	0.22		LLD	5		LLD	0.65	±	0.10
BHS 500-114	0.31	±	0.21	0.28		LLD	57		6.44	0.46	±	0.10
BHS 500-115	0.30	±	0.18	0.55	±	0.26	5		LLD	2.31	±	0.32
BHS 500-141	0.28		LLD	0.20		LLD	5		LLD	0.29	±	0.10
Average	**0.29**	**±**	**0.04**	**0.31**	**±**	**0.12**	**11**	**±**	**19**	**0.91**	**±**	**0.86**
Sampling Dates	**2023 July 19 to Aug 16**											
Clay BHS 73-1	0.26	±	0.13	0.28	±	0.20	4		LLD	17.70	±	3.27
BHS 500-42	0.39		LLD	0.68	±	0.41	4		LLD	55.80	±	6.37
BHS 500-65	0.32		LLD	0.47		LLD	4		LLD	58.70	±	6.63
BHS 500-66	0.46		LLD	0.33		LLD	4		LLD	15.10	±	3.12
BHS 79-1	0.34		LLD	0.29		LLD	4		LLD	10.60	±	2.90
BHS 500-103	0.38		LLD	0.48		LLD	20	±	4.51	12.20	±	2.98
BHS 500-107	0.52	±	0.33	1.38	±	0.59	5	±	3.99	40.60	±	5.03
Sampling Dates	**2023 Nov 2 to Nov 29**											
Clay BHS 30	0.50	±	0.24	0.58	±	0.32	25	±	5.34	38.80	±	5.45
BHS 73-1	0.39	±	LLD	0.38	±	0.28	5		LLD	18.40	±	2.57
BHS 500-32	0.69	±	0.33	1.58	±	0.55	3		LLD	96.60	±	13.60
BHS 500-36	0.52	±	0.24	1.18	±	0.47	3		LLD	48.10	±	6.80
BHS 500-38	0.24		LLD	0.40	±	0.24	3		LLD	12.30	±	1.72
BHS 500-66	0.51	±	0.27	0.38		LLD	5		LLD	14.80	±	2.07
BHS 500-69	0.41		LLD	0.47	±	0.25	3		LDD	11.50	±	1.61
BHS 500-73	0.31		LLD	0.28		LLD	3		LLD	13.40	±	1.88
BHS 500-82	0.43		LLD	0.40		LLD	3		LLD	21.70	±	3.05
BHS 500-103	0.35	±	0.22	0.47	±	0.27	45	±	6	29.20	±	4.10
BHS 500-107	0.63	±	0.27	1.37	±	0.47	10	±	4	52.60	±	7.37
Average	**0.61**	**±**	**0.46**	**0.67**	**±**	**0.39**	**10**	**±**	**16**	**33. 9**	**±**	**23.4**

Continued on next page

	Radioactivity (Bq/L)											
	Gross Beta			**Gross Alpha**			**Tritium**			**Uranium (ppb)**		
Sampling Dates	**2023 July 31 to Aug 16**											
Clay-till BHS 73-2	0.48	±	0.25	0.26		LLD	3		LLD	0.10		LLD
BHS 79-2	0.46	±	0.18	0.74	±	0.31	9.07	±	4.29	32.90	±	4.62
BHS 79-3	Dry, no sample											
BHS 500-41	0.55	±	0.26	0.59	±	0.31	3		LLD	28.00	±	3.93
BHS 500-98	0.46	±	0.23	0.66	±	0.29	3		LLD	24.00	±	3.74
BHS 500-99	0.40	±	0.24	1.17	±	0.44	22	±	5.44	57.60	±	8.08
BHS 500-102	0.48	±	0.28	0.46		LLD	56	±	6.16	29.10	±	4.08
BHS 500-106	0.42	±	0.19	0.36		LLD	4	±	4.41	30.00	±	4.21
Sampling Dates	**2023 Nov 2 to Nov 29**											
Clay-till BHS 500-31	1.06	±	0.39	1.61	±	0.54	3		LLD	85.7	±	12.0
BHS 500-35	0.31		LLD	0.42	±	0.23	3		LLD	8.78	±	3.43
BHS 500-37	0.23		LLD	0.32	±	0.20	3	±	4.89	5.59	±	0.78
BHS 500-41	0.44		LLD	0.80	±	0.33	3		LLD	27.2	±	3.81
BHS 500-64	0.41	±	0.24	0.41	±	0.24	5		LLD	15.8	±	2.22
BHS 500-72	0.23		LLD	0.27		LLD	3		LLD	1.01	±	0.14
BHS 500-78	0.34		LLD	0.28		LLD	15		5.02	0.99	±	0.14
BHS 500-73-2	0.31		LLD	0.28		LLD	3		LLD	13.4	±	1.88
BHS 500-90	0.34	±	0.20	0.60	±	0.28	20	±	5.23	19.1	±	2.68
BHS 500-94	2.45	±	0.39	2.62	±	0.56	6	±	4.77	27.4	±	3.84
BHS 500-98	0.43		LLD	0.62	±	0.32	3		4.05	23.7	±	3.32
BHS 500-102	0.36		LLD	0.86	±	0.35	53	±	6	32.9	±	4.62
BHS 500-105	0.49		LLD	0.35		LLD	3		LLD	4.20	±	0.59
BHS 500-106	0.45		LLD	0.40		LLD	3		LLD	29.0	±	4.06
BHS 500-139	1.46	±	0.43	1.90	±	0.61	3		LLD	82.5	±	11.6
BHS 500-140	2.26	±	0.50	5.60	±	0.85	3		LLD	261	±	36.6
Average	**0.64**	**±**	**0.60**	**0.94**	**±**	**1.18**	**10**	**±**	**15**	**36.5**	**±**	**53.9**
MDL	0.05 to 0.1			0.05						0.2 to 4		
Drinking Water Screening Level	1*			0.5*			7000			20**		

Notes:

1. Uncertainties and MDLs are provided by contract lab
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.
4. BHS 30 is located on the south west corner of the WMA.
5. **20 ppb natural uranium is equivalent to 0.5 Bq/L.
6. D01 refers to duplicate analyses.

Table 42: Gross Beta, Gross Alpha, Tritium and Uranium Radioactivity in Lagoon Wells and Piezometers, 2023

Radioactivity (Bq/L)												
Location	**Gross Beta**			**Gross Alpha**			**Tritium**			**Uranium (ppb)**		
Sampling Dates	**2023 July 12**											
Water Table												
BHS 500-16	0.53	±	0.27	0.66	±	0.36	3.00		LLD	30.4	±	4.3
BHS 500-23	0.27		LLD	0.57	±	0.25	3.00		LLD	12.1	±	1.7
BHS 500-27	0.34		LLD	0.29		LLD	3.00		LLD	10.8	±	1.5
BHS 500-30	0.43		LLD	0.29	±	0.40	3.00		LLD	44.3	±	6.2
Average	**0.39**	**±**	**0.11**	**0.45**	**±**	**0.19**	**3.00**		**0.00**	**24.4**	**±**	**16.0**
Minimum	**0.27**			**0.29**			**3.00**			**10.8**		
Maximum	**0.53**			**0.66**			**3.00**			**44.3**		
Basal Unit												
BHS 500-14	1.39	±	0.28	3.50	±	0.43	3.00		LLD	158	±	22
BHS 500-21	0.38	±	0.22	1.72	±	0.30	3.00		LLD	87.1	±	12.2
BHS 500-24	0.83	±	0.14	2.77	±	0.33	3.00		LLD	109	±	15
BHS 500-28	0.20		LLD	0.78	±	0.37	3.00		LLD	59.2	±	8.3
BHS 500-43	0.56	±	0.26	1.62	±	0.47	3.00		LLD	49.1	±	6.9
Average	**0.67**	**±**	**0.46**	**2.08**	**±**	**1.06**	**3.00**		**0.00**	**92.5**	**±**	**44**
Minimum	**0.20**			**0.78**			**3.00**			**49.1**		
Maximum	**1.39**			**3.50**			**3.00**			**158**		
MDL	0.05 to 0.1			0.05						0.2 to 4		
Drinking Water Screening Level	1*			0.5*			7000			20**		

Notes:

1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.
4. BHS 30 is located on the south west corner of the WMA.
5. **20 ppb natural uranium is equivalent to 0.5 Bq/L.

Table 43: Gross Beta, Gross Alpha, Tritium and Uranium Radioactivity in Landfill Wells and Piezometers, 2023

Radioactivity (Bq/L)												
Location	**Gross Beta**			**Gross Alpha**			**Tritium**			**Uranium (ppb)**		
Sampling Dates	**2023 July 5 to July 11**											
Water Table												
BHS 500-4	0.31	±	0.19	0.23		LLD	7.14	±	4.3	2.95	±	0.41
BHS 500-13	0.27		LLD	0.21			4.20	±	4.1	1.89	±	0.27
BHS 500-7	0.28		LLD	0.23		LLD	3.00		LLD	4.09	±	0.57
BHS 500-53	0.29		LLD	0.23		LLD	3.00		LLD	3.88	±	0.54
BHS 500-62	0.29		LLD	0.21		LLD	4.12		LLD	3.99	±	0.56
BHS 500-56	0.27		LLD	0.31		LLD	24.92	±	4.9	5.34	±	0.75
BHS 500-119	0.47		0.20	0.27	±	0.17	3.00		LLD	5.84	±	0.82
Average	**0.31**	±	**LLD**	**0.24**	±	**0.04**	**7.05**	±	**8.01**	**3.98**	±	**1.47**
Minimum	**0.27**			**0.21**			**3.00**			**1.89**		
Maximum	**0.47**			**0.31**			**24.92**			**5.84**		
Basal Unit												
BHS 500-1	0.29		LLD	0.22		LLD	3.00		LLD	2.85	±	0.40
BHS 500-5	0.27		LLD	0.23		LLD	3.00		LLD	2.08	±	0.29
BHS 500-54	No Sample											
BHS 500-11	0.29		LLD	0.27		LLD	3.00		LLD	4.38	±	0.61
BHS 500-60	0.35		LLD	0.22		LLD	3.00		LLD	4.33	±	0.61
BHS 500-118	0.34		LLD	0.16		LLD	3.97		LLD	1.94	±	0.27
Average	**0.30**	±	**LLD**	**0.21**	±	**0.04**	**3.19**	±	**0.43**	**2.72**	±	**1.79**
Minimum	**0.27**			**0.16**			**3.00**			**0.10**		
Maximum	**0.35**			**0.27**			**3.97**			**4.38**		
MDL	0.03			0.14						0.14		
Drinking Water Screening Level	1*			0.5*			7000			20**		

Notes:

1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.
4. **20 ppb natural uranium is equivalent to 0.5 Bq/L.

Table 44: Gross Beta, Gross Alpha, Tritium and Uranium Radioactivity in Main Campus Wells and Piezometers, 2022

Radioactivity (Bq/L)												
Location	**Gross Beta**			**Gross Alpha**			**Tritium**			**Uranium (ppb)**		
Sampling Dates	**2023 August 23 to August 24**											
Wells - Clay												
BH15-1C	Dry											
BH15-1D	Dry											
BH15-2D	Dry											
BH15-3C	Dry											
BH15-3D	Dry											
BH15-4E	Dry											
BH15-5D	Dry											
BH15-6D	Dry											
BH15-7C	Dry											
BH15-7D	Dry											
Average												
Minimum												
Maximum												
Wells - Clay -Till												
BH15-3B	1.09	±	0.23	1.80	±	0.50	3.00		LLD	65.5	±	9.2
BH15-2B		±	0.31		±	0.49			LLD		±	6.5
BH15-1A	0.35	±	0.21	0.30		LLD	3.00		LLD	5.0	±	0.7
BH15-3A	1.02	±	0.29	2.00	±	0.61	3.00		LLD	93.7	±	13.1
BH15-4B	0.84	±	0.25	1.70	±	0.54	3.00		LLD	115.0	±	16.2
BH15-4C	0.67	±	0.26	0.96		0.39	3.00		LLD	53.3	±	7.5
BH15-5B	Dry											
BH15-6B	Dry											
BH15-7A	0.63	±	0.22	0.92	±	0.43	3.00		LLD	36.5	±	5.1
Average	**0.77**	**±**	**0.27**	**1.28**	**±**	**0.66**	**3.00**	**±**	**0.00**	**61.5**	**±**	**39.5**
Minimum	**0.35**			**0.30**			**3.00**			**5.0**		
Maximum	1.09			2.00			3.00			115.0		
MDL	0.03			0.14						0.14		
Drinking Water Screening Level	1*			0.5*			7000			20**		

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Radioactivity (Bq/L)											
Location	**Gross Beta**			**Gross Alpha**			**Tritium**		**Uranium (ppb)**		
Sampling Dates	**2022 July 22 to Oct 31**										
Wells - Basal Unit											
BH15-2A	Dry										
BH15-4A	0.79		0.27	0.58	±	0.37	3.00	LLD	35.3	±	5.0
BH15-4A	Dry										
BH15-5A	1.45	±	0.29	1.50	±	0.53	3.00	LLD	77.9	±	10.9
BH15-5A	--			--			3.00	LLD	83.4	±	11.7
BH15-6A	Dry										
BH15-6A	missed			--			--		--		
Average	**1.12**	**±**	**0.47**	**1.04**	**±**	**0.65**	**3.00**		**65.5**	**±**	**26.3**
Minimum	**0.79**			**0.58**			**3.00**		**35.3**		
Maximum	**1.45**			**1.50**			**3.00**		**83.4**		
Wells - Bedrock											
BH16-2E	12.40	±	0.73	74.8	±	3.4	3.00	LLD	820	±	115
BH16-2E	10.30	±	0.68	72.5	±	3.4	3.00	LLD	886	±	124
BH16-4F	2.96	±	0.45	13.4	±	1.5	3.00	LLD	210	±	29.4
BH16-4F	2.38	±	0.42	11.2	±	1.5	3.00	LLD	192	±	26.9
BH16-7E	1.34	±	0.31	5.9	±	1.0	3.00	LLD	56.2	±	7.9
BH16-7E	1.50	±	0.38	5.5	±	1.1	3.00	LLD	37.1	±	5.2
Average	**5.15**	**±**	**4.89**	**30.6**	**±**	**33.5**	**3.00**	**0.00**	**367**	**±**	**383**
Minimum	**1.34**			**5.5**			**3.00**		**37.1**		
Maximum	**12.4**			**74.8**			**3.00**		**886**		
MDL	0.03			0.14					0.14		
Drinking Water Screening Level	1*			0.5*			7000		20**		

Notes:

1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.
4. **20 ppb natural uranium is equivalent to 0.5 Bq/L.

Table 45: Radioactivity in Flesh of Winnipeg River Fish, 2023 (Upstream)

Location and Date	Species	Length (cm)	Weight (kg)	Radioactivity (Bq/kg fresh weight)								
				Gross Beta			Cs-137			K-40		
20 km Upstream from WL - Sylvia Lake 2022	White Sucker	36	0.45	86	±	17	0.97	<	DL	87	±	14
		40	0.75	94	±	19	0.5	<	DL	111	±	10
		34	0.41	109	±	22	0.54	<	DL	123	±	10
		Average		**94**			**0.74**			**105**		
		Std. Dev.		**11**						**15**		
	Walleye	57	2.10	72	±	14	0.37	<	DL	123	±	9
		46	1.10	120	±	24	0.49	<	DL	124	±	8
		41	0.61	120	±	24	0.63	<	DL	118	±	11
		30	0.24	110	±	22	0.66	<	DL	119	±	10
		Average		**106**			**0.54**			**121**		
		Std. Dev.		**23**			**0.1**			**3**		
	Pike	88	4.80	91	±	18	0.36	<	DL	119	±	10
		82	4.39	87	±	17	0.13	<	DL	121	±	9
		Average		**89**			**0.25**			**120**		
		Std. Dev.		**3**						**1**		
	Whitefish	NA		NA			NA			NA		
		Average		NA			NA			NA		
		Std. Dev.										

Notes:

1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.

Table 46: Radioactivity in Flesh of Winnipeg River Fish, 2023 (2.0 km Downstream)

Location and Date	Species	Length (cm)	Weight (kg)	Radioactivity (Bq/kg fresh weight)								
				Gross Beta			Cs-137			K-40		
2.0 km Downstream from WL 2022	White Sucker	44	0.97	94	±	19	0.2	<	DL	121	±	14
		35	0.48	108	±	22	0.64	<	DL	109	±	12
		39	0.57	99	±	20	0.33	<	DL	128	±	10
		44	0.99	87	±	17	0.49	<	DL	122	±	12
		Average		**97**			**0.42**			**120**		
		Std. Dev.		**9**			**0.19**			**8**		
	Walleye	47	0.92	95	±	19	0.6	<	DL	118	±	11
		40	0.56	108	±	22	0.38	<	DL	133	±	10
		29	0.20	89	±	18	1.2	<	DL	116	±	16
		32	0.30	82	±	17	0.84	<	DL	119	±	13
		Average		**94**			**0.76**			**122**		
		Std. Dev.		**11**			**0.4**			**8**		
	Pike	60	1.24	96	±	19	0.4	<	DL	117	±	8
		75	0.27	77	±	15	0.2	<	DL	126	±	8
		Average		**86**			**0.29**			**122**		
		Std. Dev.		**14**			**0.19**			**6**		
	Whitefish	46	1.07	87	±	17	0.4	<	DL	99	±	10
		Average		**87**			**0.4**			**99**		
		Std. Dev.										

Notes:

1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.

* Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.

Table 47: Radioactivity in Flesh of Winnipeg River Fish, 2023 (5.0 km Downstream)

Location and Date	Species	Length (cm)	Weight (kg)	Radioactivity (Bq/kg fresh weight)								
				Gross Beta			Cs-137			K-40		
5.0 km Downstream from WL 2022	White Sucker	41	0.75	103	±	21	0.56	<	DL	121	±	12
		44	0.80	99	±	20	0.52	<	DL	98	±	9
		40	0.55	89	±	18	0.3	<	DL	110	±	8
		37	0.61	83	±	17	0.6	<	DL	101	±	11
		Average		**94**			**0.48**			**108**		
		Std. Dev.		**9**						**10**		
	Walleye	54	1.40	87	±	17	0.57	±	0.1	129	±	15
		36	0.38	85	±	17	0.73		DL	108	±	12
		34	0.36	118	±	24	0.59		LLD	137	±	10
		35	0.35	85	±	17	0.82		LLD	109	±	13
		Average		**94**			**0.68**			**121**		
		Std. Dev.		**16**			**0**			**15**		
	Pike	56	0.81	105	±	21	3.91	±	0.5	134	±	12
		80	3.06	98	±	20	0.14	±	0.07	115	±	8
		Average		**101**			**2.03**			**125**		
		Std. Dev.		**5**			**2.66**			**13**		
	Whitefish	51	1.42	109	±	22	0.39	<	DL	133	±	11
		53	1.63	89	±	18	0.19	<	DL	125	±	9
		Average		**99**			**0.29**			**129**		
		Std. Dev.		**14**			**0**			**6**		

Notes:
1. Uncertainties and MDLs are provided by contract lab.
2. LLD = Lower Limit of Detection.
3. *Compliance with Guidelines for Canadian Drinking Water [21] may be inferred if the measurements for gross alpha and gross beta are less than 0.5 Bq/L and 1 Bq/L, respectively.

Table 48: Radioactivity in Cultivated Vegetables in Vicinity of Whiteshell Laboratories, 2023

	Radioactivity (Bq/kg fresh weight)																	
Sample	**Gross Beta**			**Gross Alpha**			**Strontium-90**			**Potassium-40**			**Cesium-137**			**Beryllium-7**		
Upstream Samples																		
Potatoes	148	±	30	0.25		LD	0.05		LD	154	±	10	0.38		LD	3.5		LD
Cabbage	51	±	10	0.2	±	0.03	0.10		LD	64	±	8	0.47		LD	4.5		LD
Squash	79	±	16	0.4	±	0.1	0.06		LD	81	±	6	0.21		LD	1.9		LD
Downstream Samples																		
Potatoes	116	±	23	0.43	±	0.09	0.04		LD	130	±	9	0.35		LD	3.6		LD
Cabbage	57	±	11	1.04	±	0.09	0.10		LD	65	±	5	0.21		LD	2.0		LD
Zucchini	67	±	14	0.54	±	0.11	0.06		LD	71	±	7	0.38		LD	2.6		LD
MDL*	1			4			0.10			7.0			0.87			20		

Notes:

1. Uncertainties and MDLs are provided by contract lab.

LD = Lower Limit of Detection.

Table 49: Radioactivity in Native Vegetation at Whiteshell Laboratories and Vicinity, 2023

Sample Location	Sample Date	Gross Beta (Bq/kg)	Gross Alpha (Bq/kg)	K-40 (Bq/kg)	SR-90 (Bq/kg)	Cs-137 (Bq/kg)	Tritium (Bq/kg)	OBT (Bq/kg)
WL Perimeter								
Arms #1	11-Aug-23	41 ± 8	3.1 ± 0.6	38 ± 3	1.75 LLD	0.2 LLD	11 ± 1.3	15 ± 1.4
Arms #3	11-Aug-23	33 ± 7	3.8 ± 0.8	25 ± 4	0.97 LLD	0.3 LLD	3 LLD	10 LLD
Arms #4	11-Aug-23	48 ± 10	6.0 ± 0.4	38 ± 3	1.11 LLD	0.2 LLD	10 ± 1.1	23 ± 2.1
Arms #5	11-Aug-23	51 ± 10	5.8 ± 1.2	35 ± 5	0.78 LLD	0.8 LLD	14 ± 1.6	6 LLD
West of WMA & North of Canister Area								
WMA 1	11-Aug-23	58 ± 12	7.7 ± 1.5	53 ± 3	0.9 LLD	0.4 LLD	9 ± 1	22 ± 2
East of WMA & Near Incinerator								
WMA 7	11-Aug-23	59 ± 12	4.0 ± 0.8	52 ± 4	1.0 LLD	0.2 LLD	7 LLD	9 LLD

Notes:

1. Activities are reported per fresh weight.
2. For security improvement and fire control, the soil and vegetation was removed from the area just outside the WMA fence and replaced with gravel.

LLD = Lower Limit of Detection

ND = Not Determined

Table 50: Radioactivity in Surface Soil Near Standpipe Rows E, F and G of Whiteshell Laboratories Waste Management Area, 2023 (EFG SOIL)

Location	Gross Beta (Bq/g)	Gross Alpha (Bq/g)	K-40 (Bq/g)	Sr-90 (Bq/g)	Cs-137 (Bq/g)	Am-241 (Bq/g)
Location E - 1 m East of WMA Fence at Standpipe Row E						
Perimeter (7m south)	0.84 ± 0.17	0.20 ± 0.04	0.48 ± 0.05	1.77 ± 0.39	0.051 ± 0.004	0.003 LLD
Perimeter (8m south)	0.70 ± 0.14	0.19 ± 0.04	0.50 ± 0.03	0.63 ± 0.14	0.039 ± 0.001	0.004 LLD
Perimeter (9m south)	0.16 LLD	0.22 ± 0.05	0.46 ± 0.05	0.14 LLD	0.029 ± 0.003	0.003 LLD
Perimeter (9m west)	0.37 ± 0.07	0.13 ± 0.03	0.45 ± 0.06	0.14 LLD	0.001 ± .0004	0.003 LLD
Location F - 1 m East of WMA Fence at Standpipe Row F						
Perimeter (9m west)	0.47 ± 0.09	0.14 ± 0.03	0.46 ± 0.05	0.13 LLD	0.001 ±.0003	0.0023 LLD
Location G - 1 m East of WMA Fence at Standpipe Row G						
Perimeter (9m north)	0.58 ± 0.12	0.07 ± 0.01	0.40 ± 0.05	0.25 LLD	0.017 ± 0.002	0.004 LLD
Perimeter (9m west)	0.51 ± 0.10	0.17 ± 0.03	0.45 ± 0.00	0.04 LLD	0.004 ± 0.000	0.0004 LLD
NSRDR Clearance Level [14]	NA	1(1)	10	1.0	0.10	

Notes:

1. Alpha activity assumed to be from radionuclides of natural origin.
2. Uncertainties of individual results and LLD values are provided by the contract lab.
3. NA = Not Applicable, ND = Not Detected.

Table 51: Field Data, Winnipeg River Sediment Samples, 2023

Location Code and Distance from Outfall (km)	Sample Number	Core Depth (cm)	Wet Sample Weight (g)	Water Depth (m)	Distance from Shore (m)
J04 (-0.76 km)	001	1	15.3	2.0	3.0
	002	1	16.8	2.0	3.0
	003	1	18.6	2.0	3.0
J02 (-0.37 km)	001	1	17.3	2.0	3.0
	002	1	17.3	2.0	3.0
	003	1	20.5	2.0	3.0
OFL (0 km)	001	1	18.9	3.0	3.0
	002	1	22.9	3.0	3.0
	003	1	24.5	3.0	3.0
K01 (+0.15 km)	001	1	14.3	2.0	2.0
	002	1	24.0	2.0	2.0
	003	1	15.5	2.0	2.0
K03 (+0.52 km)	001	1	14.6	3.0	2.0
	002	1	18.6	3.0	2.0
	003	1	16.6	3.0	2.0
K05 (+0.79 km)	001	1	18.8	3.0	3.0
	002	1	21.7	3.0	3.0
	003	1	22.5	3.0	3.0
K14 (+2.56 km)	001	1	20.6	3.0	4.0
	002	1	23.4	3.0	4.0
	003	1	18.5	3.0	4.0
K19 (+3.48 km)	001	1	16.5	2.0	2.0
	002	1	16.6	2.0	2.0
	003	1	22.0	2.0	2.0
K22 (+4.63 km)	001	1	16.9	2.0	3.0
	002	1	17.7	2.0	3.0
	003	1	24.7	2.0	3.0
K23 (+4.78 km)	001	1	21.5	3.0	2.0
	002	1	17.6	3.0	2.0
	003	1	16.4	3.0	2.0
K24 (+4.93 km)	001	1	16.5	4.0	4.0
	002	1	15.5	4.0	4.0
	003	1	18.5	4.0	4.0
K30 (+13.06 km)	001	1	17.5	2.5	5.0
	002	1	22.3	2.5	5.0
	003	1	23.0	2.5	5.0

Table 52: Calculations for Incremental Dose Due to Effluents from Whiteshell Laboratories, 2023

	ACTIVITY					ADULT				INFANT			
	Local Fraction	**Down-stream**	**Up-Stream**	**Difference**	**Unit**	**DCF[1] (Sv/Bq)**	**Consumption**	**Unit**	**Dose (mSv/a)**	**DCF (Sv/Bq)**	**Consumption**	**Unit**	**Dose (mSv/a)**
Water Ingestion													
Cs-137	1.00	0.0040	0.0030	0.0010	Bq/L	1.30E-08	840	L/a	1.09E-05	1.20E-08	347	L/a	4.16E-06
Sr-90	1.00	0.0080	0.0190	-0.011 = 0.00	Bq/L	2.80E-08	840	L/a	nil	7.30E-08	347	L/a	nil
Total Water									1.09E-05				4.16-06
Game Meat Ingestion (deer)													
Cs-137	0.5	0.19	6[2]	-5.81 = 0.00	Bq/kg	1.30E-08	34	kg/a	nil	1.20E-08	6.1	kg/a	nil
Fish Ingestion (pike)													
Cs-137	0.3	2.03	0.36	1.67	Bq/kg	1.30E-08	7.41	kg/a	4.83E-05	1.20E-08	0.31	kg/a	1.86E-06
Total Dose		**(mSv)**							5.92E-05				6.03E-06
% of Limit									5.92E-03				6.03E-04

Notes:

1. DCF = Dose Conversion Factor
2. Known background for deer is 6 Bq/kg