ONTARIO POWER GENERATION

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May 31, 2024

CD# 92896-CORR-00531-01544 P

Ms. Candace Salmon
Commission Registrar,
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
Ottawa, Ontario, K1P 5S9

Dear Ms. Salmon:

Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure

The purpose of this letter is to request the Canadian Nuclear Safety Commission, referred to as "the Commission", for an amendment to the Pickering Waste Management Facility (PWMF), Waste Facility Operating Licence (WFOL) WFOL-W4-350.00/2028, to construct and operate the Pickering Component Storage Structure (PCSS) for storage of Low and Intermediate Level Waste (L&ILW) that will be generated by Pickering Nuclear Generating Station (NGS).

This additional interim storage capacity, intended for radioactive component waste/material, will be required to support the refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities. OPG has previously provided a letter of intent communicating the operational need to construct and operate the PCSS (Reference 1) and received CNSC staff's recommendations on requirements and expectations for the OPG licence amendment application for this activity (Reference 2).

This submission includes the following documentation:

- Attachment 1 provides the compliance matrix for the *Nuclear Safety and Control Act*, and the associated regulations required for the amendment of the PWMF WFOL to construct and operate the PCSS.
- Attachment 2 provides the licence impact assessment of the proposed new licensed activity on PWMF's licensing basis for each of the 15 Safety and Control Areas of PWMF's WFOL. It also provides the description and key attributes of the PCSS, and provides the proposed wording for the amendment to PWMF WFOL-W4-350.00/2028.
- Enclosure 1 provides 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*" in support of the licensing impact assessment.
- Enclosure 2 provides 92896-REP-00701-00019 R001, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*" which was previously submitted as Enclosure 1 of Reference 1.

The design considerations for the PCSS complies with all applicable regulatory requirements. The safety analysis, 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*", which is referred to as the "safety case", can be summarized as follows:

- **Design:** OPG has and will continue to follow its Engineering Change Control process, as described in N-PROG-MP-0001, "*Engineering Change Control*", for ensuring the design complies with applicable regulatory requirements as defined in the LCH, LCH-W4-350.00/2028, and that configuration management will be maintained.

- **Continued Safe Operation:** The safety case, 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*", provided as Enclosure 1 of this submission, demonstrates that the operation of the PCSS and storage of L&ILW components will have a negligible effect on the safe operation, public and worker safety.

- **Environmental Protection:** The predictive environmental risk assessment completed for PCSS, 92896-REP-00701-00019 R001, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*", provided as Enclosure 2 of this submission, concludes that the construction and operation of the PCSS will have negligible impact on the environment.

- **Licensing Basis:** The construction and operation of the PCSS will have minimal impact on PWMF's licensing basis, governance, programs, and processes. Attachment 1 of this submission provides the compliance matrix for the Nuclear Safety Control Act and associated regulations required for the amendment of the PWMF WFOL.

OPG continues to regularly engage with Indigenous Nations and communities to provide and share information regarding activities at the Pickering NGS and PWMF, including the PCSS. OPG will continue to proactively engage the identified Indigenous Nations and communities through various activities, such as staff briefings, community information sessions, written communication and workshops. The specific objective is to ensure that Indigenous Nations and communities around the Pickering NGS and PWMF are provided with a forum to discuss key topics of Indigenous interest which includes the licence amendment application, for the PCSS.

The following documentation will be provided for CNSC staff review prior to the target commencement date of construction activities:

- The design requirements, environmental management plan, and construction verification plan for the PCSS in accordance with PWMF WFOL-W4-350.00/2028, Licence Condition 15.1, *Construction Plans*. This submission is tracked under Regulatory Action Management Request (REGM) # 28267121.

- An update to the safety analysis report, 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*" for the final design of the PCSS. This submission is tracked under REGM # 28267123.

Based on the most current project information, the target availability of the PCSS to begin storing L&ILW on an interim basis was re-evaluated as April 2027 which is sooner than the in-service date of August 2027, previously communicated in Reference 1. As the project progresses, OPG will inform CNSC staff of any updates to the in-service date through the submission of the required regulatory documents.

The following subsequent technical documentation will be provided to CNSC staff prior to the target operation date of the PCSS:

- The PCSS final commissioning report for CNSC staff acceptance in accordance with PWMF WFOL-W4-350.00/2028, Licence Condition 15.2, *Commissioning Report*. This submission is tracked under REGM # 28267122.

- The updates to the Operating Policies and Principles for the PWMF. This submission is tracked under REGM # 28267257.

In summary, OPG remains committed to the safe operation of the PWMF and re-affirms that the construction and operation of the PCSS will be implemented in accordance with the PWMF licensing basis. L&ILW will be stored safely in the PCSS as presented in the associated safety case without compromise to continued safe facility operation, public and worker safety, and environmental protection.

OPG is requesting the Canadian Nuclear Safety Commission to amend the PWMF, WFOL-W4-350.00/2028, to construct and operate the PCSS for interim storage of L&ILW from Pickering NGS by February 2025.

Should you have any questions, please contact Ms. Liliana Moraru, Senior Manager, Regulatory Affairs - Strategic Projects, at (905) 260-4089 or liliana.moraru@opg.com.

Sincerely,

Kapil Aggarwal, M. Eng., P. Eng
Vice President
Nuclear Sustainability Services
Ontario Power Generation Inc.

Encl.

cc:
K. Campbell	-	CNSC (Ottawa)
T. Kalindjian	-	CNSC (Ottawa)
R. Buhr	-	CNSC (Ottawa)
R. van Hoof	-	CNSC (Ottawa)
M. McLaughlin	-	CNSC (Ottawa)

References:

1. OPG Letter, K. Aggarwal to N. Petseva, “Pickering Waste Management Facility – Letter of Intent to Construct the Pickering Component Storage Structure”, February 1, 2024, e-Doc# 7214316, CD# 92896-CORR-00531-01485.

2. CNSC letter, K. Campbell to K. Aggarwal, “CNSC Staff Response to OPG Submission - Letter of Intent to Construct the Pickering Component Storage Structure at the Pickering Waste Management Facility”, March 20, 2024, e-Doc 7240022, CD# 92896-CORR-00531-01545.

ATTACHMENT 1

OPG letter, K. Aggarwal to C. Salmon, “Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure”

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Licence Compliance Matrix – Nuclear Safety Control Act and Associated Regulations

Prepared By: **P. Hendrix**

Checked By: **B. Noye**

ATTACHMENT 1

Licence Compliance Matrix – Nuclear Safety Control Act and Associated Regulations

This Attachment, along with the accompanying letter and Attachment 2 of this submission, provides the information required by the Nuclear Safety and Control Act and the applicable Nuclear Regulations made pursuant to the Act, and constitutes an application by OPG to amend the current Pickering Waste Management Facility (PWMF) Waste Facility Operating Licence WFOL-W4-350.00/2028 to construct and operate the Pickering Component Storage Structure (PCSS) for interim storage of low and intermediate level waste from Pickering NGS.

The tables below are divided by applicable Regulation and demonstrate how OPG has addressed each applicable regulatory requirement of the subject Regulation.

Nuclear Safety and Control Act		
Section	**Requirement**	**OPG Response**
Licences		
24(2)	***Application*** *The Commission may issue, renew, suspend in whole or in part, amend, revoke, or replace a licence, or authorize its transfer on receipt of an application:* *(a) in the prescribed form;*	This submission (letter and attachments) provides the information required by the Nuclear Safety and Control Act (referred to as the Act) and the applicable Regulations made pursuant to the Act and provides supplemental information in support of OPG's application for licence amendment. This requirement has been met.
	(b) containing the prescribed information and undertakings and accompanied by the prescribed documents; and	See response above under clause 24 (2) (a).
	(c) accompanied by the prescribed fee.	OPG is in good standing with respect to the provision of CNSC licensing fees and will provide any additional fees associated with this WFOL amendment request, if requested.
24(4)	***Conditions for issuance, etc.*** *No licence may be issued, renewed, amended, or replaced - and no authorization to transfer one given - unless, in the opinion of the Commission, the applicant:* *(a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and*	OPG understands that qualification will be determined through consideration by the Commission of this application and the associated supporting material, as well as deliberation through the Commission decision-making process. OPG is qualified to safely undertake the additional activities associated with the storage of Low and Intermediate Level Waste (L&ILW) at the PWMF.

Nuclear Safety and Control Act		
Section	**Requirement**	**OPG Response**
	(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.	Attachment 2 of this submission documents the assessments and provisions in support of the licence amendment request. Specifically: • documents worker health and safety provisions. • documents assessments and impact on environmental protection. • documents the security considerations.
25	***Renewal, etc.*** *The Commission may, on its own motion, renew, suspend in whole or in part, amend, revoke or replace a licence under the prescribed conditions.*	OPG understands this requirement and will continue to comply.
26	***Prohibitions*** *Subject to the regulations, no person shall, except in accordance with a licence:* *(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;* *(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;* *(c) produce or service prescribed equipment;* *(d) operate a dosimetry service for the purposes of this Act;* *(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or* *(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.*	OPG staff understand these requirements and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
Licences – General Application Requirements		
3(1)	*An application for a licence shall contain the following information:* *(a) the applicant's name and business address;*	Applicant's name and business address: **Ontario Power Generation, Inc** **1908 Colonel Sam Dr.** **Oshawa, Ontario, L1H 8W8** Official Language: **English** Contact person, signing authority and licence holder: **Kapil Aggarwal** **Vice President** **Nuclear Sustainability Services,** **Ontario Power Generation** **Telephone: 416-402-6484**
	(b) the activity to be licensed and its purpose;	OPG requests an amendment to the PWMF WFOL, WFOL-W4-350.00/2028, to construct and operate the PCSS for storage of L&ILW from Pickering NGS.
	(c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;	L&ILW from refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities. Per unit, the quantity of waste will be but is not limited to: • 12 Steam Generators • 380 Fuel Channels (comprising of end fittings, pressure tubes, calandria tubes, annulus spacers and calandria tube inserts). Details of the quantity and form of the waste can be found in Enclosure 1 of this submission.
	(d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;	A description of the PWMF is provided in Attachment 2 of this submission.
	(e) the proposed measures to ensure compliance with the Radiation	OPG understands this requirement and will remain in compliance with the current licence

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	Protection Regulations, the Nuclear Security Regulations and the Packaging and Transport of Nuclear Substances Regulations, 2015;	conditions documented in WFOL-W4-350.00/2028 and with the Radiation Protection Regulations, the Nuclear Security Regulations, and the Packaging and Transport of Nuclear Substances Regulations as described in Attachment 2 of this submission.
	(f) any proposed action level for the purpose of section 6 of the Radiation Protection Regulations;	The requested WFOL amendment will not require changes to the radiation protection action levels.
	(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;	The requested WFOL amendment will not require changes to the measures to control PWMF site access, the nuclear substance, prescribed equipment or prescribed information.
	(h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;	The requested WFOL amendment will not require changes to the measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.
	(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	The requested WFOL amendment to authorize the storage of L&ILW in the PCSS at the PWMF is supported by a robust safety case that is summarized in Attachment 2 of this submission.
	(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	See response above under clause 3 (1) (c). This waste will be managed in accordance with OPG's current programs and processes.
	(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority;	The organizational management structure will not change as a result of the requested licence amendment.
	(l) a description of any proposed financial guarantee relating to the activity to be licensed; and	OPG understands the regulatory requirement to maintain a financial guarantee for its facilities per REGDOC-3.3.1. The financial impact related to the PCSS will be included in the 2027

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
		CNSC Financial Guarantee submission associated with the updated PWMF PDP.
	(m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.	OPG understands this requirement and will continue to comply.
(1.1)	*The Commission or a designated officer authorized under paragraph 37(2)(c) of the Act, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant* *(a) is qualified to carry on the activity to be licensed;* *(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.*	OPG understands this requirement and will continue to comply.
Application for Amendment, Revocation or Replacement of Licence		
6	*An application for the amendment, revocation or replacement of a licence shall contain the following information:* *(a) a description of the amendment, revocation or replacement and of the measures that will be taken and the methods and procedures that will be used to implement it;* *(b) a statement identifying the changes in the information contained in the most recent application for the licence;*	(a) Attachment 2 of this submission documents the description of the amendment (Appendix A) and of the measures that will be taken and the methods and procedures that will be used to implement it. (b) Attachment 2 of this submission documents the changes that will be required to any licensing basis documents. The L&ILW will be stored within a specified array in the PWMF PCSS, a shielded building.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	(c) a description of the nuclear substances, land, areas, buildings, structures, components, equipment and systems that will be affected by the amendment, revocation or replacement and of the manner in which they will be affected; and *(d) the proposed starting date and the expected completion date of any modification encompassed by the application.*	(c) This licence amendment request is to operate the Pickering Waste Management Facility (hereinafter "the facility"), to include the PCSS in addition to the Pickering Used Fuel Dry Storage Facility located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario. (d) The first steam generators (SGs) would arrive between 2027 and 2028. The remaining wastes will follow pending the refurbishment activities on each unit with completion expected in 2034.
Incorporation of Material in Application		
7	*An application for a licence or for the renewal, suspension in whole or in part, amendment, revocation or replacement of a licence may incorporate by reference any information that is included in a valid, expired or revoked licence.*	OPG understands and has provided applicable references to information contained in the existing licence and Licence Conditions Handbook.
Obligations		
12(1)	***Obligations of Licensees*** *Every licensee shall*	OPG understands the requirements and will continue to comply. Specifically:
	(*a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;*	OPG will ensure a sufficient number of qualified workers will be available to safely carry out the activities requested under this licence amendment.
	(b) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;	OPG staff will be trained on operation and maintenance activities associated with the requested licence amendment.
	(c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances;	Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for details on environmental protection.
	(d) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	(e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence;	OPG understands this requirement and will continue to comply.
	(f) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the *licensed activity and into the environment as a result of the licensed activity;*	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 for further details on control of releases.
	(g*) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;*	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(h) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(i) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement;	OPG understands this requirement and will continue to comply.
	(j) instruct the workers on the physical security program at the site of the licensed activity and on their obligations under that program;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security.
	(k) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.	OPG understands this requirement and will continue to comply.
12(2)	*Every licensee who receives a request from the Commission or a person who is authorized by the Commission for the purpose of this subsection, to conduct a test, analysis, inventory or inspection in respect of the licensed activity or to review or to modify a design, to modify equipment,*	OPG understands this requirement and will continue to comply. Testing and commissioning procedures and reports associated with the storage of L&ILW will

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	to modify procedures or to install a new system or new equipment shall file, within the time specified in the request, a report with the Commission that contains the following information: *(a) confirmation that the request will or will not be carried out or will be carried out in part;* *(b) any action that the licensee has taken to carry out the request or any part of it;* *(c) any reasons why the request or any part of it will not be carried out;* *(d) any proposed alternative means to achieve the objectives of the request; and* *(e) any proposed alternative period within which the licensee proposes to carry out the request.*	be made available to facilitate the regulatory role of CNSC staff.
Transfers		
13	*No licensee shall transfer a nuclear substance, prescribed equipment or prescribed information to a person who does not hold the licence, if any, that is required to possess the nuclear substance, prescribed equipment or prescribed information by the Act and the regulations made under the Act*.	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
Notice of Licence		
14	*(1) Every licensee other than a licensee who is conducting field operations shall post, at the location specified in the licence or, if no location is specified in the licence, in a conspicuous place at the site of the licensed activity,* *(a) a copy of the licence, with or without the licence number, and a notice indicating the place where any record referred to in the licence may be consulted; or* *(b) a notice containing* *(i) the name of the licensee,* *(ii) a description of the licensed activity,* *(iii) a description of the nuclear substance, nuclear facility or prescribed equipment encompassed by the licence, and* *(iv) a statement of the location of the licence and any record referred to in it*. *(2) Every licensee who is conducting field operations shall keep a copy of the licence at the place where the field operations are being conducted.* *(3) Subsections (1) and (2) do not apply to a licensee in respect of* *(a) a licence to import or export a nuclear substance, prescribed equipment or prescribed information;* *(b) a licence to transport a nuclear substance; or* *(c) a licence to abandon a nuclear substance, a nuclear facility, prescribed equipment or prescribed information.*	OPG understands this requirement and will continue to comply with this requirement.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
Publication of Health and Safety Information		
16	*(1) Every licensee shall make available to all workers the health and safety information with respect to their workplace that has been collected by the licensee in accordance with the Act, the regulations made under the Act and the licence.* *(2) Subsection (1) does not apply in respect of personal dose records and prescribed information.*	OPG understands this requirement and will continue to comply. OPG's Health and Safety Policy is posted on the OPG intranet website.
Obligations of Workers		
17	*Every worker shall:* *(a) use equipment, devices, facilities and clothing for protecting the environment or the health and safety of persons, or for determining doses of radiation, dose rates or concentrations of radioactive nuclear substances, in a responsible and reasonable manner and in accordance with the Act, the regulations made under the Act and the licence;* *(b) comply with the measures established by the licensee to protect the environment and the health and safety of persons, maintain security, control the levels and doses of radiation, and control releases of radioactive nuclear substances and hazardous substances into the environment;* *(c) promptly inform the licensee or the worker's supervisor of any situation in which the worker believes there may be* *(i) a significant increase in the risk to the environment or the health and safety of persons,* *(ii) a threat to the maintenance of the security of nuclear facilities and of*	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Requirement**	**OPG Response**
	nuclear substances or an incident with respect to such security, *(iii) a failure to comply with the Act, the regulations made under the Act or the licence,* *(iv) an act of sabotage, theft, loss or illegal use or possession of a nuclear substance, prescribed equipment or prescribed information, or* *(v) a release into the environment of a quantity of a radioactive nuclear substance or hazardous substance that has not been authorized by the licensee;* *(d) observe and obey all notices and warning signs posted by the licensee in accordance with the Radiation Protection Regulations; and* *(e) take all reasonable precautions to ensure the worker's own safety, the safety of the other persons at the site of the licensed activity, the protection of the environment, the protection of the public and the maintenance of the security of nuclear facilities and of nuclear substances.*	

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
Licence Applications – General Requirements		
3	*An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the General Nuclear Safety and Control Regulations:* *(a) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;*	The changes to the site are described in Section 1 of Attachment 2. A map showing the site layout is shown in Figure 1 of Attachment 2.
	(b) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;	
	(c) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;	The requested WFOL amendment will not require changes to site ownership.
	(d) the proposed management system for the activity to be licensed, including measures to promote and support safety culture;	OPG understands this requirement and will continue to comply. Refer to section 2.1, LC 1.1 in Attachment 2 of this submission for further details on management system.
	(d.1) the proposed human performance program for the activity to be licensed, including measures to ensure workers' fitness for duty.	OPG understands this requirement and will continue to comply. Refer to section 2.2, LC 2.1 in Attachment 2 of this submission for further details on human performance and fitness for duty.
	(e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;	Similar to the Retube Waste Storage Building at the Darlington Waste Management Facility, it is expected there will be minimal hazardous material.
	(f) the proposed worker health and safety policies and procedures;	OPG understands this requirement and will continue to comply. Refer to sections 2.7 and 2.8 (LC 7.1 and LC 8.1) in Attachment 2 of this submission for further details on radiation protection and conventional health and safety respectively.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(g) the proposed environmental protection policies and procedures;	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for further details on environmental protection including environmental monitoring.
	(h) the proposed effluent and environmental monitoring programs;	
	(i) if the application is in respect of a nuclear facility referred to in paragraph 2(b) of the Nuclear Security Regulations, the information required by section 3 of those Regulations;	Not Applicable
	(j) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and	OPG understands this requirement and will continue to comply. Refer to Section 3 in Attachment 2 of this submission for further details on public information and Indigenous Nations engagement.
	(k) the proposed plan for the decommissioning of the nuclear facility or of the site.	OPG understands this requirement and will continue to comply. Refer to section 2.11, LC 11.2 in Attachment 2 of this submission for further details on decommissioning plans.
Licence to Operate		
6	*An application for a licence to operate a Class 1 nuclear facility shall contain the following information in addition to the information required by section 3:* *(a) a description of the structures at the nuclear facility, including their design and their design operating conditions;* *(b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions;*	OPG understands this requirement and will continue to comply.
	(c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;	OPG understands this requirement and will continue to comply.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
		Refer to section 2.4, LC 4.1 in Attachment 2 of this submission for further details on safety analysis.
	(d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility;	OPG understands this requirement and will continue to comply. Refer to section 2.3, LC 3.1 in Attachment 2 of this submission for further details on operating performance.
	(e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances;	OPG understands this requirement and will continue to comply. Refer to section 2.14, LC 14.1 in Attachment 2 of this submission for further details on packaging and transport.
	(f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;	OPG understands this requirement and will continue to comply. Refer to section 2.13, LC 13.1 in Attachment 2 of this submission for further details on safeguards.
	(g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility;	OPG understands this requirement and will continue to comply.
	(h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;	OPG understands this requirement and will continue to comply. Refer to sections 2.7, 2.8, and 2.9 (LC 7.1, LC 8.1 and LC 9.1 respectively) in Attachment 2 of this submission for further details on radiation protection, conventional health and safety respectively and environmental protection.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(i) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics; *(j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;*	OPG understands this requirement and will continue to comply. Refer to section 2.9, LC 9.1 in Attachment 2 of this submission for further details on environmental protection.
	(k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of national security, including measures to *(i) assist off-site authorities in planning and preparing to limit the effects of an accidental release,* *(ii) notify off-site authorities of an accidental release or the imminence of an accidental release,* *(iii) report information to off-site authorities during and after an accidental release,* *(iv) assist off-site authorities in dealing with the effects of an accidental release, and* *(v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;*	OPG understands this requirement and will continue to comply. Refer to section 2.10, LC 10.1 in Attachment 2 of this submission for further details on emergency preparedness.

Class 1 Nuclear Facility Regulations		
Section	**Requirement**	**OPG Response**
	(l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts;	OPG understands this requirement and will continue to comply. Refer to section 2.12, LC 12.1 in Attachment 2 of this submission for further details on security program.
	(m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and *(n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility.*	OPG understands this requirement and will continue to comply. Refer to section 2.2, LC 2.2 in Attachment 2 of this submission for further details on training program.

Radiation Protection Regulations		
Section	**Requirement**	**OPG Response**
4	*Every licensee must implement a radiation protection program and must, as part of that program,* *(a) keep the effective dose and equivalent dose received by and committed to persons as low as reasonably achievable, taking into account social and economic factors, through the implementation of* *(i) management control over work practices,* *(ii) personnel qualification and training,* *(iii) control of occupational and public exposure to radiation, and* *(iv) planning for unusual situations; and* *(b) ascertain the quantity and concentration of any nuclear substance released as a result of the licensed activity* *(i) by direct measurement as a result of monitoring, or* *(ii) if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the quantity and concentration using that method, by estimating them.*	OPG has a well-established radiation protection program that complies with all elements of the Radiation Protection Regulations. Further details are provided in Section 2.7, LC 7.1 on OPG's radiation protection considerations for the storage of L&ILW.

Nuclear Security Regulations
OPG will continue to adhere to all facets of the Nuclear Security Regulations and keep in place all current security processes in the handling and storage of L&ILW from Pickering NGS.

ATTACHMENT 2

OPG letter, K. Aggarwal to C. Salmon, “Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure”

CD# 92896-CORR-00531-01544 P

Licence Impact Assessment in Support of Construction and Operation of the Pickering Component Storage Structure at Pickering Waste Management Facility

Prepared By: **L. Van Vliet**

Checked By: **B. Noye**

ATTACHMENT 2
CD# 92896-CORR-00531-01544

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Licence Impact Assessment in Support of Construction and Operation of the Pickering Component Storage Structure at Pickering Waste Management Facility

Table of Contents

LAND ACKNOWLEDGEMENT

The lands and waters on which the Pickering Nuclear Generating Station (PNGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

PNGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

1.0 INTRODUCTION

1.1 Background

The purpose of this document is to provide technical information in support of Ontario Power Generation's (OPG) request for amendment to the Pickering Waste Management (PWMF) Waste Facility Operating Licence (WFOL), WFOL-W4-350.00/2028, to allow for the construction and operation of a new Pickering Component Storage Structure (PCSS) that will support the refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities.

OPG currently operates the PWMF which is composed of two sites:

- PWMF Phase I site: This is located within the Pickering Nuclear Generating Station (PNGS) protected area, south-east of Pickering NGS Unit 8, adjacent to the east side of the station security fence.
- PWMF Phase II site: This is located approximately 500 m north-east of the site in the East Complex.

The proposed PCSS location will be adjacent to the northern boundary of Phase II (See Figure 1). Ownership and operation of the PCSS will reside with the PWMF.

It was determined that in order to support the refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities, construction and operation of the PCSS will provide storage of the Low and Intermediate Level Waste (L&ILW).

The refurbishment project will include activities such as Steam Generators (SG), Pressure Tube, Feeders, and Calandria Tube replacements, that will produce Low Level Waste (LLW) and Intermediate Level Waste (ILW) that will need to be accommodated in PCSS. Similar to Darlington refurbishment project, Retube Waste Containers (RWC) will be used to store the ILW. Based on the expected waste streams that will be produced, the PCSS is expected to have an area of approximately 3,700 m^2 (40,000 square feet).

The information provided in this Attachment is divided into the following sections:

Section 1: Provides the background, summary and operational considerations for the request of the licence amendment to construct and operate the PCSS.

Section 2: Summarizes regulatory compliance for the construction and operation of the PCSS and impact on OPG's governance, programs and processes for each of PWMF's WFOL's fourteen Safety and Control Areas (SCA).

Section 3: Summarizes public, Indigenous Nations and Métis engagement related to this application for a licence amendment.

Appendix A: Provides the proposed wording for the amendment to the PWMF WFOL-W4-350.00/2028.

1.2 Summary of Proposed Activity Requiring Licence Amendment

OPG intents to construct the PCSS with main phases of the project including design, site preparation, construction, operation, and maintenance. *Site preparation* includes all activities associated with preparing the project area for construction of the PCSS. Activities may include clearing the site, excavation, grading, and installation of utilities and infrastructures. *Construction* includes all activities associated with constructing the PCSS immediately following site preparation. *Operation and maintenance* includes all activities associated with normal operation of the PCSS and includes accepting, storing waste, performing regular inspections and general maintenance activities.

Pending the licence amendment, OPG targets to have the PCSS operational by April 2027 in order to support additional interim storage capacity for radioactive component waste from the refurbishment activities and the decommissioning activities.

Long term management and permanent disposal facilities are planned per Canada's Integrated Strategy for Radioactive Waste (ISRW), which was developed by the Nuclear Waste Management Organization (NWMO) at the request from Natural Resources Canada. The recommendations for the strategy were endorsed by the Minister of Energy and Natural Resources in October 2023. Per the ISRW, low-level waste (LLW) will be permanently disposed of in near surface disposal facility, and it will be the responsibility of OPG as the waste generator and owner to develop such a facility. At OPG, we take our role as a steward of nuclear by-products and waste. In 2024, OPG intends to initiate province-wide outreach to find solutions for permanent disposal of our LLW. The outreach will begin with a learning phase, in which OPG reaches out to Indigenous Nations and Communities across Ontario, followed by municipalities, to begin two-way dialogue on the role of nuclear energy and disposal of LLW. For intermediate level waste (ILW), the ISRW determined that a Deep Geologic Repository (DGR) is appropriate for permanent disposal, and the NWMO will implement a consent-based siting process for this. The planning process for this work is now underway.

Figure 1 below is a layout of the proposed PCSS and PWMF.

Figure 1: PCSS and NSS-PWMF Layout

1.3 Safety Case

Safety of the workers, public, and environment is OPG's over-riding priority, proven over many years of both Power Reactor operation and radioactive waste management and storage. OPG is responsible for the continued safe operation of the PWMF and confirms that the construction and operation of the PCSS will be implemented based on a robust safety case and in accordance with OPG's Engineering Change Control process. This is supported by 92896-REP-01320-00019, "*Pickering Component Storage Structure Safety Assessment*", provided as Enclosure 1 of this submission, which demonstrates the continued safe facility operation, public and worker safety, and environmental protection.

The safety case for the construction and operation of the PCSS can be defined based on the following elements:

1. **Design:** OPG has and will continue to follow its Engineering Change Control (ECC) process, as described in N-PROG-MP-0001, "*Engineering Change Control*", for ensuring the design complies with applicable regulatory requirements as defined in the PWMF Licence Condition Handbook (LCH), LCH-W4-350.00/2028, and that configuration management will be maintained.

2. **Continued Safe Operation:** The safety case, 92896-REP-01320-00019, "*Pickering Component Storage Structure Safety Assessment*", provided as Enclosure 1 of this submission, demonstrates that the operation of the PCSS and storage of L&ILW components will have a negligible effect on the safe operation, public and worker safety.

3. **Environmental Protection:** The predictive environmental risk assessment completed for PCSS, 92896-REP-07701-00019 R001, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*", provided as Enclosure 2 of this submission, concludes that the construction and operation of the PCSS will have negligible impact on the environment.

4. **Licensing Basis:** The construction and operation of the PCSS will have a negligible impact on PWMF's licensing basis, governance, programs, and processes. Attachment 1 of this submission provides the compliance matrix for the Nuclear Safety Control Act and associated regulations required for the amendment of the PWMF WFOL.

Overall, there are no significant safety or operational issues resulting from construction and operation of the PCSS.

2.0 Safety and Control Areas

This section provides the impact assessment of the proposed new activities on the licensing basis for each of the PWMF WFOL SCAs. OPG is responsible for the continued safe operation of the PWMF and confirms that all modifications made with respect to the construction and operation of the PCSS, will be implemented based on a robust safety case and in accordance with OPG's ECC process. This is supported by safety assessments, which demonstrate continued safe operation of the PWMF, public safety, worker safety and environmental protection.

2.1 Management System

2.1.1 Management System

Licence Condition 1.1 states "*the licensee shall implement and maintain a management system*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1). OPG's proven Nuclear Management System provides a framework that establishes the processes and programs required to ensure that OPG achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a healthy nuclear safety culture.

Table 2.1.a: List of Management System Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Management System Requirements for Nuclear Facilities	CSA N286 (2012)	Continued compliance as applied to all aspects of operation and modifications at PWMF.

Table 2.1.b: Impact of the Construction and Operation of the PCSS on PWMF's Management System Licensing Basis Documents

OPG Management System Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Items and Services Management	OPG-PROG-0009	No Change
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change
Nuclear Management Systems Organization	N-STD-AS-0020	No Change
Nuclear Safety and Security Culture Assessment	N-PROC-AS-0077	No Change
Nuclear Safety Oversight	N-STD-AS-0023	No Change
Nuclear Safety Policy	N-POL-0001	No Change
Nuclear Management System	N-CHAR-AS-0002	No Change

2.1.2 Quality Assurance, CSA Standard N286-12 Compliance

OPG is compliant with CSA Standard N286-12, "*Management system requirements for nuclear facilities*". The Nuclear Charter, N-CHAR-AS-0002, "*Nuclear Management System*", establishes the Nuclear Management System for OPG Nuclear. The Nuclear Management System will not change because of the proposed construction and operation of the PCSS.

2.1.3 Nuclear Safety and Security Culture

OPG routinely monitors the health of its nuclear safety culture through Nuclear Safety Monitoring Panels. These panels were established based on the industry best practices documents in the Nuclear Energy Institute's NEI-09-07, "*Fostering* a *Strong Nuclear Safety Culture*". The Nuclear Safety Monitoring Panel examines information from a variety of the processes that have been implemented, such as the corrective action process, the human performance program, audits and self-assessments, external inspections such as CNSC staff's inspections or industry evaluations, employee concerns, and business performance monitoring. This information is evaluated against the traits of a healthy nuclear safety culture to identify strengths and areas for focused attention within the organization. The panel is composed of all the managers senior leadership within OPG. The panel evaluates the information and approves any initiatives or reinforces communications as needed. The construction and operation of the PCSS will not impact the Nuclear Safety and Security Culture requirements.

2.1.4 Management of Contractors

Licence Condition 1.2 requires that "*the licensee shall ensure that every contractor at the facility complies with this licence*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Vendors and contractors are qualified by OPG Supply Chain Quality Services under a process that ensures that the contractors have developed and implemented a management system that meets the applicable requirements outlined in the CSA Standard N286 series of standards.

OPG is ultimately responsible for ensuring that all on-site contractor activities comply with OPG's safety requirements. Day-to-day operations at PWMF are generally maintained by full-time staff of OPG.

2.2 Human Performance Management

2.2.1 Human Performance Program

Licence Condition 2.1 states "*the licensee shall implement and maintain a human performance program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Human performance relates to reducing the likelihood of human error in work activities. It refers to the outcome of human behaviour, functions, and actions in a specified environment, reflecting the ability of workers and management to meet the system's defined performance under the conditions in which the system will be employed.

Table 2.2.a: List of Human Performance Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Fitness for Duty: Managing Worker Fatigue	REGDOC-2.2.4 (2017)	Continued compliance, no impact.
Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3	REGDOC- 2.2.4 (2021)	Continued compliance, no impact.
Safety Culture	REGDOC-2.1.2 (2018)	Continued compliance, no impact.

Table 2.2.b: Impact of Construction and Operation of the PCSS on PWMF's Human Performance Management Licensing Basis Documents

OPG Human Performance Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Human Performance	N-PROG-AS-0002	No Change
Hours of Work Limits and Managing Worker Fatigue	N-PROC-OP-0047	No Change

The objective of OPG's Human Performance program, N-PROG-AS-0002, "*Human Performance*" is to minimize human performance events and errors by managing defenses in pursuit of zero events of consequence.

The Human Performance program integrates proactive (prevention) and reactive (detection and correction) human performance initiatives, which includes the following:

- Providing oversight and monitoring of department human performance.
- Identifying emerging human performance issues and determining strategies for related improvement.
- Approving site-wide human performance improvement initiatives and overseeing the implementation progress.
- Use of the human performance toolbox
- Identifying and implementing human performance improvement communication, education, and training opportunities.

2.2.2 Fitness for Duty

As part of OPG's fitness for duty program, OPG has a continuous behaviour observation program in place which trains supervisors and managers to monitor workers for signs of fatigue or other factors which could adversely impact worker performance. OPG has in place hours of work requirements in N-PROC-OP-0047, "*Hours of Work Limits and Managing Worker Fatigue*" which sets limits for the number of hours within a specified time period that station staff can work. The limits, which are in place to guard against fatigue in the workplace, are strict in comparison to other jurisdictions.

The construction and operation of the PCSS will not impact OPG's fitness for duty program or compliance to hours-of-work requirements.

2.2.3 Training Program

Licence Condition 2.2 states "*the licensee shall implement and maintain a training program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1). Similar to the Re-tube Waste Service Building (RWSB), personnel at the PCSS will be fully trained in the storage of L&ILW and on mitigative measures for backout when required. All required staff will be fully trained before the first SG/RWC is received and stored in the PCSS.

Table 2.2.c: List of Training Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Personnel Training	REGDOC-2.2.2 (2016)	Continued compliance, no impact.

Table 2.2.d: Impact of the Construction and Operation of the PCSS on PWMF's Training Program Licensing Basis Documents

OPG Human Performance Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Systematic Approach to Training	N-PROC-TR-0008	No Change
Training	N-PROG-TR-0005	No Change

2.3 Operating Performance

2.3.1 Operating Performance

Licence Condition 3.1 states "*the licensee shall implement and maintain an operating program, which includes a set of operating limits*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Operations and Maintenance of the PCSS will be conducted in accordance with the PWMF Operating Policies and Principles and within the conditions of the operating licence to be issued for the facility by the CNSC. Operations and Maintenance standards will be such that equipment performance and reliability in accordance with design specifications is maintained.

Table 2.3.a Impact of the Construction and Operation of the PCSS on PWMF's Operating Performance Related Licensing Basis Documents

OPG Document Title	OPG Document Number	Impact from Construction and Operation of PCSS
Application for Renewal of Pickering Waste Management Facility Operating Licence	92896-CORR-00531-01031	No Change
Additional Information to Support the Application for Renewal of Pickering Waste Management Facility Operating Licence	92896-CORR-00531-01075	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change
Operating Policies and Principles, Pickering Waste Management Facility	92896-OPP-01911.1-00001	Updates to the Operating Policies and Principles will be completed prior to operation of the PCSS.
Pickering Waste Management Facility – Safety Report	92896-SR-01320-10002	Changes will be reflected in the next update of the PWMF Safety Report scheduled for 2028.

The updates to the Operating Policies and Principles for the PWMF will be completed prior to the targeted operation date of the PCSS. This submission is tracked under Regulatory Action Management Request (REGM) # 28267257.

2.3.2 Reporting Requirements

Licence Condition 3.2 states "*the licensee shall implement and maintain a program for reporting to the Commission or a person authorized by the Commission*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.3.b: List of Reporting Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Public Information and Disclosure	REGDOC-3.2.1 (2022)	Continued compliance, no impact.
Reporting Requirements, Volume I: Non-Power Reactor Class I Nuclear Facilities and Uranium Mines and Mills	REGDOC-3.1.2 (2018)	Continued compliance, no impact.

Table 2.3.c: Impact of the Construction and Operation of the PCSS on PWMF's Reporting Requirements Related Licensing Basis Documents

OPG Document Title	OPG Document Number	Impact from Construction and operating of the PCSS
Conduct of Regulatory Affairs	N-PROG-RA-0002	No Change
Performance Improvement	N-PROG-RA-0003	No Change
Preliminary Event Notification	N-PROC-RA-0020	No Change
Operating Policies and Principles, Pickering Waste Management Facility	92896-OPP-01911.1-00001	No Change

2.3.3 Quarterly and Annual Operational Reporting

The annual operational reports will continue as currently conducted and will account for the construction and operation of the PCSS. The quarterly operational reporting to the CNSC is no longer required (Reference 2-2).

2.4 Safety Analysis

2.4.1 Safety Analysis Program

Licence Condition 4.1 states "*the licensee shall implement and maintain a safety analysis program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

2.4.2 Safety Analysis

The preliminary safety analysis, also referred to as the "safety case" of the PCSS, 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*" is provided as Enclosure 1 of this submission. The normal operations safety analysis considered several design options for the PCSS and assessed the corresponding dose rate impact to the public during normal operations. The annual normal operations public dose estimates have increased compared to that of the existing PWMF configuration due to the proximity of the PCSS to the nearest public receptor. The annual dose to an individual member of the public with the most favorable design option of the PCSS is still a small percentage of the 1 mSv limit and meets the 100 μSv annual target for the PWMF.

The normal operations safety analysis demonstrates that compliance with the radiation safety requirements during normal operation of the PCSS can be achieved and several recommendations are given to guide the detailed design of the structure. With respect to malfunction and potential accident scenarios, the estimated bounding doses to members of the public are less than the 1 mSv acceptance criterion. The dose to workers following a postulated bounding accident scenario involving a building collapse of the PCSS is found to be much less than the 50 mSv limit. It is concluded that the dose consequences to workers and members of the public following credible postulated malfunction / accident scenarios will meet all acceptance criteria.

The safety analysis will be updated with the final design requirements of the PCSS and will be provided to CNSC staff prior to the targeted commencement date of construction. This submission is tracked under REGM # 28267123.

Table 2.4.a: List of Safety Analysis Program Related Regulatory Requirements

Licensing Basis Document Title	Document Title	Impact from Operation of the PCSS
General principles for the management of radioactive waste and irradiated fuel	CSA N292.0 (2014)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Interim Dry Storage of Irradiated Fuel	CSA N292.2 (2013)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Management of Low and Intermediate Level Radioactive Waste	CSA N292.3 (2014)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.
Quality Assurance of Analytical, Scientific and Design Computer programs	CSA N286.7 (2016)	PCSS preliminary safety analysis was conducted in compliance with applicable requirements.

Table 2.4.b: Impact of the Construction and Operation of the PCSS on PWMF's Safety Analysis Licensing Basis Documents

OPG Safety Analysis Licensing Basis Document Title	OPG Document Number	Impact from operation of the PCSS
Pickering Waste Management Facility – Safety Report	92896-SR-01320-10002	Changes will be reflected in the next update of the PWMF Safety Report scheduled for 2028.

2.5 Physical Design

2.5.1 Design Program

Licence Condition 5.1 states "*the licensee shall implement and maintain a design program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

The design and any modifications to the PCSS shall comply with applicable codes, standards, and regulations including adequate consideration for human factors. For all designs, the licensee shall modify and otherwise carry out work related to the PCSS in compliance with the applicable versions of the National Building Code of Canada and the National Fire Code of Canada.

Table 2.5.a: List of Design Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393	The PCSS's design will comply with the requirements in this code
National Building Code of Canada (2020)	NRC	The PCSS's design will comply with the requirements in this national code.
National Fire Code of Canada (2020)	NRC	The PCSS's design will comply with the requirements in this national code.

The PCSS design requirements will be provided to CNSC staff prior to the targeted commencement date of construction activities. This submission is tracked under REGM # 28267121.

Table 2.5.b: Impact of the Construction and Operation of the PCSS on PWMF's Design Program Related Licensing Basis Documents

OPG Physical Design Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Conduct of Engineering	N-STD-MP-0028	No Change
Configuration Management	N-STD-MP-0027	No Change
Design Management	N-PROG-MP-0009	No Change
Engineering Change Control	N-PROG-MP-0001	No Change

2.5.2 Pressure Boundary

Licence Condition 5.2 states "*the licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.5.c: List of Pressure Boundary Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Power Piping	ASME B31.1 (2010)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Boiler, pressure vessel, and pressure piping code	CSA B51 (2009 and Update No. 1)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
General requirements for pressure-retaining systems and components in CANDU nuclear power plants	CSA N285.0 (2008 and Updates No. 1 and 2; and Annex N of N285.0-12 and Update No. 1)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Standard for the Installation of Private Fire Service Mains and Their Appurtenances	NFPA-24 (2010)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.
Standard for the Installation of Stationary Pumps for Fire Protection	NFPA-20 (2010 and Amendment 1 and Amendment 2)	No Impact from the construction and operation of the PCSS and storage of L&ILW on an interim basis.

Table 2.5.d: Impact of the Construction and Operation of the PCSS on PWMF's Pressure Boundary Related Licensing Basis Documents

OPG Physical Design Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Index to OPG Pressure Boundary Program Elements	N-LIST-00531-10003	No Change
Pressure Boundary Program Manual	N-MAN-01913.11-10000	No Change
Authorized Inspection Agency Service Agreement	N-CORR-00531-20012	No Change

Design Registration	N-PROC-MP-0082	No Change
Pressure Boundary	N-PROG-MP-0004	No Change
System and Item Classification	N-PROC-MP-0040	No Change

2.6 Fitness for Service

Licence Condition 6.1 states "*the licensee shall implement and maintain a fitness for service program*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.6.a: List of Fitness for Service Program Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from Construction and Operation of the PCSS
Aging Management	REGDOC-2.6.3 (2014)	Continued compliance.

Table 2.6.b: Impact of the Construction and Operation of the PCSS on PWMF's Aging Management Program Related Licensing Basis Documents

OPG Fitness for Service Licensing Basis Document Title	OPG Document Number	Impact from Construction and Operation of the PCSS
Conduct of Engineering	N-STD-MP-0028	No Change
Design Management	N-PROG-MP-0009	No Change
Equipment Reliability	N-PROG-MA-0026	No Change
Integrated Aging Management	N-PROG-MP-0008	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change

2.7 Radiation Protection

2.7.1 Radiation Protection

Licence Condition 7.1 states "*the licensee shall implement and maintain a radiation program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

As per OPG's N-PROG-RA-0013, "*Radiation Protection*", the overriding objective of the Radiation Protection program at OPG is the control of occupational and public exposure to radiation. For the purposes of controlling radiation doses to workers and the public, this program has five implementing objectives:

- Keeping individual radiation doses below regulatory limits,
- Avoiding unplanned radiation exposures,
- Keeping individual risk from lifetime radiation exposure to an acceptable level
- Keeping collective radiation doses ALARA, social and economic factors taken into account
- Keeping public exposure to radiation well within regulatory limits.

2.7.2 Dose Rate Impact on the Public and Environment

An assessment has been conducted on the impact of calculated dose rates on OPG personnel, the public and the environment.

The construction and use of the PCSS to support storage of radioactive materials (L&ILW) will not result in exceedances of the derived dose rate limit at the boundary of the PWMF licensed area. This will be facilitated by adequate shielding of the PCSS itself as well as operational controls.

The existing Thermoluminescent Dosimeters around PWMF Phase I and Phase II will measure the dose rates and will be reported to CNSC staff in accordance with the facility operations report.

Personnel radiation exposures associated with the storage and placement of L&ILW will be managed within the framework of the existing Radiation Protection Program (N-PROG-RA-0013).

Table 2.7.a: List of Radiation Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Radiation Protection Regulations	SOR/2000-203	No Impact

Table 2.7.b: Impact from the Construction and Operation of the PCSS on PWMF's Radiation Protection and ALARA Licensing Basis Documents

OPG Radiation Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Occupational Radiation Protection Action Levels for Nuclear Waste Management Facilities	N-STD-RA-0045	No Change
Radiation Protection	N-PROG-RA-0013	No Change

2.8 Conventional Health and Safety

Licence Condition 8.1 states "*the licensee shall implement and maintain a conventional health and safety program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.8.a: Regulatory Requirements Related to Conventional Health and Safety

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
General Nuclear Safety and Control Regulations	SOR/2000-202	Continued compliance

Table 2.8.b: Impact from the Construction and Operation of the PCSS on PWMF's Conventional Safety Program Licensing Basis Documents

OPG Conventional Safety Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Employee Health and Safety Policy	OPG-POL-0001	No Change
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change

2.9 Environmental Protection

2.9.1 Environmental Protection

Licence Condition 9.1 states "*the licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days*" and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.9.a: List of Environmental Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Addition of the PCSS
Environmental Protection: Environmental Principles, Assessments and Protection Measures	REGDOC-2.9.1, Version 1.2 Section 4.6 (2020)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements.
Environment management of nuclear facilities: Common requirements of the CSA N288 series of Standards	CSA N288.0 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements

Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	CSA N288.1 (2020)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	CSA N288.3.4 (2013 R2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Environmental monitoring program at nuclear facilities and uranium mines and mills	CSA N288.4 (2019)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Effluent and emissions monitoring programs at nuclear facilities	CSA N288.5 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Environmental risk assessments at nuclear facilities and uranium mines and mills	CSA N288.6 (2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Groundwater protection programs at Class I nuclear facilities and uranium mines and mills.	CSA N288.7 (2015)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements
Establishing and implementing action levels for releases to the environment from nuclear facilities	CSA N288.8 (2017 R2022)	Environmental-related assessment (Enclosure 2 of this submission) was conducted in accordance with requirements

Table 2.9.b Impact from the Storage of the addition of the PCSS on PWMF's Environmental Protection Licensing Basis Documents

OPG Environmental Protection Licensing Basis Document Title	OPG Document Number	Impact from the Addition of the PCSS
Environment Health and Safety Managed Systems	OPG-PROG-0005	No Change
Environment Policy	OPG-POL-0021	No Change
Management of the Environmental Monitoring Programs	N-PROC-OP-0025	No Change
Monitoring of Nuclear and Hazardous Substances in Effluents	N-STD-OP-0031	No Change
Environmental Risk Assessment Report for Pickering Nuclear	P-REP-07701-00007	No Change

Derived Release Limits and Environmental Action Levels for Pickering Nuclear	P-REP-03482-00006	No Change
Action Levels for Environmental Releases - Pickering Nuclear	P-REP-03482-00007	No Change

2.9.2 Effluent and Emissions Control (Releases)

OPG is committed to complying with the requirements of the CSA Standard N288 series documents, as required in the PWMF LCH. The licensee shall control radiological releases to ALARA, thereby minimizing dose to the public resulting from PWMF/PCSS operation.

The PWMF adheres to approved Derived Release Limits (DRLs) under PNGS, which are defined in CSA Standard N288.1 as the release rate that would cause an individual of the most highly exposed group to receive and be committed to a dose equal to the regulatory annual dose limit, due to release of a given radionuclide to air or surface water during normal operation of a nuclear facility over the period of a calendar year.

Because radiological releases are very small in comparison with the DRLs and Action Levels, lower Internal Investigation Levels (IILs) are used to demonstrate and maintain adherence to the ALARA principle. There will be no changes to the DRLs, Action Levels or IILs as a result of the PCSS. Consistent with current performance, the cumulative public dose resulting from the PCSS will remain well below 1% of the regulatory public dose limit of 1,000 µSv per year.

During operation and maintenance of the PCSS, radiological waste will be contained and as a result, no radiological emissions are expected during normal operations. There will be gamma radiation fields emitted during the transfer of waste storage containers and once waste is stored in the PCSS during operation. The design of the PCSS will provide shielding, which will be verified upon the completion of the structure design.

2.9.3 Environmental Management System (EMS)

OPG's OPG-POL-0021, "*Environmental Policy*" requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001, "*Environmental Management System Standard*".

Operation of the PCSS will continue to be in accordance with OPG's EMS as described in OPG-PROG-0005, "*Environment Health and Safety Managed Systems*" and OPG-POL-0021. The EMS provides specific directions on how the Environmental Policy is implemented while meeting the expectations of OPG-POL-0032, "*Safe Operations Policy*", N-POL-0001, "*Nuclear Safety & Security Policy"*, and N-CHAR-AS-0002, "*Nuclear Management System*".

2.9.4 Continued Validity of Prior Submissions to the CNSC/Licensing Documents

92896-REP-00701-00019 R001, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*" (Enclosure 2 of this submission) provides the results of the assessment that reviewed the following licensing documents:

Environmental Assessments (EAs):

- 92896-REP-07701-00002, "*Pickering Waste Management Facility Phase II Final Environmental Assessment Study Report*" (Reference 2-3)
- NK30-REP-07701-00002, "*Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment*" (Reference 2-4)

Environmental Risk Assessment (ERA) and Predictive Effects Assessment (PEA):

- P-REP-07701-00007 R001 "*Environmental Risk Assessment Report for Pickering Nuclear*" (Reference 2-5)
- P-REP-07701-00002, "*Predictive Effects Assessment for Pickering Nuclear Safe Storage*" (Reference 2-6)

2.9.5 Environmental Assessment Follow-Up Program

Licence Condition 9.2 states "*the licensee shall implement an environmental assessment follow- up program"* and the details in the PWMF LCH outline the regulatory requirements. This licence condition was specific to expanding the capacity of the PWMF by constructing and operating two additional storage buildings (#3 and #4) at the PWMF Phase II site. The EA process for that project identified the need for an EA follow-up program for the PWMF Phase II project. The follow up items listed in 92896-REP-07701.8-00001, "*Environmental Assessment Follow-up Plan*" (Reference 2-7) were completed and are reported annually with the most recent Annual Compliance Report, 92896-REP-00531-00072-R000 "*Pickering Waste Management Facility – Fourth Quarter Report and Annual Compliance Report for 2023*" (Reference 2-8).

The construction and operation of the PCSS will not impact the EA follow up program and as such, this licence condition is not applicable.

Table 2.9.c Impact from the Construction and Operation of the PCSS on PWMF's Environmental Assessment Follow-Up Plan Licensing Basis Documents

OPG Environmental Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Impact of the PCSS
Pickering Waste Management Facility Phase II – Environmental Assessment Follow-Up Plan	92896-REP-07701.8-00001	No Change

2.10 Emergency Management and Fire Protection

2.10.1 Emergency Preparedness Program

Licence Condition 10.1 states "*the licensee shall implement an emergency preparedness program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.10.a: List of Emergency Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Impact of the PCSS
Nuclear Emergency Preparedness and Response, Version 2	REGDOC-2.10.1 (2016)	No Change

Table 2.10.b: Impact from the Construction and Operation of the PCSS on PWMF's Emergency Management Licensing Basis Documents

OPG Emergency Management and Fire Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Impact of the PCSS
Radioactive Materials Transportation Emergency Response Plan	N-STD-RA-0036	No Change
Consolidated Nuclear Emergency Plan	N-PROG-RA-0001	No Change

2.10.2 Fire Protection Program

Licence Condition 10.2 states "*the licensee shall implement a fire protection program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.10.c: List of Fire Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393-22 (2022)	No Change
National Building Code of Canada (2020)	NRC	No Change
National Fire Code of Canada (2020)	NRC	No Change

Table 2.10.d: Impact from the Construction and Operation of the PCSS on PWMF's Fire Protection Licensing Basis Documents

OPG Emergency Management and Fire Protection Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Fire Protection	N-PROG-RA-0012	No Change

2.11 Waste Management

2.11.1 Waste Management Program

Licence Condition 11.1 states "*the licensee shall implement a waste management program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.11.a: List of Waste Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Wate Management Volume 1: Management of Radioactive Waste	REGDOC-2.11.1	The interim storage of L&ILW waste complies with the requirements in this CNSC regulatory document.
General principles for the management of radioactive waste and irradiated fuel	CSA N292.0 (2019)	The interim storage of L&ILW waste complies with the requirements in this CSA standard.
Management of low and intermediate-level radioactive waste	CSA N292.3 (2014)	The interim storage of L&ILW waste complies with the requirements in this CSA standard.

Table 2.11.b: Impact of the Construction and Operation of the PCSS on PWMF's Waste Management Licensing Basis Documents

OPG Waste Management Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Segregation and Handling of Radioactive Waste	N-PROC-RA-0017	No Change
Management of Waste and Other Environmentally Regulated Materials	OPG-STD-0156	No Change
Nuclear Waste Management	W-PROG-WM-0001	No Change
Radiation Protection	N-PROG-RA-0013	No Change

2.11.2 Decommissioning Plan

Licence Condition 11.2 states "*the licensee shall maintain a decommissioning plan"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.11.c List of Decommissioning Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Decommissioning	REGDOC-2.11.2 (2021)	The PWMF Preliminary Decommissioning Plan (PDP) will comply to these requirements and reflect implementation of these requirements.
Decommissioning of facilities containing nuclear substances	CSA N294-19 (2019)	The PWMF PDP complies to these requirements.

Table 2.11.d: Impact of the Construction and Operation of the PCSS on PWMF's Decommissioning Licensing Basis Documents

OPG Waste Management Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Decommissioning Program	W-PROG-WM-0003	No Change.
Preliminary Decommissioning Plan Pickering Waste Management Facility	92896-PLAN-00960-00001	PWMF PDP updates for the PCSS will be included for the submission of the 2027 Financial Guarantee in accordance with RegDoc 2.11.2.

2.11.3 Preliminary Decommissioning Plan

A PDP, 92896-PLAN-00960-00001, "*Preliminary Decommissioning Plan – Pickering Waste Management Facility*" is in place for the PWMF. The PWMF PDP complies with regulatory requirements of CSA N294-19, "*Decommissioning of Facilities Containing Nuclear Substances*". The PDP is updated every 5 years, with the next update scheduled for submission to CNSC staff in 2027. The next PDP update will reflect the implementation of REGDOC-2.11.2, "*Decommissioning*" and the addition of the PCSS.

As per the requirements in LC 11.2, OPG is required to maintain annual financial guarantee for the decommissioning of OPG Class 1 facilities, including the PWMF, in accordance with CNSC REGDOC-3.3.1, "*Financial Guarantees for Decommissioning of Nuclear Facilities and Termination of Licensed Activities*". Decommissioning cost estimates in support of the OPG Financial Guarantees (FG) are updated on a five-year cycle in accordance with CNSC REGDOC-2.11.2, CNSC REGDOC-3.3.1, and CSA Guide N294. The financial impact related to the PCSS will be included in the next 2027 FG submission associated with the updated PDP.

2.12 Security

2.12.1 Security Program

Licence Condition 12.1 states "*the licensee shall implement and maintain a security program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

2.12.a: List of Security Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Nuclear Security Regulations	SOR/2000-209	Continued compliance
Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	REGDOC-2.2.4 (2018)	Continued compliance.
High Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	REGDOC-2.12.1 (2018)	Continued compliance.
Site Access Security Clearance	REGDOC- 2.12.2 (2013)	Continued compliance.

2.12.b: Impact from the Construction and Operation of the PCSS on PWMF's Security Program Licensing Basis Documents

OPG Security Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Pickering Waste Management Facility Phase II Security Report	92896-REP-08160-00001	No Change
Pickering Waste Management Facility Security Report Addendum	92896-REP-08160-00001 ADD 001	No Change
Nuclear Security	N-PROG-RA-0011	No Change
Cyber Security	N-PROC-RA-0135	No Change
Nuclear Waste Management Cyber Essential Assets	W-LIST-08161-00001	No Change

2.12.2 Facilities and Equipment

The construction and operation of the PCSS will not require changes to security related facilities or equipment because it will be storing L&ILW.

2.12.3 Response Arrangements

The construction and operation of the PCSS will not require changes to security response arrangements or processes.

2.12.4 Construction

Licence Condition 12.2 states "*The licensee shall not carry out the activities referred to in paragraph (iii) of Part IV of this licence that relate to completed construction activities in paragraph (iv) of Part IV of this licence until the submission of the proposed security arrangements and measures for the new building, or any potential modifications to the protected area that may be associated with this new building, that is acceptable to the Commission or a person authorized by the Commission*."

The construction of the PCSS will not require security arrangements, measures, or modifications to the protected area.

2.13 Safeguards and Non-Proliferation

2.13.1 Safeguards Program

Licence Condition 13.1 states "*the licensee shall implement and maintain a safeguards program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.13.a: List of Safeguards and Non-Proliferation Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Safeguards and Nuclear Material Accountancy	CNSC REGDOC-2.13.1 (2018)	Continued compliance

Table 2.13.b: Impact from the Construction and Operation of the PCSS on PWMF's Safeguards Program Licensing Basis Documents

OPG Safeguards and Non- Proliferation Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Safeguards and Nuclear Material Accountancy	N-PROG-RA-0015	No Change
Safeguards and Nuclear Material Accountancy Implementation	N-STD-RA-0024	No Change

2.14 Packaging and Transport

2.14.1 Packaging and Transport Program

Licence Condition 14.1 states "*the licensee shall maintain a packaging and transport program"* and the details in the PWMF LCH outline the regulatory requirements. The information provided in the last PWMF licence renewal application is still valid (Reference 2-1).

Table 2.14: Impact from the Construction and Operation of the PCSS and storage of L&ILW on PWMF's Packaging and Transport Licensing Basis Documents

OPG Transportation and Packaging Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Radioactive Material Transportation	W-PROG-WM-0002	No Change
Radioactive Materials Transportation Emergency Response Plan	N-STD-RA-0036	No Change
Radiation Protection	N-PROG-RA-0013	No Change

2.15 Facility Specific

2.15.1 Construction Plans

Licence Condition 15.1 states "*The licensee shall submit an environmental management plan, a construction verification plan and the project design requirements prior to the commencement of construction activities described in paragraph (iv) of Part IV of this licence*."

Table 2.15: List of Construction Plans Related Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction of the PCSS
Fire protection for facilities that process, handle, or store nuclear substances	CSA N393-13	The PCSS design will adhere to these requirements.
NRC National Building Code of Canada (2015)	N/A	The PCSS design will adhere to the NRC National Building Code of Canada (2020) requirements.
NRC National Fire Code of Canada (2015)	N/A	The PCSS design will adhere to the NRC National Fire Code of Canada (2020) requirements.

The submission of environmental management plan, construction verification plan and design requirements will be provided to CNSC staff prior to the targeted commencement date of construction activities. This submission is tracked under REGM # 28267121.

2.15.2 Commissioning Report

Licence Condition 15.2 states "*The licensee shall not carry out the activities referred to in paragraph (ii) of Part IV of this licence that relate to completed construction activities in paragraph (iv) of Part IV of this licence until the submission of a commissioning report that is acceptable to the Commission or a person authorized by the Commission*."

OPG shall not operate the PCSS until a commissioning report has been submitted that is acceptable to the Commission or a person authorized by the Commission.

The PCSS final commissioning report will be provided to CNSC staff for acceptance prior to the targeted operation date of the PCSS. This submission is tracked under REGM # 28267122.

3.0 Other Matters of Regulatory Interest

3.1 Public Information and Engagement

OPG believes in timely open and transparent communication to maintain positive and supportive relationships and confidence of key stakeholders. OPG's Corporate Relations and Communications organization adheres to the principles and process for external communications as governed by the nuclear standard N-STD-AS -0013, "*Nuclear Public Information and Disclosure".*

Table 3.1.a List of Public Information and Disclosure Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Impact from the Construction and Operation of the PCSS
Public Information and Disclosure	REGDOC-3.2.1 (2018)	Continued compliance

Table 3.1.b Impact from the Construction and Operation of the PCSS on PWMF's Public Information and Disclosure Licensing Basis Documents

OPG Transportation and Packaging Licensing Basis Document Title	OPG Document Number	Impact from the Construction and Operation of the PCSS
Nuclear Public Information and Disclosure	N-STD-AS-0013	No Change

OPG provides responses to issues and questions raised by stakeholders and the public, and tracks issues and questions to identify trends in order to further refine proactive communications. Two-way dialogue with community stakeholders and residents is facilitated through personal contact, community newsletters, speaking engagements, advertising, and educational outreach.

Through this regular outreach of an on-going nature, OPG continues to provide members of the public and interested parties with information regarding the activities carried out at the PWMF.

3.2 Community Committees

The Pickering Community Advisory Council (CAC) is made up of citizens, representatives of non-government organizations and members of local government staff who examine a number of issues associated with the existing and future activities of the Pickering Nuclear site. The CAC assists Pickering NGS in identifying and responding effectively to the concerns of the community. The Council's purpose is to identify community issues and concerns and define the actions members believe will be required to continuously improve operations at the site and promote the well-being of the community, among other purposes. The Council's advice focuses on, but is not limited to, the effects of Pickering NGS operations on the environmental, health, safety, social and economic interests of the community.

In addition to the CAC, OPG has a representative on the Durham Nuclear Health Committee (DNHC). DNHC is a committee of Durham Regional Council chaired by the Region's Commissioner and Medical Officer of Health. The DNHC is a forum for discussing and addressing potential radiation and environmental human health impacts. OPG Nuclear staff make regular presentations to the DNHC on a variety of environmental, community outreach and operational issues.

3.3 Community Publications

OPG provides a community newsletter called "*Neighbours*" on a quarterly basis that is circulated by mail to residents throughout Durham Region (specific to the proximity of the respective nuclear power reactor stations). This provides an update of activities and events that occur at the respective stations.

This forum will be used as an opportunity to communicate and engage the public by providing updates on major OPG initiatives at Pickering NGS including PWMF.

3.4 Indigenous Engagement

OPG acknowledges the Aboriginal and Treaty Rights as recognized in the Constitution Act, 1982. Under its Indigenous Relations Policy, OPG regularly engages with Indigenous Nations and communities with established, asserted rights, and/or interests in the areas surrounding OPG operations.

OPG's Pickering NGS and PWMF are located on Williams Treaties First Nations (WTFN) traditional and Treaty Territory. Located in Pickering (just east of Toronto), it is one of the largest nuclear stations in the world and has been safely and reliably providing Ontario with electricity for decades.

OPG values the relationship it holds with the WTFN and remains committed to meaningful engagement with these Rights Holders. Rights Holders are defined as those who have signed treaties over the lands upon with the Pickering NGS is located. The team at the Pickering NGS and the PWMF have begun, and will continue to, engage with the WTFN. Other Indigenous Nations and communities who have an interest in its current nuclear operations and future projects, such as the PCSS will also be notified and engaged as necessary to respect the constitutionally protected rights and interests that exist. Through ongoing engagement, OPG will aim to identify concerns and thoughts on the future of the Pickering NGS and PWMF. Engagement will involve frequent dialogue and regular updates regarding ongoing operations, economic opportunities, and environmental monitoring activities, both general and technical.

A list of Indigenous Nations and communities OPG has or will be engaging with are provided below. WTFN are legally recognized as Treaty Rights Holders through the Williams Treaties settlement

process and continue to have Treaty Rights and interests with respect to OPG's waste operations at the PWMF:

- Williams Treaties First Nations - Rights Holders
    - Alderville First Nation
    - Curve Lake First Nation
    - Hiawatha First Nation
    - Mississaugas Scugog Island First Nation
    - Beausoleil First Nation
    - Georgina Island First Nation
    - Rama First Nation

The following Indigenous Nations and communities have expressed interest in OPG sharing information related to the PWMF:

- Six Nations of the Grand River
- Huron-Wendat Nation, Quebec
- Mohawks of the Bay of Quinte (MBQ)
- Métis Nation of Ontario Region 8

OPG has a long-standing and ongoing relationship with the WTFN and so, during Quarter 1 of 2024, meetings were held for the activities related to Pickering Nuclear site and engagement with the WTFN was focused on providing information regarding activities at the Pickering NGS and the PWMF. This included collaborating with the Nations on a draft Pickering Indigenous Engagement Plan (IEP), which will serve as a guide to discussions, engagement and involvement with regards to all developments at the Pickering NGS and the PWMF. The final working version of the IEP was shared with the Nations in May 2024. A subsequent kick-off workshop for WTFN was conducted to provide an overview of the activities including the PCSS and provided an opportunity for the Nations to give feedback, ask questions and voice concerns, as well to advance the opportunity for ongoing dialogue through collaboration on all aspects of the IEP outlined in an established Memorandum of Understanding (MOU).

OPG will continue to proactively engage the WTFN and all interested Indigenous Nations and communities through various activities such as staff briefings, community information sessions, written communication and/or workshops as outlined in the Pickering NGS IEP. The objective is to ensure there is an established forum for two-way dialogue with Indigenous Nations and communities around the PWMF which provides capacity support to discuss key topics of Indigenous interest related to the licence amendment application.

Over the course of the engagement activities, other Indigenous Nations and communities, not currently identified in the Pickering NGS IEP, may express interest in the Pickering NGS and the PWMF and OPG will work with the CNSC staff and the Indigenous Nation or community to determine a path forward. Furthermore, some Indigenous Nations and communities may determine they are not interested in further engagement on Pickering NGS and/or PWMF activities and OPG will respect their requests. These changes may be reflected in future revisions of the IEP.

4.0 Conclusion

The initiative to construct the PCSS that will store L&ILW components on an interim basis is essential for OPG to support the refurbishment of Pickering NGS Units 5 through 8 and decommissioning activities. OPG is requesting an amendment of the PWMF WFOL-W4-350.00/2028 to construct and operate the PCSS for interim storage of L&ILW generated at Pickering NGS.

OPG is responsible for continued safe operation of the PWMF and confirms that the construction and operation of the PCSS will be implemented based on a robust safety case. The proposed activities to support the construction and operation PCSS will not compromise continued safe operation at PWMF nor the public and employee safety, and environmental protection.

The safety case for this project can be summarized as follows:

- **Design:** OPG has and will continue to follow its Engineering Change Control process, as described in N-PROG-MP-0001, "*Engineering Change Control*", for ensuring the design complies with applicable regulatory requirements as defined in the LCH, LCH-W4-350.00/2028, and that configuration management will be maintained.

- **Continued Safe Operation:** The safety case, 92896-REP-01320-00019 R000, "*Pickering Component Storage Structure Safety Assessment*", provided as Enclosure 1 of this submission, demonstrates that the operation of the PCSS and storage of L&ILW components will have a negligible effect on the safe operation, public and worker safety.

- **Environmental Protection:** The predictive environmental risk assessment completed for PCSS, 92896-REP-00701-00019 R001, "*Predictive Environmental Risk Assessment for Pickering Component Storage Structure*", provided as Enclosure 2 of this submission, concludes that the construction and operation of the PCSS will have negligible impact on the environment.

- **Licensing Basis:** The construction and operation of the PCSS will have a negligible impact on PWMF's licensing basis, governance, programs, and processes. Attachment 1 of this submission provides the compliance matrix for the Nuclear Safety Control Act and associated regulations required for the amendment of the PWMF WFOL.

References:

2-1. OPG letter, K. Aggarwal to M. Leblanc, "Application for Renewal of Pickering Waste Management Facility Operating Licence," October 28, 2016, CD# 92896-CORR-00531-01031.

2-2. CNSC letter, K. Campbell to K. Aggrawal, "OPG WMF – Discontinuation of Quarterly Operations Reports for OPG's Waste Management Facilities," May 3, 2024, e-Doc 7274580, CD# W-CORR-00531-02005.

2-3. OPG letter, K. Nash to B. Belfadhel, "Pickering Waste Management Facility Phase II Project – Submission of Final Environmental Assessment Study Report," December 19, 2003, CD# 92896-CORR-00531-00205.

2-4. OPG letter, D. Patrick McNeil to T. Schaubel, “Pickering B Environmental Assessment (EA) for Proposed Refurbishment and Continued Operation - Submission of Final EA Studv Report”, December 17, 2007, CD# NK30-CORR-00531-04644.

2-5. OPG letter, J. Franke to R. Richardson, “Pickering NGS - Revised Environmental Risk Assessment Report for Pickering Safe Nuclear and OPG Responses to CNSC Comments”, April 17, 2023, e-Doc 7021982, CD# P-CORR-00531-23186.

2-6. OPG letter, R. Lockwood to A. Viktorov, "Environmental Risk Assessment Report for Pickering Nuclear and Predictive Effects Assessment for Pickering Nuclear Safe Storage", April 28, 2017, e-Doc 5241174, CD# P-CORR-00531-04982.

2-7. OPG email, A. Khan to K. Klassen, “PWMF FP II Follow-up Plan,” February 8, 2008, CD# 92896-CORR-00531-00972.

2-8. OPG Letter, H. Rambukkana to T. Kalindjian, “Pickering Waste Management Facility Quarterly Operations Report, Fourth Quarter and Annual Compliance Report for 2023,” March 26, 2024, CD# 92896-CORR-00531-01502.

APPENDIX A

Proposed Amendment to PWMF WFOL-W4-350.00/2028

Current WFOL W4-350.00/2028	Requested Amendment to WFOL W4-350.00/2028 (Revised proposed amendment in bold and italic)
IV) LICENSED ACTIVITIES: This licence authorizes the licensee to: (i) operate the Pickering Waste Management Facility ("the facility") located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario; (ii) possess, transfer, use, process, package, manage, and store nuclear substances that are required for, associated with or arise from the activities described in (i); (iii) transport Category II nuclear materials that are associated with the activities described in (i) on the site of the Pickering Nuclear Generating Station; (iv) carry out the site preparation, construction, or construction modifications at the facility associated with the authorized additional processing and storage buildings, when on completion will result in a total of no more than 1 dry storage container processing building and no more than 6 used fuel dry storage buildings; and, (v) possess and use prescribed equipment and prescribed information that are required for, associated with or arise from the activities described in (i), (ii), (iii), and (iv).	**IV) LICENSED ACTIVITIES:** This licence authorizes the licensee to: (i) operate the Pickering Waste Management Facility ("the facility") located at the Pickering Nuclear Generating Station, City of Pickering, Regional Municipality of Durham, Province of Ontario; (ii) possess, transfer, use, process, package, manage, and store nuclear substances that are required for, associated with or arise from the activities described in (i); (iii) transport Category II nuclear materials that are associated with the activities described in (i) on the site of the Pickering Nuclear Generating Station; (iv) carry out the site preparation, construction, or construction modifications at the facility associated with the authorized additional processing and storage buildings, when on completion will result in a total of no more than 1 dry storage container processing building and no more than 6 used fuel dry storage buildings; and, (v) possess and use prescribed equipment and prescribed information that are required for, associated with or arise from the activities described in (i), (ii), (iii), and (iv). ***(vi) carry out the site preparation, construction, or construction modifications and operate the Pickering Component Storage Structure for interim storage of Low and Intermediate Level Waste from Pickering NGS.***

ENCLOSURE 1

OPG letter, K. Aggarwal to C. Salmon, “Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure”

CD# 92896-CORR-00531-01544 P

Pickering Component Storage Structure Safety Assessment

92896-REP-01320-00019 R000

(119 total pages)

The following document is the Redacted Report of Pickering Component Storage Structure Safety Assessment (92896-REP-01320-00019-R000)

REPORT

KINECTRICS

PICKERING COMPONENT STORAGE STRUCTURE SAFETY ASSESSMENT

PV209/RP/0001 R01

March 18, 2024

Prepared for

Ontario Power Generation

Security Classification: Kinectrics Confidential

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ONTARIO POWER GENERATION

Safety Analysis Improvement Project Dept.

Document No.: 92896-REP-01320-00019

Revision No.: R000

Accepted by: (print name) Philip Smith

Date: March 18, 2024

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OPG Proprietary

OPG Purchase Order Number:

Kinectrics:	300215	☑
Worley Parsons:	300216	☐
Candu Energy:	300217	☐
Calian Ltd:	300219	☐
Other:	PO	

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Revision History

Rev	Date	Author	Description of Revision
R00	December 15, 2023	E. Heritage, J. Peng	Initial Issue
R01	March 18, 2024	E. Heritage, J. Peng	Updated in response to OPG comments

Certification Statement

I, the undersigned, being a licensed professional engineer in the province of Ontario and being competent in the applicable field, have prepared or directly supervised the preparation of this document, following the procedures of the Kinectrics quality management system.

Kinectrics document and revision no. PV209/RP/0001 R01

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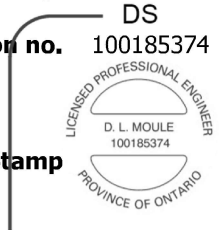

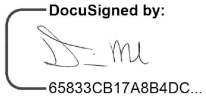

Date: March 18, 2024

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1.0 Introduction

Ontario Power Generation (OPG) currently operates the Nuclear Sustainability Service Pickering Waste Management Facility (PWMF). The PWMF is composed of 2 sites. The PWMF Phase I site is located within the Pickering Nuclear Generating Station (PNGS) protected area, south-east of Pickering NGS Unit 8, adjacent to the east side of the station security fence [1]. The PWMF Phase II site is located approximately 500 m north-east of the site in the East Complex. The PWMF Phase I site consists of the following sub-facilities: Used Fuel Dry Storage for interim storage of Pickering used fuel in Dry Storage Containers (DSCs); and Retube Component Storage for interim storage of PNGS A irradiated reactor components in Dry Storage Modules (DSMs). The PWMF Phase II site contains a security kiosk, DSC Storage Buildings 3 and 4 and the site for additional DSC storage.

OPG is planning to construct the Pickering Component Storage Structure (PCSS) on the PWMF Phase II site directly to the northeast of SB3, and directly north of the future SB5. The PCSS will fall under the ownership of Pickering Waste Management. The structure will be used to support the refurbishment of Pickering B.

2.0 Objectives and Scope of Work

To support the construction of the PCSS, a safety assessment must be prepared, similar to what has been prepared for other waste storage buildings at the Pickering site. The assessment will consist of the following scopes of work:

1. Normal Operations Safety Assessment
2. Malfunctions/Accident Safety Assessment
3. ALARA Assessment

3.0 Safety Assessment Methodology

The methodology to be used for each piece of the safety assessment for the PCSS are outlined in the sub-sections below. The methodology used is informed by and consistent with OPG's Guideline For Safety Assessment [2].

3.1 Normal Operations Safety Assessment

3.1.1 Public Dose from Chronic Emissions

The emissions from the PWMF during normal operations and the doses to public were calculated recently [3]. In this work, the emissions from the expanded PWMF were evaluated based on the latest emission data for PWMF and the potential emissions from the PCSS taking into account the design of the PCSS. On this basis, it would be determined if the previous assessment sufficiently represented the radiological impact on public health resulting from the expanded PWMF.

3.1.2 Public and Worker Dose from External Gamma Radiation

An MCNP assessment was performed to calculate the external dose rates from the PCSS. This assessment followed the two stage MCNP calculation method outlined in the OPG reference methodology for heavily shielded containers [4]. The first stage is to generate a single container

surface source for each waste type and container using MCNP's surface source write function. The second stage is to use the surface sources generated for the waste containers to calculate a full site dose rate. OPG provided the MCNP model used to perform an analysis of the dose rates due to used fuel within SB 3, 4, and a conceptual layout for SB5 [5]. This model was used as the basis for the external dose calculations.

3.1.2.1 Single Container MCNP Models

For the first stage of this methodology, three single container MCNP models were developed:

- A Retube Waste Container (RWC) containing Pressure Tubes (PTs) or Calandria Tubes (CTs) or Calandria Tube Inserts (CTIs). This container is known as the RWC-PT
- An RWC containing End Fittings (known as an RWC-EF)
- A Pickering B Steam Generator (SG)

The models for the RWC-PT and SG were developed from scratch based on inputs provided by OPG. Only a single RWC-PT model was required to address the modelling of an RWC containing PTs, CTs, or CTIs since those containers all have the same dimensions and are assumed to produce dose rates at the Waste Acceptance Criteria (WAC). The model for the RWC-EF was provided by OPG from a shielding analysis of the preliminary design for the container described in Reference [6].

Source terms for each container type were developed and scaled to meet the WAC provided by OPG in the Task Order Request for this project [7]. Following the scaling, a surface source write run was performed in MCNP to create a surface source for use in full building calculations (stage 2 of the MCNP reference methodology).

RWC-PT Geometry

The dimensions assumed for the RWC-PT at the conceptual stage were provided by OPG in Reference [8]. The container was assumed to be a simple symmetric carbon steel box with dimensions as shown in Table 1.

Table 1: Dimensions for RWC-PT [8]

[redacted]

Unless otherwise noted, redactions are made according to exemptions from Freedom of Information and Protection of Privacy Act (FIPPA) S. 18 and Access to Information and Privacy (ATIP) S.13.

The MCNP model for this container was a straightforward box, as shown in Figure 1. The waste stored in the box was treated as a homogenous mass, as with other analysis of RWC-PTs from other OPG waste facilities [9], since the PTs and CTs stored in the container will be cut up and compacted into coupons and stored in the central cavity.

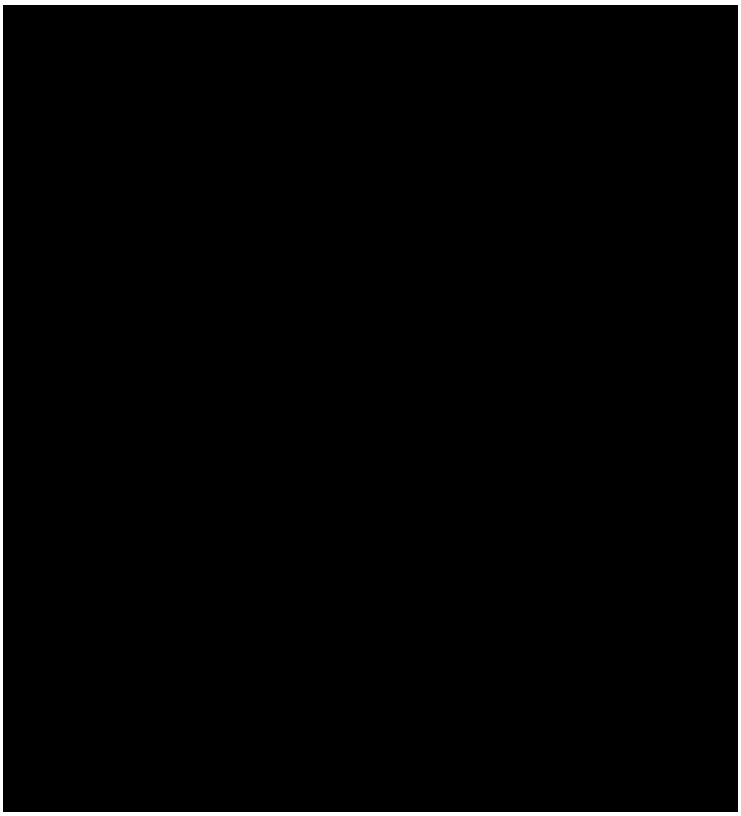


Figure 1: RWC-PT MCNP Model

RWC-EF Geometry

The MCNP model of the RWC-EF used in the shielding analysis for the conceptual design of the container in Reference [6] was provided by OPG. The geometry was left unchanged from the previous shielding analysis. , as shown in Figure 2.

Figure 2: RWC-EF MCNP Model

Steam Generator Geometry

A simplified model of the SGs was created in MCNP based on the dimensions from the general arrangement drawing [10]. The SG is a complex assembly of thousands of tubes and plates. To simplify the modelling, a similar approach was taken as with previously modelled SGs from the

Western Waste Management Facility (WWMF) [9]. The major modelling simplifications were as follows:

- The main components modelled were the u-tube bundle, the tubesheet, the head drum, and the shell.
- The shell was assumed to have constant thickness, the thinnest dimensions available for thickness was used.
- The u-tube bundle was represented by a single homogenized cylinder with a spherical cap.
- The head drum components were modelled as a single homogenized cylinder.
- The tubesheet was modelled as a single homogenized cylinder.
- The gap between the u-tube bundle and the shroud was assumed to be 0.5 inches.
- The nozzles on the SG were not modelled. At the WWMF, metal plates were welded to the nozzles so that the dose emanating from the nozzles was not different than the rest of the SG body. It was assumed this will also be the case for Pickering B.

The geometry of the MCNP model of the Pickering B SG is shown in Figure 3.

Figure 3: MCNP Model of Pickering B SG

Materials

A detailed description of the materials used in the single container MCNP models is provided in Appendix D.

Source Terms

The source activity of each waste container and SG was scaled to ensure that the dose rates around the containers were consistent with OPG's WAC. To do so, tallies were added at contact and at 1 m for each container.

OPG's Waste Acceptance Criteria are as follows:

- RWCs:
  - Case 1 – 200 mrem/h on contact and 10 mrem/h at 1 m
  - Case 2 – 200 mrem/h on contact, 20 mrem/h on the sides, 40 mrem/h on the top and bottom at 1 m

- SGs:
  - 40 mrem/h at 1 m

MCNP's surface source write (SSW) card was used to create surface source files for use in the full building calculations (stage 2 of the MCNP reference methodology). The details of the source for each container are outlined below.

RWC-PT Source Term

The source region for the RWC-PT was the entire homogenized PT/CT volume inside the container. As a simplifying assumption for the purpose of scaling the source strength to the WAC, the source spectrum was treated as entirely composed of Co-60. For Case 1, no source biasing was used, and the entire source was treated as homogenous. The source strength was scaled until the WAC was achieved at either contact or at 1 m.

For Case 2, to achieve a higher dose rate on the top and bottom, the source was biased towards the top and the bottom so that the ratio of dose rates at the side and the top was consistent with the WAC.

For the purpose of performing the source calibration, tallies were placed outside the container at the centre of each of the RWC's faces, at both contact (5 cm) and at 1 m.

RWC-EF Source Term

For the RWC-EF, the existing source used in the conceptual design shielding analysis of the RWC-EF was re-used. It is described in Section 2.3.3 of Reference [6]. The source for each component in the end fitting assembly was modelled explicitly. The only difference from the previous source term was that the source strength was scaled until the WAC was achieved at either contact or at 1 m.

For the purpose of performing the source calibration, tallies were placed outside the container, centered on each of the six sides of the container and placed at 5 cm and at 1 m from it. The tallies placed at 5 cm correspond to the contact point and were moved 5 cm from the container to avoid having a tally located at a boundary between two materials. For the bottom and the lid of the container, second dose points were added to confirm that the maximum dose rate was considered for the scaling.

Steam Generator Source Term

The source regions used in the SGs were the homogenized u-tube bundle, the tubesheet, and the homogenized head drum. As with the RWC-PT, the source spectrum was modelled as Co-60 and the strength was adjusted until the WAC was achieved.

For the purpose of performing the source calibration, tallies were placed outside the SG at 5 cm (corresponding to contact with the SG) and at 1 m from the SG shell side. A total of four dose points (two sets of two dose points) diametrically opposite were used to calibrate the source.

3.1.2.2 Full Building MCNP Calculations

The second stage of the MCNP calculations was performed by updating the previously prepared MCNP model of the PWMF, which was outlined in Reference [5]. This model of the PWMF included what's known as Phase II of the PWMF, including buildings SB3 and SB4, as well as the conceptual design for future building SB5. It did not include Phase I of the PWMF. The model was updated to include the PCSS as well as the RWC and SG container models described in Section 3.1.2.1 above.

As shown in Figure 4, the proposed location for the PCSS is directly to the northeast of SB3, and it will be directly north of the future SB5. The co-ordinates for the 4 corners of the PCSS were provided in email from OPG [11] and are also shown in Figure 4.

The distance from the proposed location for the PCSS to the northeast corner was then estimated by entering the building corner co-ordinates and measuring the distance to the northeast corner of SB3 using Google Earth. These distances were used to place the PCSS geometry in the MCNP model relative to the other buildings, as shown in Figure 5.

Label	X	Y	Lat	Long
PCSS	656385	4852755	43.811322	-79.0556
PCSS	656366	4852812	43.811839	-79.055817
PCSS	656418	4852829	43.811982	-79.055162
PCSS	656437	4852772	43.811466	-79.054946

Figure 4: Proposed Location of the PCSS [11]

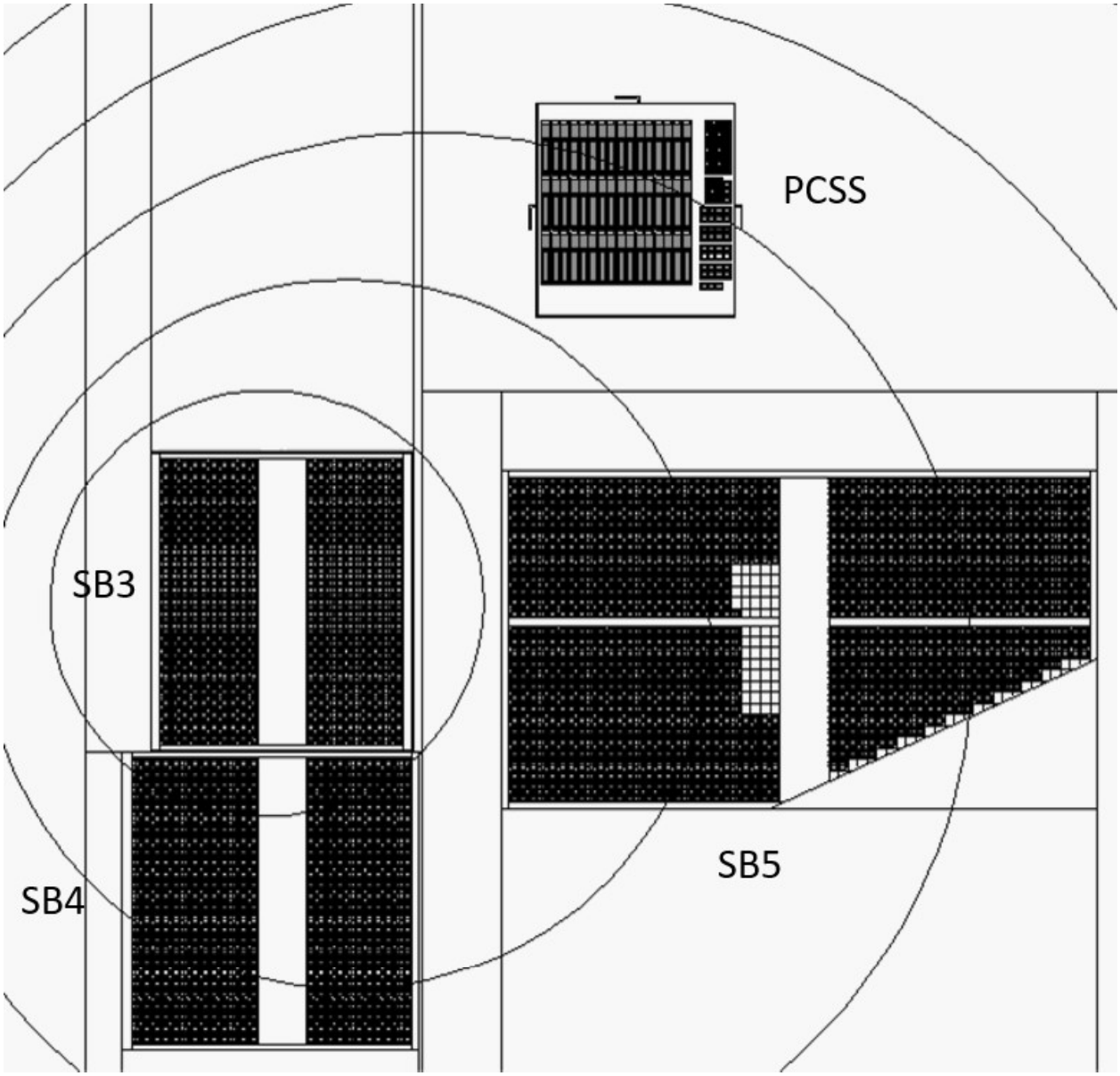


Figure 5: MCNP Model of PWMF with PCSS

The design of the PCSS is not complete. To aid OPG in evaluating different shielding design options, three configurations were considered for the analysis of the PCSS. The base case considered a PCSS design based on the Darlington Waste Management Facility (DWMF) Retube Waste Storage Building (RWSB), which has concrete shielding panels and an industrial roof [12]. Three sensitivity cases were then also considered. The first sensitivity case considered a building with a shielded roof, similar to the Steam Generator Storage Building (SGSB) at the WWMF [13]. The second sensitivity considered the same building design as the base case, but with additional shielding added to the area around the overhead door which serves as the main entry point for waste packages into the building. The purpose of adding this second sensitivity case was to demonstrate that with additional shielding around the door, the dose rates can be controlled As Low As Reasonably Achievable (ALARA). The last sensitivity case considered a reduced SG dose rate of 10 mrem/hr at a distance of 1 m. The geometry for

these cases is described below. For all cases, the geometry of SB3, SB4, and SB5 were left unchanged from the previously developed model described in Reference [5].

Base Case

The configuration of the PCSS considered in the base case was based on the DWMF RWSB. To do this, the wall and roof thicknesses for the PCSS were taken from the shielding analysis of the DWMF in Reference [12]. Concrete shielding panels with a thickness of [redacted] and a height of [redacted] were used around the entire building. Above the shielding panels, an industrial roof was modelled with [redacted] of rockwool insulation between a [redacted] steel sheet on the inside, and a 0.46 mm steel sheet on the outside. The floor of the building was modelled as 30 cm thick concrete. The total length of the building modelled was [redacted] and the total width modelled was [redacted] These dimensions were calculated from the co-ordinates provided by OPG in Figure 4. As with the other buildings in the MCNP model of the PWMF, the area outside of the PCSS was modelled as dirt with no vegetation or gradient modelled.

The doors for the building were assumed to be similar to the RWSB. One personnel door was added to the centre of each of the north, west, and east walls. These personnel doors included a shielded labyrinth on the exterior of the building to reduce streaming through the unshielded door. An overhead door was added on south wall with an adjacent personnel door. No labyrinths were added to the south wall as it was assumed this would not be compatible with the loading of steam generators into the building. The personnel doors were modelled with a height of [redacted] and a width of [redacted]. The overhead door was modelled with a height of [redacted] and a width of [redacted]. The labyrinths were made of [redacted] thick concrete, the same as the shielding panels, and extended to a height of [redacted] The geometry of the base case PCSS is shown in Figure 6.

Figure 6: Geometry of PCSS, Base Case

Sensitivity 1: Shielded Roof

For the first sensitivity case, a PCSS with a shielded roof was considered. This configuration is based on the design of the SGSB and the WWMF. The shielding analysis of the SGSB in Reference [13] was used as the basis for the MCNP modelling of this sensitivity case. This configuration maintained the same PCSS dimensions, doors, labyrinths, and concrete shielding panel thickness [redacted] as the base case but extended them up to a height of [redacted] The roof was modelled as [redacted] thick ordinary concrete. The shielded roof geometry for this sensitivity case is shown in Figure 7.

Figure 7: Shielded Roof Sensitivity Case Geometry

Sensitivity 2: Shielded Overhead Door

The second sensitivity case considered added shielding to the overhead and personnel doors. The shielding configuration considered was similar to a sensitivity case analyzed for the SGSB at the WWMF in Reference [14]. A concrete wall representing a temporary wall of 8" thick hollow cinder blocks (with an effective shielding thickness of 10.6 cm of concrete) was added 5 cm away from the overhead door. It extends 15 cm past the edge of the overhead and personnel doors and to a height of 555 cm. As with the base case, the industrial roof was considered for this case. The geometry of the shielding added to the overhead door is shown in Figure 8.

Figure 8: Geometry of Shielded Door Sensitivity Case

Sensitivity 3: 10 mrem/hr SG Dose Rate

The third sensitivity case considers an SG dose rate below the 40 mrem/hr at 1 m assumed in the base case and first two sensitivity cases. For this sensitivity case, the dose rate from the SGs was reduced to 10 mrem/hr at 1 m. This was achieved by dividing the MCNP results for the SG by a factor of 4, and keeping the uncertainty the same. This is mathematically equivalent to reducing the source strength within MCNP itself.

Materials

A detailed description of the materials used in the full building (PCSS) MCNP model is provided in Appendix D.

Layout of Waste Containers Within PCSS

The conceptual layout for the wastes stored in the PCSS was provided by OPG in Reference [15], which is shown in Figure 9. All waste containers were kept a minimum of 1 m from the walls of the PCSS. For the RWCs, a space of 50 cm in the north/south direction was kept between containers within the same group, and a space of 110 cm was kept between groups of containers. In the east/west direction, a space of 24 cm was kept between RWC-PTs, and a space of 30.935 cm kept between RWC-EFs. For the SGs, a separation of 14 cm between SGs was used in the east/west direction, and a separation of 10 cm was used in the north/south direction. The SGs were modelled as essentially laying on the ground (3 cm off the ground).

The number and location of containers was taken from Figure 9. The RWC-PTs were stacked 2 containers high, and the RWC-EFs were stacked 3 containers high. The only difference is that the conceptual layout shows a stack containing a single RWC-EF (labelled EF64 in the figure). For flexibility, it was assumed in the model that this would be a full 3-high stack of RWC-EFs. Therefore, the total number of containers included in the model were 66 RWC-EFs, 76 RWC-PTs (note that for the MCNP modelling, RWCs containing PT/CTs are not treated differently than those containing CTIs), and 48 SGs.

The MCNP surfaces and cells from the containers and SGs used to generate the surface sources in Section 3.1.2.1 were incorporated into the full building.

Figure 9: Conceptual Layout of Wastes within PCSS [15]

Other Buildings and Wastes

The models and layouts for SB3, SB4, SB5, and the DSCs within them were left unchanged from the previous MCNP model of the PWMF in Reference [5]. The DSC surface sources that were used in the current analysis were those generated in Reference [16].

Dose Points

The existing dose points from the previously developed model of the PWMF [5] were re-used for this analysis. The title and location of the main site dose points are shown in Figure 10. The dose acceptance criteria for these dose points are discussed in Section 3.4.

A new tally was added to the model for the purpose of determining where a facility fence might need to be located. This tally extended from 2 m south and 2 m west of the southwest corner of the PCSS to 50 m north and 50 east of the PCSS. This tally is shown schematically in Figure 11.

The previous model included many tallies, not all of which were needed for this analysis. They were left in the input files, however the main tallies of interest for this work are listed in Table 2. These include the site dose points, as well as the PCSS mesh tally, and the mesh tally which surrounds the dry storage buildings SB3/SB4/SB5, which is shown in Figure 12. The dose conversion factors that were used for each of the tallies are listed in Table 2, and these dose conversion factors are discussed in Section 3.1.2.4.

Table 2: Description of MCNP Tallies

Dose Point	Dose Conversion Factors	Description
PW10	ICRP 116 AP	1ft below TMB roof peak (height 41 ft above TMB floor)
PW24	ICRP 116 ROT	Montgomery Park Rd turnaround
PW26	ICRP 116 ROT	Bend in bike path northeast of PWMF Phase II
LS03	ICRP 116 ROT	Off shoreline
LS04	ICRP 116 ROT	Off shoreline
LS05	ICRP 116 ROT	Lake 282 m off shoreline
LS06	ICRP 116 ROT	Lake 144 m off shoreline
LS07	ICRP 116 ROT	Lake, where shoreline intersects with land site boundary
-	ICRP 116 AP	Mesh tally around SB3/SB4/SB5
-	ICRP 116 AP	Mesh tally around PCSS

*AP=Anterior-Posterior, ROT=Rotational

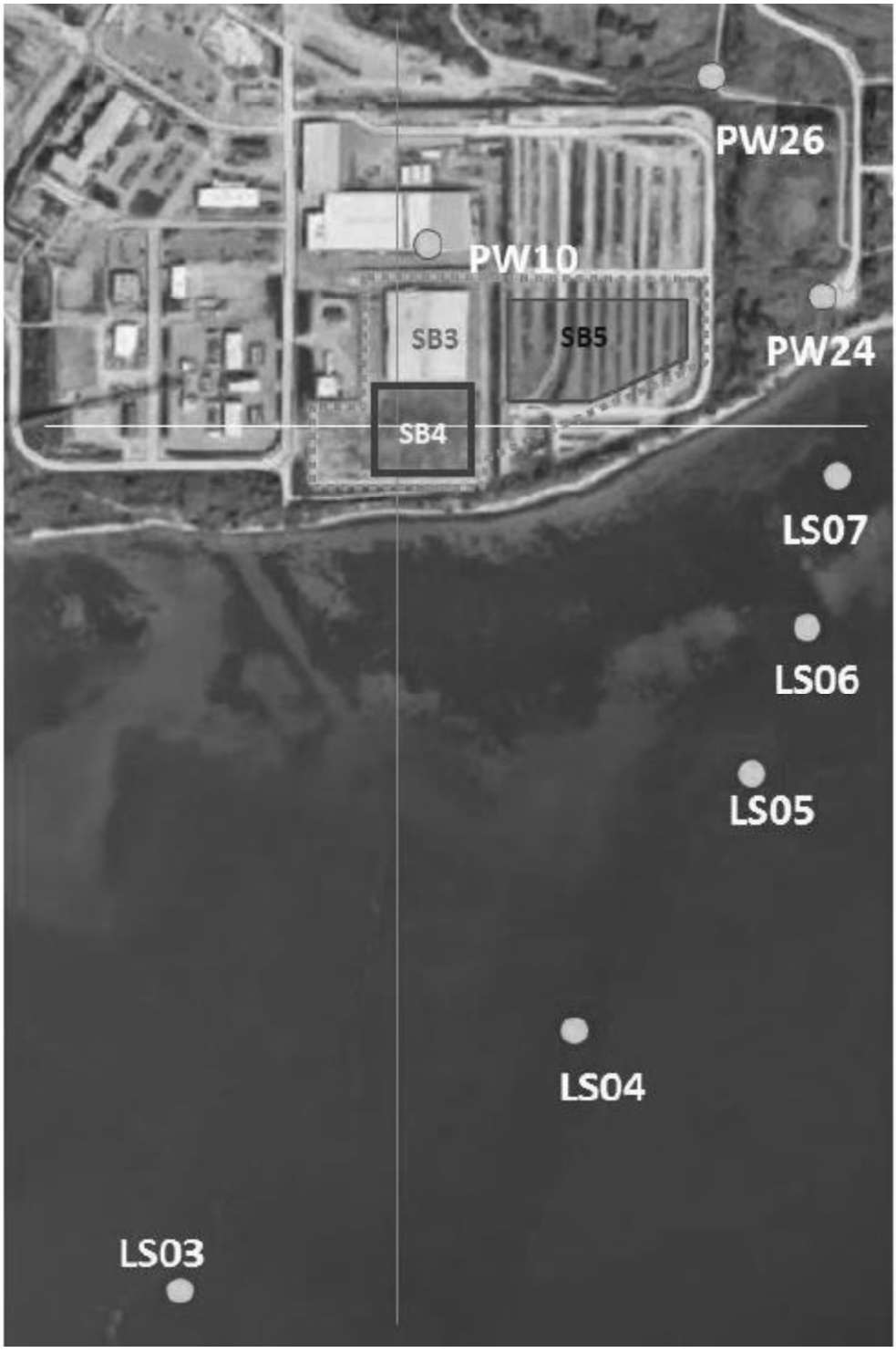


Figure 10: PWMF Site Dose Points

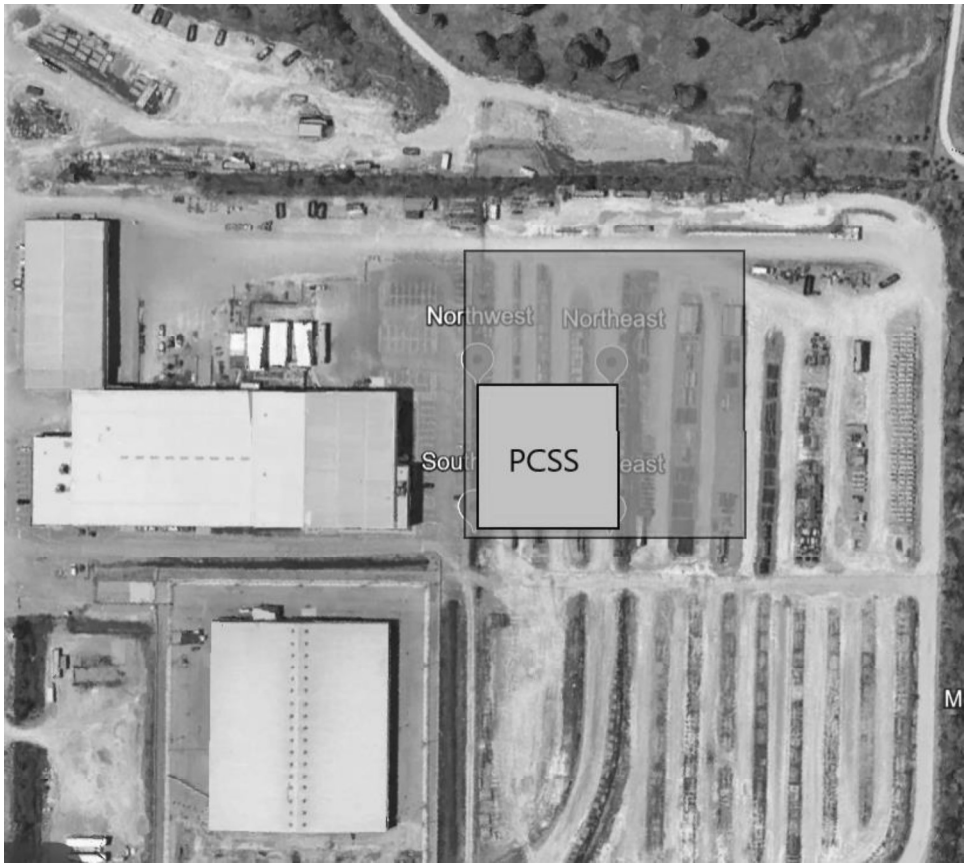


Figure 11: Mesh Tally Around PCSS

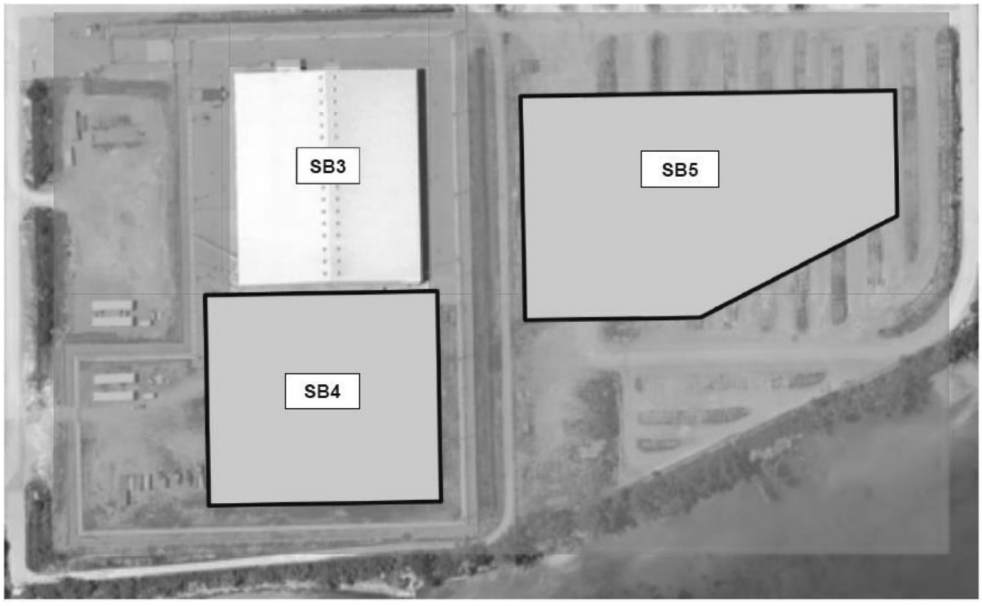


Figure 12: Mesh Tally Around SB3/SB4/SB5

3.1.2.3 Cross-Section Libraries

The cross-section libraries used in both the single container and full building MCNP calculations were those installed on the Kinectrics technical computing platform for use with MCNP. They rely primarily on the ENDF/B-VI R8 and ENDF/BVII.1 data libraries [17]. Consistent with the previous MCNP model of the PWMF site, the cross-section library used in this work was the MCLIB04 photon library, based on ENDF/B-VI cross sections.

3.1.2.4 Dose Conversion Factors

The Dose Conversion Factors (DCF) used in both the single container and full building MCNP calculations were the International Commission on Radiation Protection (ICRP) 116 Anterior-Posterior DCF [18] for the on-site tallies, and ICRP 116 Rotation DCF for the site boundary dose points. These are internationally recognized and accepted conversion factors and are specifically identified in the OPG reference methodology for heavily shielded containers [4].

3.2 Malfunctions/Accidents Safety Assessment

OPG guidelines for safety assessment in support of safety report updates for OPG waste facilities [2] were used for screening of potential accident scenarios, radionuclide inventory and release estimates, and dose assessment including public dose and worker dose resulting from malfunctions and accidents. REGDOC-2.4.4 [19] was adopted and applied in this assessment as well.

3.2.1 Hazard Identification, Screening and Classification of Bounding Accidents

Hazard screening of construction, transfer, handling and storage activities was carried out based on analysis of the activities involved, the characterization of the waste of concern (i.e., SG and RWCs), OPEX and the OPG internal hazard [20] and external hazard [21] screening guides. The following general steps will be performed as part of the hazard identification and screening process [2]:

- Perform hazard identification study,
- Pre-screening of internal and external hazards, and
- Detailed qualitative and quantitative event screening.

If the frequency of occurrence estimated for any postulated accident scenario is less than 10^{-6} events per year (refer to CSA N292.0:19 [22] and REGDOC-2.4.4 [19]), it is considered incredible and is not considered for further assessment.

The hazards include human induced hazards and external hazards. Transfer hazards from the station to the PCSS were considered.

As required by REGDOC-2.4.4 [19], the credible events will be classified into the following facility states:

- Anticipated Operational Occurrence (AOO),
- Design-Basis Accident (DBA), and
- Design Extension Conditions (DEC).

The frequency ranges of these states were as per Appendix C.2 of REGDOC-2.4.4 [19].

3.2.2 Radiological Releases

To calculate the radiological releases to the environment, estimates of the radionuclide inventories for SG and RWC are required:

- Inventories for SG: Gamma spectroscopy survey information from PNGS boilers with the secondary/primary side drained was taken into account to derive the source term for SG. Specifically, Co-60 activities from the gamma spectroscopy survey results for PNGS boilers were compared with the previous work [23]] and the bounding value was used to determine the inventory of SG (refer to Table 4-9 of [23]).
- Inventories for RWC: Bounding fuel channel source terms was used to derive the source term for RWC, accounting for the total inventory in the RWC. Specifically, bounding inventories for the RWCs at WWMF was used (refer to Table 5-9 of Reference [23]) in this work. These source terms were derived for the WWMF which has similar reactor component materials and a similar container design, and were considered conservative and acceptable for PNGS.

The release fractions for airborne radionuclide releases of L&ILW were calculated using the following equation [2][1]:

$$Airborne\ Source\ Term\ =\ MAR \times DR \times ARF \times RF \times LPF$$

Where

MAR = Material-at-Risk (Bq),

DR = Damage Ratio,

ARF = Airborne Release Fraction (or Airborne Release Rate for continuous release),

RF = Respirable Fraction, and

LPF = Leak Path Factor.

The radionuclide releases are a product of the inventory and release fraction of the respective radionuclides. The ARF, RF, and LPF used will be similar to previous assessments from the WWMF.

3.2.3 Dose to Public from the Postulated Malfunctions/Accidents

ADDAM analysis was performed to calculate doses to public resulting from the airborne releases to the environment following accidents and malfunctions. The modelling was performed as follows:

- ADDAM input files for the bounding scenarios identified above were prepared. Specifically, the release activity data files were based on the analysis of source term generated above using the methods described above. The ADDAM dataset was based on that used in the previous PWMF assessment [3] with the exception of the meteorological data. The meteorological data used in Reference [3] was for the year 2021. That data is not compliant with the requirements of CSA N288.2 as it does not represent the most recent one-year period. Meteorological data for the Pickering site for

[1] Note the scaling factors used for ALARA assessment (refer to Section 3.3.2) were not applied here, which makes the source term estimate more conservative.

the period of 2017-2021 was recently prepared in Reference [24]. This data meets the requirements of CSA N288.2 and was therefore used for this assessment.

- The receptors selected for the dose assessment were those in all habitable sectors of interest including the site boundary and representative group locations defined in Environmental Monitoring Program (EMP) for Pickering site [3]. Specifically, the receptors selected were consistent with the previous work, that is, those identified in Reference [3].

The 95th percentile individual dose for an exposure period of 30 days was calculated, consistent with the recommendations of REGDOC-2.4.1 and CSA N288.2-19. Note in this work, the release duration was extended to 100 hours with a negligible, small tail representing 0.01% of the estimated release to avoid zero doses for some sectors due to infrequent wind directions and short duration release. This is aligned with the recommendations made in [25].

3.2.4 Dose to Workers from the Postulated Malfunctions/Accidents

The doses to workers resulting from exposure to radioactivity during the postulated accidents were calculated based on the bounding scenario identified. Three exposure pathways were considered, that is, inhalation which includes skin absorption, cloudshine (immersion) and groundshine. Excel spreadsheet calculations were carried out for dose calculations based on the assumed releases, exposure time, inhalation rate, and other parameters. The equations for the calculation of doses from these pathways were the same as those used in the previous update of the PWMF Safety Assessment [3] and are given below:

Dose from Inhalation:

$$D_{inhalation} = \sum_{n=1} (R_n \times BR \times sk_{a,n} \times DCF_{inhalation,n}) \times T/V$$

Where

$D_{inhalation}$ = worker dose from inhalation (Sv)

R_n= released activity of nuclide n during the exposure time (Bq)

BR = worker's inhalation rate (m^3/s)

$sk_{a,n}$ = skin absorption factor for nuclide n ($sk_{a,n}$ =1.5 for tritium as HTO and 1 for other radionuclides)

$DCF_{inhalation,n}$ = inhalation dose coefficient of nuclide n (Sv/Bq)

T = exposure time (s)

V = contaminated cloud volume (m^3)

Dose from Cloudshine:

$$D_{cloudshine} = \sum_{n=1} (R_n \times DCF_{cloudshine,n}) \times T/V$$

Where

$D_{cloudshine}$ = worker dose from cloudshine (Sv)

$DCF_{cloudshine,n}$ = cloudshine dose coefficient of nuclide n (Sv-m^3/(Bq-s))

Dose from Groundshine (if applicable):

$$D_{groundshine} = \sum_{n=1} (R_n \times DCF_{groundshine,n}) \times T/A$$

where

$D_{groundshine}$ = worker dose from groundshine (Sv)

$DCF_{groundshine,n}$ = groundshine dose coefficient of nuclide n (Sv-m^2/(Bq-s))

A = area contamination (m^2)

The total dose to workers was calculated as:

$$Total\ Dose\ =\ D_{inhalation} + D_{cloudshine} + D_{groundshine}$$

The estimated doses to workers were compared against the dose criteria specified in Section 3.4.

3.3 ALARA Assessment

The objective of the ALARA assessment was to:

- assess potential individual and collective doses to workers resulting from the placement of wastes into the preliminary waste storage configuration option shown in Figure 9.
- determine whether they comply with the regulatory limits, applicable OPG governance and PWMF licensing requirements.
- to provide recommendations to ensure that doses resulting from the chosen option are ALARA.

The individual and collective doses estimated refer to operations taking place at the PCSS. Doses incurred during the removal and transportation of waste to the PWMF were not included in this work, nor were doses incurred from waste segmentation. The task involved the estimation of potential individual and collective worker dose for the following cases:

I. The handling and emplacing of one SG, one EF RWC, and one PT/CT/CTI RWC exclusive of surrounding waste packages (per the WAC);

II. Handling and emplacing of all SGs, EF RWCs, and PT/CT/CTI RWCs.

It was assumed that the waste in the PCSS is the same regardless of whether the building will be used to support Pickering-B retube or decommissioning (i.e., only one ALARA assessment is performed).

It was also assumed that data from previous ALARA assessments for the WWMF and DWMF (such as transfer operations to be performed, durations, frequencies, personnel, etc.) can be used in the ALARA assessment for the PCSS.

Note that it was assumed that the SGs and RWCs are sealed prior to all transfer operations within the scope of this ALARA assessment. As such, internal uptakes are expected to be negligible and no accounting for internal doses (i.e., committed effective doses) was considered.

3.3.1 Container Dose vs. Distance Estimates

The ALARA assessment accounted for activities which take place at varying distances from the RWCs and SGs. It was therefore necessary to produce a rough estimate of the dose rate as a function of distance for each container type. This was done by creating a simplified MicroShield model for each container type. The gamma spectra was created using the radionuclide inventories for the limiting waste type (the same inventories outlined in Section 3.2.2). The dose rate for each container type was then scaled to the WAC for each container, and the dose rate was calculated at distances of contact, 30 cm, 1 m, and 5 m.

3.3.2 Dose Calculations

The external gamma dose received by workers, while storing SGs and RWC in the PCSS is determined by the average external gamma dose rate during the task multiplied by the exposure time for the task. A given task may be broken down to sub tasks so as to better approximate the distance and dose rates.

The individual dose for each task was calculated as follows:

$$Dose(mSv) = DoseRate(mSv{\bullet}h^{-1}) \times Exposure\ Time\ per\ task(h) \times \#\ times\ task\ is\ conducted$$

While most of the space inside the PCSS will be taken up by the 48 SG cartridges, these are anticipated to be emplaced after the RWCs.

The proposed RWCs layout is currently such that the RWC-EFs are stacked three high and the RWC-PT/CT/CTIs are stacked two high (see Figure 9). Only a small amount of PCSS space is to be taken-up by the 140 RWCs.

There are preparatory tasks prior to handling the package that result in minor exposures and these have been accounted for (e.g., starting-up the ventilation system, walkdown, inspection of forklift, etc.).

The tasks required for handling and emplacement result in more significant exposures, of course, and these are described below.

3.3.2.1 Retube Waste RWCs

The following steps are carried out in order to store 140 RWCs inside the PCSS.

- Receive and inspect the Pickering-B RWCs and confirm dose rates
- Remove tie-downs
- Perform contamination scan of the forklift and personnel prior to exit from PCSS

- Align Forklift and Remove RWC from Flatbed Truck
- Move RWC inside PCSS and Emplace at appropriate location

Note that, in the case of RWC- EFs, these will be stacked three high and the RWC-PT/CT and RWC-CTIs will be stacked two high.

3.3.2.2 SG Cartridges

The following steps are required to store singly-stacked SG cartridges inside the PCSS.

- Setting-up the rigging (gantry and track system) inside PCSS (see Figure 13);
- Receiving the 48 SG cartridges from the Pickering-B;
- Transferring SG cartridges on to the storage saddles inside the PCSS;

Figure 13: Gantry Crane

3.4 Dose Acceptance Criteria

The radiation safety requirements under normal operation of the PWMF are the following [1]:

- ≤ 0.5 μSv/h outside the RCS and UFDS areas, on a quarterly average basis, based on the CNSC dose limit of 1 mSv per year for a member of the public, over a maximum of 2,000 hours per year occupancy for non-NEWs (Nuclear Energy Workers).
- For a member of the public, the dose constraint is ≤ 100 μSv per year at the Pickering site boundary. This is an administrative dose target of ten percent of the CNSC dose limit of 1 mSv per year.
- For NEWs, the dose limit is 50 mSv in any single year and 100 mSv over 5 years.

The radiation requirements considered under a malfunction or credible accident scenario are the following [1]:

- For the public including non-NEWs, the dose limit at or beyond the OPG property boundary due to a malfunction/credible accident scenario shall be 1 mSv.
- For NEWs, the dose target for NEWs due to a malfunction/credible accident scenario shall be 50 mSv.

The criteria listed above apply to all events, including AOO, DBA or DEC.

The occupancy times for the site are assumed to be 2000 hr/year for dose points located on land, and 1000 hr/year for dose points located on Lake Ontario. The resulting acceptance criteria for each of the normal operation external gamma radiation dose points is outlined in Table 3.

Table 3: Dose Acceptance Criteria

Dose Points	Annual Dose Acceptance Criteria	Occupancy	Hourly Dose Acceptance Criteria
PW24, PW26	100 µSv/yr	2000 hr	0.05 µSv/hr
LS03, LS04, LS05, LS06, LS07	100 µSv/yr	1000 hr	0.1 µSv/hr
PW10, mesh tallies (outside of buildings)	1 mSv/yr	2000 hr	0.5 µSv/hr

The ALARA assessment considered the Exposure Control Levels (ECLs) and Administrative Dose Limits (ADLs) which are set in OPG procedure N-PROC-RA-0019 [26]. Adherence to these levels and limits maintains control on personal dose when working in a radioactive area. ECLs are set lower than ADLs to alert employees and supervisors that dose control measures are required to ensure the ADLs are not exceeded. ECLs and ADLs are presented in Table 4and Table 5.

Table 4: OPG Exposure Control Levels

Organ or Tissue	Nuclear Energy Worker (NEW)	Pregnant NEW rem/balance of pregnancy	Nursing NEW rem/CY for balance of nursing	Non-NEWs (Public) (rem/CY)
Whole Body (Effective Dose) Including tritium committed dose	1 rem/CY	0.010	1 (no radioactive work with risk of tritium exposure or internal contamination is allowed)	0.010
Skin	25 rem/CY	N/A	25	N/A
Hands and Feet	25 rem/CY	N/A	25	N/A
Eye Lens	3 rem/CY	N/A	3	N/A

Table 5: OPG Administrative Dose Limits

	Whole Body Dose Limits in Ontario Power Generation (rem/CY)	
	Ontario Power Generation Employees	**Contract and Building Trades Union Employees(1)**
NEW	2	4
NEW with a lifetime Whole Body dose greater than 50 rem	1	N/A
Non-NEW	0.050	0.050
Whole Body Dose Limits (rem/rolling 5 CY)		
NEW	5	9

3.5 Use of Software

3.5.1. MCNP

The code that was used for the normal operation dose analysis was MCNP 6.1. MCNP is a general-purpose continuous energy Monte Carlo code that can be used for simulating photon and neutron transport phenomenon. MCNP is qualified for static calculations using k-code or source term methods for various CANDU-related analyses. It is a Grade 1 code based on Section 4.2 of the Kinectrics Software Qualification Procedure, AWI-4-30 [27]. It is qualified for use in radiation shielding applications, as documented in Reference [28]. MCNP 6.1 was used to model photon transport in this analysis, and MCNP 6.1 was found to be suitable for this application as per the code applicability report [29].

3.5.2. ADDAM

ADDAM-IST v1.4.2, the latest version of the ADDAM-IST code, was used in this work [30]. ADDAM is a safety analysis computer program developed by Atomic Energy of Canada Limited for use by the CANDU Owners Group community. ADDAM calculates doses to the public due to a postulated accident release of radioactive material to the atmosphere from a nuclear facility in the form of gases, vapours or particulates, taking into account the following processes:

- Plume rise;
- Downwash;
- Modification of effective height release due to building entrainment;
- Plume broadening due to building entrainment;
- Fumigation;
- Reflection at an elevated inversion;
- Plume transport;

- Plume diffusion;
- Wet deposition;
- Dry deposition;
- Plume depletion;
- Exposure to cloudshine;
- Exposure to groundshine;
- Internal exposure due to inhalation.

ADDAM calculates doses for various organs, age groups, and receptor locations, and are categorized by different release pathways including stack, inlet, leakage, or hole and different exposure pathways of inhalation, cloudshine, and groundshine. The calculations of atmospheric dispersion and doses were based on the CSA N288.2-M91 standard [31].

The ADDAM 1.4.2 qualification report [32] documents all qualification activities performed by CANDU Owner Group (COG) and concludes that ADDAM v1.4.2 is qualified for this work. A recent code assessment documented in Reference [33] has confirmed that ADDAM is also in compliance with CSA N288.2-14. Following the issue of the latest revision of the standard (CSA N288.2:19), an impact assessment of ADDAM against CSA N288.2:19 is currently being prepared under COG Work Package 50115. The code applicability for ADDAM for this work is summarized in the previous assessment [3].

3.5.3 MicroShield

The code used in the ALARA assessment was MicroShield 9.05 [34]. MicroShield is a general-purpose point-kernel code that can be used for simulating photon shielding problems. MicroShield is qualified for static calculations for various CANDU-related analyses. It is a Grade 3 code based on Section 4.2 of the Kinectrics Software Qualification Procedure, AWI-4-30 [27]. It is qualified for use in radiation shielding applications, as documented in Reference [35].

4.0 Key Technical Assumptions

Assumption #1

The only types of waste expected to be stored at the PCSS are steam generators and fuel channel components from the Pickering Nuclear Generating Station.

Basis/ Rationale: This is similar to the storage of retube and refurb components at both the Darlington and Western Waste Management Facilities.

Assumption #2

The geometry, materials, layouts, and DSC fuel decay times used in Reference [5] was assumed for the MCNP modelling of Storage Buildings 3/4/5.

Basis/ Rationale: This is the most recent MCNP dose rate assessment of the PWMF and should be used for consistency.

Assumption #3

For calculation of worker dose resulting from SG/RWC drop event, the worker was assumed to be present in the vicinity of the location where the accident occurs, wearing no Personal Protective Equipment (PPE). The worker's response time to leave the accident location under emergency back-out conditions was assumed to be 120

seconds. For the earthquake event, it is assumed that workers at the PWMF will be able to evacuate. Therefore, the dose consequence to the worker would be similar to the dose calculated for members of the public.

Basis/ Rationale: It is conservative and consistent with the existing PWMF Safety Report [1] and WWMF Safety Assessment [36].

Assumption #4

The radionuclides considered in the malfunction and accident assessment is consistent with the previous work [23].

Basis/Rationale: The previous work [23] represented the results of comprehensive study and the radionuclides in that work was considered representative.

Assumption #5

The SG radionuclide inventory was based on direct measurements and using calculated scaling factors based on the measured Co-60 activity, which was further compared with the scaling factor reported in other work [23] . Radionuclides were not estimated using scaling factors based on used fuel radionuclides inventories or predicted using fission product release and activation models.

Basis/Rationale: This approach is justified on the basis of the low scaling factors in Table A-2 of Reference [23], based on used fuel radionuclides inventories or predicted using fission product release and activation models.

Assumption #6

The activity scaling factor based on the ALARA assessment was not applied to source term estimates.

Basis/Rationale: The scaling factor based on the ALARA assessment reduces the waste inventory. Therefore, the results are more conservative without applying the scaling factor to the source term estimate.

Assumption #7

A Fire Hazard Assessment (FHA) for the PCSS was not prepared during the time frame of this project. The FHA report for similar storage buildings on another waste management facility [37] was used instead.

Basis/Rationale: An FHA report is required for the screening process for fire scenarios and any consequence assessment (dose calculation). The buildings at another waste management facility are of similar design and contain similar waste, ignition sources, etc. and so are expected to be similar to the eventual PCSS FHA.

Assumption #8

For the earthquake event, it is assumed that workers at the PWMF will be able to evacuate. Therefore, the dose consequence to the worker would be similar to the dose calculated for members of the public.

Basis/Rationale: This assumption is consistent with worker dose assessment for earthquake event for other waste management facility safety assessment [36].

Assumption #9

It is assumed that 50% of the PCSS is occupied by RWCs and only this portion of the PCSS was taken into account the calculation of cumulative aircraft crash frequency for

safety containers [38]. The crash frequency for the rest of the building used for the storage of SGs was calculated separately.

Basis/Rationale: Based on the arrangement of RWCs and SGs in the PCSS, RWCs will occupy less than 30% of the PCSS. Therefore, the assumption of 50% descried above is conservative. In addition, the calculation of cumulative frequency only applies to safety related packages including DSCs, DSM and RWCs, which is consistent with other assessment [36].

5.0 Normal Operations Safety Assessment

5.1 Total Public Dose

The maximum individual dose to members of the public can be calculated by adding together the maximum individual dose from chronic releases which is 1.88E-03 µSv per year (see Section 5.2), and the dose rate from external gamma radiation at the most conservative public dose point (PW26). As shown in Section 5.3.2 below, the dose rates calculated from external gamma radiation at PW26 for all cases except for the 10 mrem/h SG sensitivity cases with a shielded roof in Section 5.3.2.4, are above the acceptance criteria of 0.05 µSv/h which equates to 100 µSv per year (assuming 2,000h occupancy). The lowest dose rate from external gamma radiation calculated at PW26 was 0.0228 µSv/h (Shielded Roof Case 1 - Sensitivity in Table 21), which equates to 45.6 µSv per year. Therefore, the dose contribution from chronic releases is negligible compared to the dose contribution from external gamma radiation. The administrative dose target of 100 µSv per year is exceeded due to the dose from external gamma radiation, except for the 10 mrem/h SG sensitivity cases with a shielded roof which are discussed in Section 5.3.2.4 .

5.2 Public Dose from Chronic Emissions

The chronic emissions from the PWMF during normal operations and the doses to public were calculated recently [3]. The locations of the receptors of concerns are shown in Figure 14 and Figure 15.

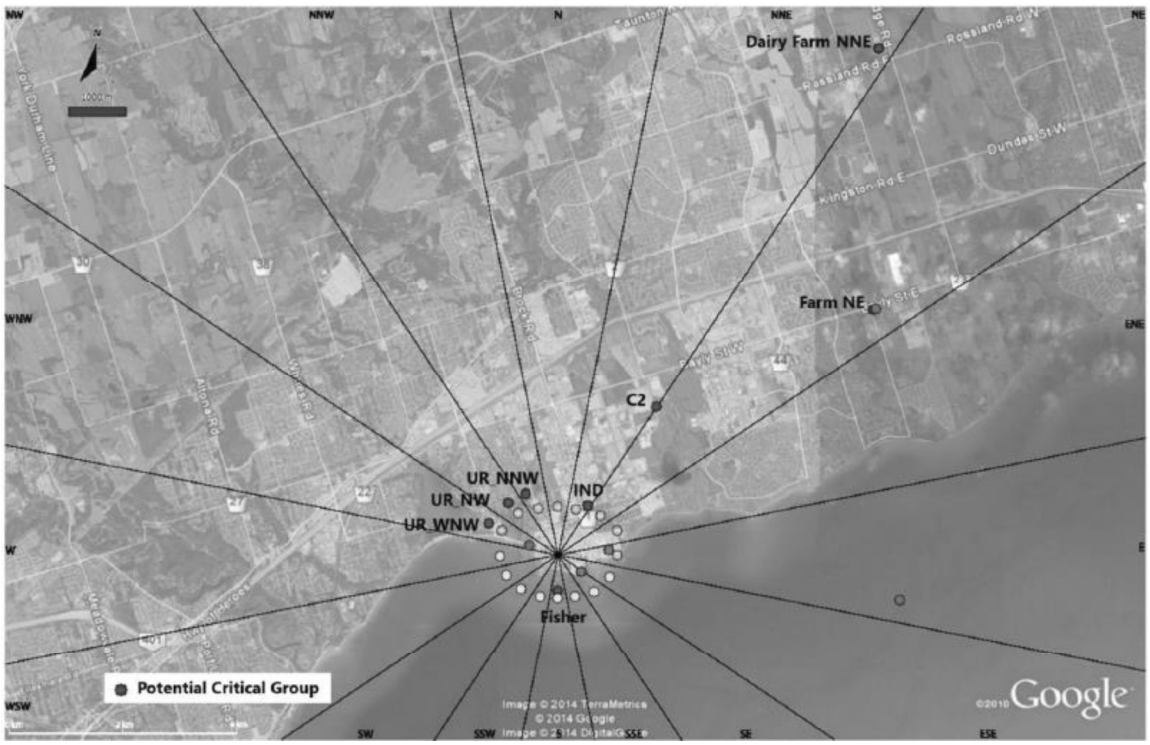


Figure 14: Locations of Representative Persons [3].

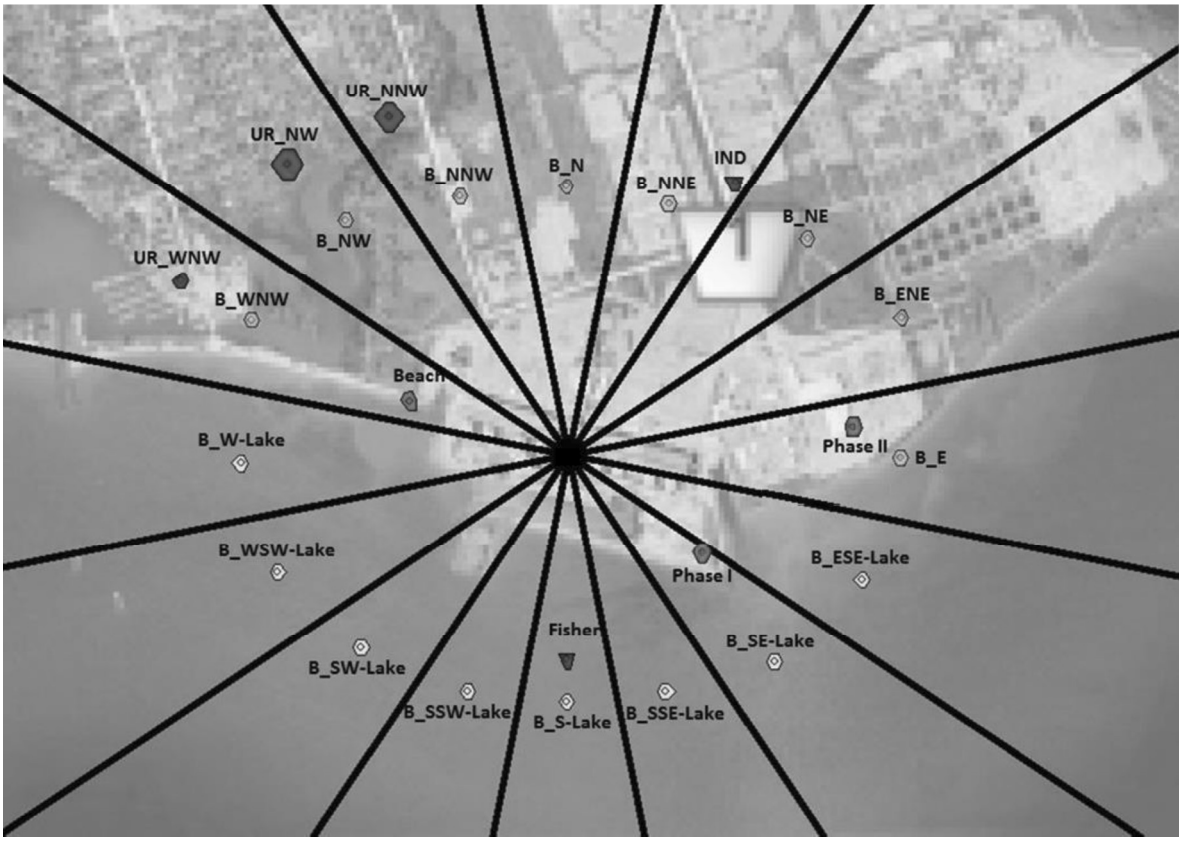


Figure 15: Locations of Representative Persons, Showing Details on Hypothetical Locations [3]

The dose calculation accounted for the following aspects:

- Update of chronic emission estimate to include the latest measurements.
- A revision of the IMPACT models to incorporate the latest meteorological data, representative persons, routine emission, and the latest code version.
- Incorporation of information from the DSC Storage Building (SB) 4 safety assessment [39].

The results are shown in Table 6 [3]. As shown in the table, the maximum individual dose at the landside receptor locations from chronic releases is 1.88E-03 µSv per year, which occurs for an infant at the dairy farm group, NNE from the PWMF facility. The maximum individual dose at the lakeside receptor locations from chronic releases is 1.00E-03 µSv per year for a child, which occurs at the hypothetical receptor location at SSE direction from the PWMF. These doses are both less than the administrative dose target of 100 µSv per year as discussed in Section 3.4.

Table 6: Public Dose during Normal Operation of PWMF [3]

	Annual individual dose (µSv/a)		
Location	Adult	Child	Infant
B_E	4.63E-04	5.29E-04	4.51E-04
B_ENE	2.19E-04	2.49E-04	2.17E-04
B_NE	1.65E-04	1.87E-04	1.66E-04
B_NNE	5.84E-05	6.63E-05	5.80E-05
B_N	7.49E-05	8.48E-05	7.51E-05
B_NNW	9.15E-05	1.03E-04	9.35E-05
B_NW	9.97E-05	1.11E-04	1.04E-04
B_WNW	1.20E-04	1.33E-04	1.25E-04
B_W-Lake	4.51E-05	5.32E-05	4.03E-05
B_WSW-Lake	5.52E-05	6.51E-05	4.93E-05
B_SW-Lake	7.22E-05	8.51E-05	6.45E-05
B_SSW-Lake	1.35E-04	1.59E-04	1.21E-04
B_S-Lake	3.15E-04	3.72E-04	2.82E-04
B_SSE-Lake	8.51E-04	1.00E-03	7.60E-04
B_SE-Lake	7.53E-04	8.88E-04	6.72E-04
B_ESE-Lake	3.41E-04	4.02E-04	3.05E-04
Fisher	2.86E-05	3.37E-05	2.55E-05
C2	1.35E-04	1.52E-04	0.00E+00
IND	5.02E-05	0.00E+00	0.00E+00
UR_NNW	8.29E-04	8.66E-04	7.23E-04
UR_NW	9.15E-04	9.55E-04	8.05E-04
UR_WNW	1.06E-03	1.11E-03	9.40E-04
Dairy Farm NNE	1.21E-03	1.15E-03	1.88E-03
Farm NE	8.21E-04	5.24E-04	4.46E-04

It should be noted that the above dose calculations were based on the radiological emissions up to the end of 2021 taking into account the postulated releases during DSC processing and postulated releases from DSMs during storage. The releases in 2022 [40] [redacted] per year, were lower than 2021 values of [redacted] per year [41], which was further bounded by the historical emission value used in the assessment [3]. Also it is expected that there are no emissions from SB5 to be built within the PWMF area for the storage of DSCs [39] . Furthermore, the preliminary design of the PCSS is based on Steam Generator Storage Building (SGSB)/ Retube Component Storage Building (RCSB) at the WWMF and it is expected that there will be negligible releases to the air and water from PCSS under normal conditions. In addition, the characteristics of public receptors as described in 2022 assessment [3] is up to date. Given all these factors, the dose calculations performed in the previous assessment sufficiently represented the radiological impact on the public, taking into account the operation of the proposed PCSS. Therefore, no revision to public dose calculations is required at this time.

Prescribed information under the General Nuclear Safety and Control Regulations

5.3 Public and Worker Dose from External Gamma Radiation

5.3.1 Single Container MCNP Dose Rates

The dose rates that were calculated using the single container MCNP models are discussed in the subsections below. These models were then used to generate the surface sources that were used for the full building calculations.

5.3.1.1 RWC-PT

The calibration for Case 1 and Case 2 are shown in

Table 7. For Case 1, the WAC was first achieved at the 1 m distance for the long side of the container. The 1 m dose rates were all generally much closer to the WAC than the contact dose rates. For Case 2, the WAC was also achieved first at 1 m. The ratio of 40 mrem/hr on top and bottom with 20 mrem/hr on the sides was achieved. After biasing the source towards the top and bottom of the container, the contact dose rates on the sides were quite low, in fact below the 1 m dose rate.

Table 7: Dose Rate Calibration for RWC-PTs

Dose Point	Case 1 Dose Rate (mrem/hr)	Uncertainty	Case 2 Dose Rate (mrem/hr)	Uncertainty
Short Side (5 cm)	20.384	2.13%	11.974	5.23%
Short Side (1 m)	8.4145	0.41%	20.016	0.67%
Long Side (5 cm)	21.074	1.53%	12.002	5.81%
Long Side (1 m)	10.099	0.29%	20.272	0.74%
Top (5 cm)	11.82	3.07%	188.95	2.51%
Top (1 m)	0.5874	0.72%	40.217	0.35%
Bottom (5 cm)	11.859	3.09%	185.84	1.22%
Bottom (1 m)	0.58895	0.55%	40.467	0.57%

5.3.1.2 RWC-EF

The RWC-EF source activity was scaled twice:

- To reach 200 mrem/h on contact and 10 mrem/h at 1 m (Case 1)
- To reach 200 mrem/h on contact, 20 mrem/h on the sides, 40 mrem/h on the top and bottom at 1 m (Case 2).

The limiting criterion for both cases was the dose rate at 1 m. The limiting criterion for both cases occurred at 1 m. The dose rates calculated before and after scaling for each case are described in Table 8.

Table 8: Summary of Dose Rates Calculated for RWC-EF

Tally description	Case 1			Case 2		
	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	Relative error	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	Relative error
Contact back edge lid	200	24.26	5.39%	200	48.75	5.39%
Contact front edge lid	200	24.17	4.62%	200	48.58	4.62%
Contact right edge lid	200	39.20	15.29%	200	78.78	15.29%
Contact left edge lid	200	35.28	14.29%	200	70.89	14.29%
Contact bottom	200	27.76	2.79%	200	55.78	2.79%
Contact bottom (second point)	200	4.68	12.65%	200	9.41	12.65%
Contact Top Lid	200	26.87	2.80%	200	54.00	2.80%
contact Top Lid (second point)	200	10.63	19.14%	200	21.36	19.14%
1m back edge lid	10	3.79	0.91%	20	7.62	0.91%
1m front edge lid	10	4.02	0.82%	20	8.08	0.82%
1m right edge lid	10	9.49	2.10%	20	19.06	2.10%
1m left edge lid	10	9.38	2.15%	20	18.84	2.15%
1m bottom	10	4.34	0.88%	40	8.71	0.88%
1m Top Lid	10	5.40	2.04%	40	10.85	2.04%

5.3.1.3 Steam Generators

SG source activity was scaled to reach 40 mrem/h at 1 m. The dose rates calculated at various dose points are described in Table 9.

Table 9: Summary of Dose Rates Calculated for SGs

Tally description	Waste Acceptance Criteria (mrem/hr)	Dose rate (mrem/hr)	relative error
Contact	/	1.11E+02	11.60%
1m	40	4.00E+01	0.49%
Contact - second point	/	9.14E+01	2.67%
1m - second point	40	3.95E+01	0.33%

5.3.2 Full Building MCNP Dose Rates

An MCNP run was performed for each source in the base case, as well as the two sensitivities. For each case, the total dose rate was calculated by summing the contributions from all sources. The results for the DSCs were only run for the base case and re-used for the three sensitivity cases. This assumes that the dose rates from the DSCs are not significantly impacted by the design of the PCSS, which is reasonable as the dose from the DSCs to the site dose points is dominated by skyshine, and the dose to the areas around the SBs and the PCSS are dominated by the nearby wastes. Detailed results are presented in the sub-sections below.

5.3.2.1 Base Case

The best estimate dose rates for the base case site dose points are shown in Table 10 and Table 11. As with the previous analyses of the PWMF site [5] [16], the dose rates were highest at site dose points PW10, PW24, and PW26 all located on the land near the waste storage buildings. The dose rates were lower at the lake dose points, which are further from the buildings.

The Steam Generators contribute around 80% of the dose rate to the land dose points, indicating that they are not only the major contributor of the PCSS wastes, but also exceed the dose rate of all the DSCs combined for the site dose points on the land. The SGs contributed a smaller fraction to the site dose points on the lake, however they still contributed more than all other sources combined.

As expected, the dose rates were higher for Case 2 where the RWC-EF and RWC-PT container dose rates were higher. However, as the SGs form such a large part of the overall dose rate, the difference in RWC dose rates from the two cases did not have a large overall impact on the dose rates.

Table 10: Base Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (µSv/hr)					
	PW24	Error	PW26	Error	PW10[2]	Error
Acceptance Criteria	**5.00E-02**	-	**5.00E-02**	-	**5.00E-01**	-
Steam Generators	8.44E-02	2.9%	1.84E-01	2.0%	1.74E+00	4.1%
RWC-EF Case 1	7.69E-04	2.0%	2.39E-03	1.2%	3.92E-02	12.5%
RWC-PT Case 1	7.48E-04	4.3%	1.55E-03	1.8%	6.30E-02	4.1%
Base Case 1	**1.05E-01**	**2.6%**	**1.97E-01**	**1.8%**	**2.07E+00**	**3.5%**
RWC-EF Case 2	1.54E-03	2.0%	4.81E-03	1.2%	7.87E-02	12.5%
RWC-PT Case 2	4.54E-03	3.1%	9.21E-03	1.7%	1.97E-01	9.9%
Base Case 2	**1.10E-01**	**2.5%**	**2.07E-01**	**1.8%**	**2.24E+00**	**3.3%**

[2] The tally for PW10 was mistakenly removed from the cases for SB4 and SB5. The dose contributions for these buildings were taken from the previous calculations in Reference [5]. This was considered acceptable as the PCSS is not located between the buildings and the tally.

Table 11: Base Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (μSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**	**1.00E-01**	**-**
Steam Generators	3.15E-05	7.3%	4.16E-04	6.4%	3.42E-03	6.7%	9.60E-03	5.0%	2.80E-02	2.8%
RWC-EF Case 1	1.15E-06	8.8%	1.88E-05	5.0%	5.76E-05	4.1%	1.17E-04	3.9%	2.85E-04	2.4%
RWC-PT Case 1	7.45E-07	5.0%	8.35E-06	3.7%	4.37E-05	3.3%	1.06E-04	3.1%	2.36E-04	2.4%
Base Case 1	**4.88E-05**	**4.8%**	**7.00E-04**	**3.9%**	**5.20E-03**	**4.4%**	**1.38E-02**	**4.9%**	**3.89E-02**	**2.1%**
RWC-EF Case 2	2.32E-06	8.8%	3.77E-05	5.0%	1.16E-04	4.1%	2.35E-04	3.9%	5.73E-04	2.4%
RWC-PT Case 2	1.85E-06	9.5%	2.71E-05	6.3%	2.15E-04	6.1%	5.41E-04	5.3%	1.43E-03	2.9%
Base Case 2	**5.11E-05**	**4.6%**	**7.37E-04**	**3.7%**	**5.43E-03**	**4.3%**	**1.44E-02**	**3.4%**	**4.04E-02**	**2.0%**

As outlined in the OPG methodology for shielding analysis of thick walled waste containers [4], the dose rates were compared against the dose acceptance criteria after adding 2σ to the best estimate to account for code uncertainty. This is shown in Table 12. The dose acceptance criteria for the base case are exceeded for dose points PW24, PW26, and PW10. This was largely the result of the SGs, as they exceeded the dose rate acceptance criteria on their own, though for PW26 and PW10, the dose acceptance criteria was nearly exceeded without the SGs as well.

Table 12: Base Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[2]
	Dose Rate (μSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Base Case 1	1.11E-01	2.05E-01	5.35E-05	7.55E-04	5.67E-03	1.52E-02	4.05E-02	2.21E+00
Base Case 2	1.15E-01	2.15E-01	5.58E-05	7.93E-04	5.90E-03	1.54E-02	4.20E-02	2.39E+00

The dose rates around the buildings for Base Case 1 were also plotted for the purpose of planning access fence locations. These are shown in Figure 16 for the area around the PCSS and Figure 17 for the area around the used fuel dry storage buildings. As shown, the dose rate around the PCSS does not drop below the acceptance criterion for non-NEW worker access (0.5 μSv/hr) within 50 m of the building. Around the dry storage buildings, the proposed fence lines for the buildings (shown in Figure 10) would no longer be sufficient to meet the acceptance criterion. This is especially the case along the north fence line closest to the PCSS, which exceeds the criterion for its entire length.

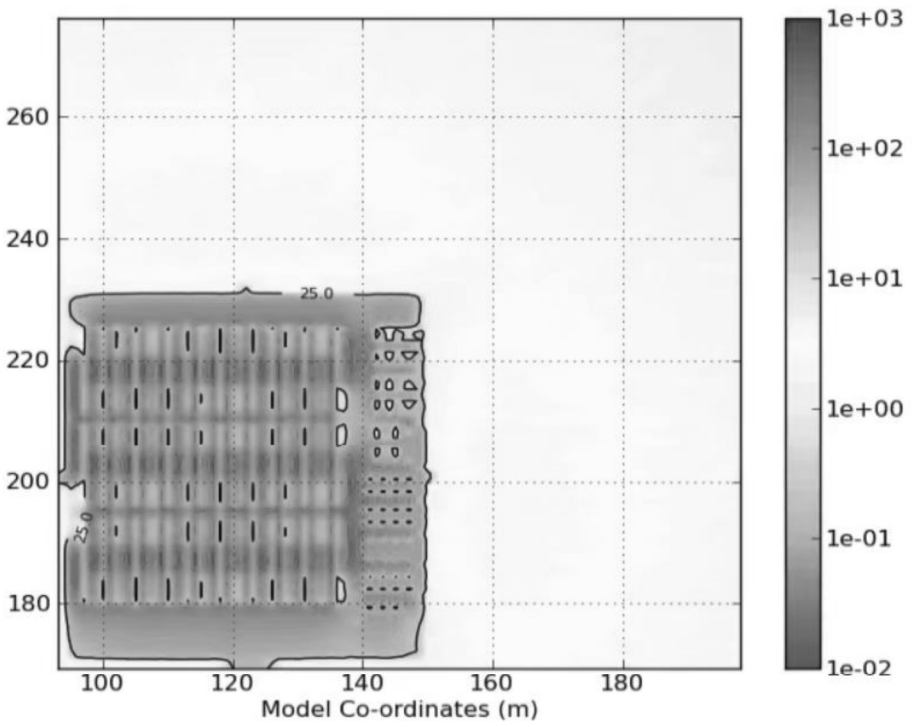


Figure 16: Base Case 1 Best Estimate Dose Rates (µSv/hr) Around PCSS

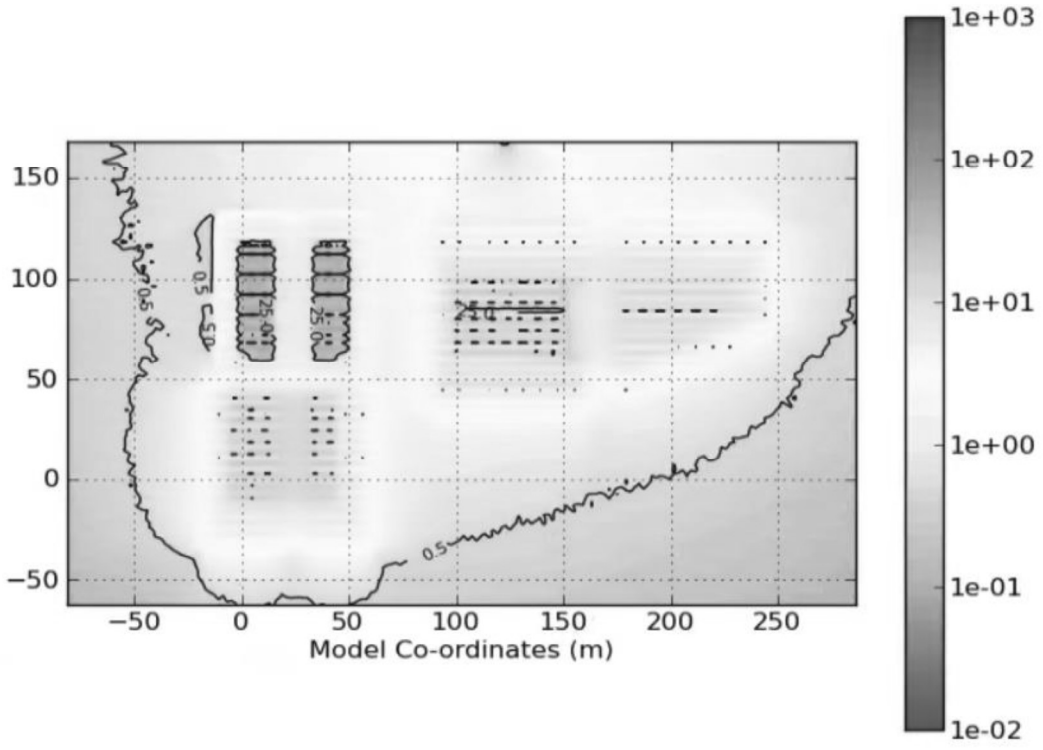


Figure 17: Base Case 1 Best Estimate Dose Rates (µSv/hr) Around DSC Storage Buildings

5.3.2.2 Sensitivity 1: Shielded Roof

The best estimate door rates for the shielded roof cases are shown in Table 13 and Table 14. Compared to the base case, the shielded roof reduces the dose rates at the site dose points on the land by between 60-70%, and the lake dose points by 50-60%.

However, as shown in Table 15, the reduction in dose rate produced by the shielded roof is not enough to meet the acceptance criteria at all dose points. The dose rates at PW26 and PW10 both exceed the criteria.

Table 13: Shielded Roof Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (μSv/hr)					
	PW24	Error	PW26	Error	PW10[2]	Error
Acceptance Criteria	**5.00E-02**	-	**5.00E-02**	-	**5.00E-01**	-
Steam Generators	1.92E-02	2.8%	4.53E-02	1.9%	5.03E-01	5.8%
RWC-EF Case 1	2.12E-04	4.7%	6.17E-04	2.2%	2.50E-03	7.3%
RWC-PT Case 1	2.68E-04	17.3%	3.49E-04	6.4%	2.49E-03	11.6%
Shielded Roof Case 1	**3.88E-02**	**3.6%**	**5.62E-02**	**1.6%**	**7.38E-01**	**4.1%**
RWC-EF Case 2	4.26E-04	4.7%	1.24E-03	2.2%	5.03E-03	7.3%
RWC-PT Case 2	1.33E-03	7.2%	2.83E-03	5.1%	1.97E-02	18.1%
Shielded Roof Case 2	**4.01E-02**	**3.5%**	**5.93E-02**	**1.5%**	**7.57E-01**	**4.0%**

Table 14: Shielded Roof Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (μSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-
Steam Generators	5.78E-06	10.4%	8.72E-05	5.2%	7.51E-04	5.7%	2.24E-03	5.4%	6.38E-03	3.0%
RWC-EF Case 1	8.80E-08	27.3%	9.81E-07	14.3%	5.81E-06	5.7%	1.80E-05	6.4%	5.16E-05	4.5%
RWC-PT Case 1	7.19E-08	19.6%	8.73E-07	21.5%	4.86E-06	8.7%	1.40E-05	8.1%	4.80E-05	8.8%
Shielded Roof Case 1	**2.14E-05**	**3.5%**	**3.45E-04**	**2.3%**	**2.45E-03**	**2.2%**	**6.29E-03**	**2.2%**	**1.69E-02**	**1.9%**
RWC-EF Case 2	1.77E-07	27.3%	1.97E-06	14.3%	1.17E-05	5.7%	3.62E-05	6.4%	1.18E-04	3.8%
RWC-PT Case 2	2.77E-07	27.3%	5.40E-06	16.1%	3.52E-05	11.7%	1.14E-04	10.5%	4.30E-04	11.3%
Shielded Roof Case 2	**2.17E-05**	**3.5%**	**3.51E-04**	**2.3%**	**2.48E-03**	**2.2%**	**6.41E-03**	**2.1%**	**1.73E-02**	**1.9%**

Table 15: Shielded Roof Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[2]
	Dose Rate (μSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Shielded Roof Case 1	4.16E-02	5.79E-02	2.29E-05	3.61E-04	2.56E-03	6.57E-03	1.76E-02	7.97E-01
Shielded Roof Case 2	4.29E-02	6.11E-02	2.32E-05	3.67E-04	2.59E-03	6.69E-03	1.80E-02	8.18E-01

The addition of a shielded roof does reduce the distance required for access fencing around both the PCSS and the used fuel storage buildings. The fence around the PCSS would still have to extend more than 50 m from the north and east walls, but as shown in Figure 18, it is reduced compared to the base case.

As shown in Figure 19, around the used fuel storage buildings the shielded roof reduces dose rates below the acceptance criterion within the existing proposed fence lines to the west, south, and east of the storage buildings. However, the dose rates around the fence to the north of the storage buildings would exceed the criterion due to the dose contributions from the PCSS.

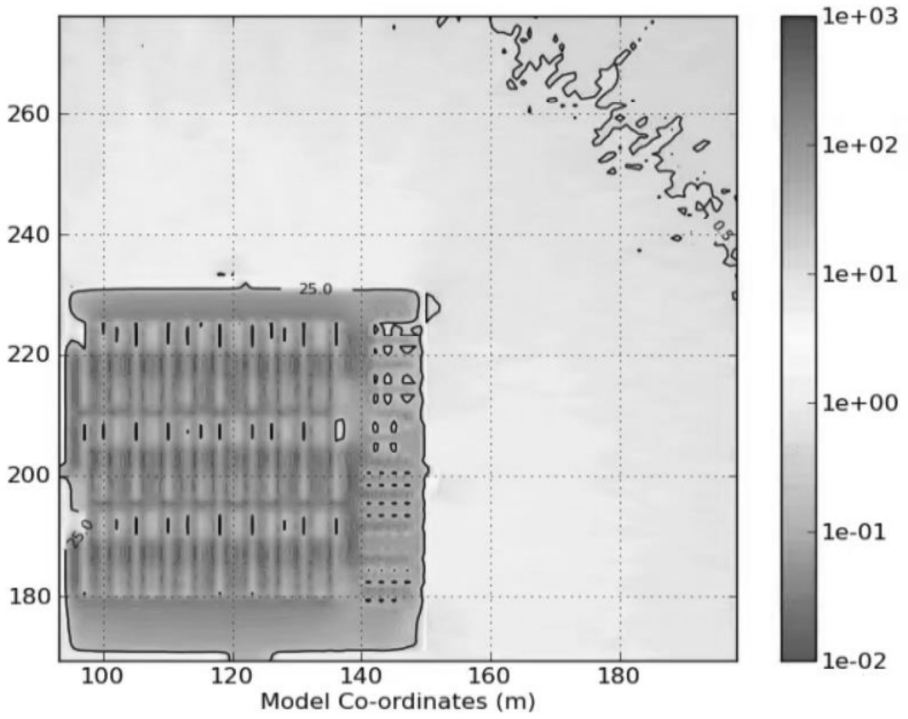


Figure 18: Shielded Roof Case 1 Best Estimate Dose Rates (µSv/hr) Around PCSS

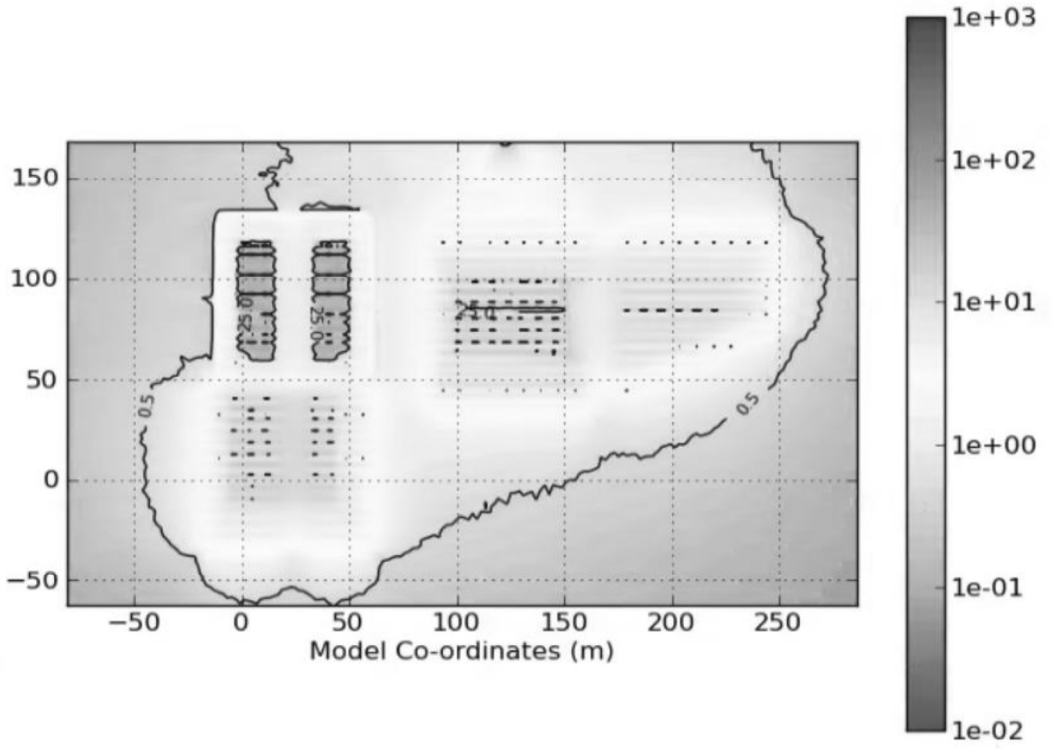


Figure 19: Shielded Roof Case 1 Best Estimate Dose Rates (μSv/hr) Around DSC Storage Buildings

5.3.2.3 Sensitivity 2: Shielded Door

The best estimate dose rates for the shielded door case are shown in Table 16 and Table 17. At the site dose points, the dose rates from the shielded door case are very similar to the base case and are within the uncertainty of the calculation. This is to be expected since the main impact of the shielded door is to the areas immediately to the south of the PCSS around the overhead door.

As shown in Table 18, the same set of dose point exceed the acceptance criteria in the shielded door cases as the base case: PW24, PW26, and PW10, by the same margin.

Table 16: Shielded Door Case Best Estimate Dose Rates, Land Dose Points

Dose Point	Dose Rate (μSv/hr)					
	PW24	Error	PW26	Error	PW10[2]	Error
Acceptance Criteria	**5.00E-02**	-	**5.00E-02**	-	**5.00E-01**	-
Steam Generators	9.38E-02	3.2%	1.89E-01	2.1%	1.97E+00	4.5%
RWC-EF Case 1	7.79E-04	2.0%	2.39E-03	1.2%	3.98E-02	15.0%
RWC-PT Case 1	6.64E-04	6.5%	1.54E-03	2.3%	6.93E-02	6.5%
Shielded Door Case 1	**1.14E-01**	**2.8%**	**2.03E-01**	**1.9%**	**2.30E+00**	**3.9%**
RWC-EF Case 2	1.56E-03	2.0%	4.81E-03	1.2%	7.99E-02	15.0%
RWC-PT Case 2	4.30E-03	5.1%	9.95E-03	4.2%	2.36E-01	14.6%
Shielded Door Case 2	**1.19E-01**	**2.7%**	**2.13E-01**	**1.8%**	**2.51E+00**	**3.8%**

Table 17: Shielded Door Case Best Estimate Dose Rates, Lake Dose Points

Dose Point	Dose Rate (µSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-
Steam Generators	3.02E-05	8.2%	3.86E-04	4.4%	3.08E-03	3.7%	9.77E-03	3.6%	2.86E-02	2.5%
RWC-EF Case 1	1.14E-06	8.1%	1.81E-05	5.0%	5.65E-05	5.3%	1.15E-04	4.1%	2.83E-04	2.3%
RWC-PT Case 1	7.58E-07	7.2%	9.00E-06	8.2%	4.40E-05	5.4%	9.31E-05	4.1%	2.44E-04	3.5%
Shielded Door Case 1	**4.76E-05**	**5.3%**	**6.69E-04**	**2.7%**	**4.86E-03**	**2.5%**	**1.40E-02**	**2.5%**	**3.95E-02**	**1.9%**
RWC-EF Case 2	2.30E-06	8.1%	3.63E-05	5.0%	1.14E-04	5.3%	2.31E-04	4.1%	5.68E-04	2.3%
RWC-PT Case 2	1.79E-06	18.6%	3.10E-05	10.9%	1.95E-04	8.2%	5.47E-04	7.3%	1.45E-03	5.2%
Shielded Door Case 2	**4.98E-05**	**5.1%**	**7.09E-04**	**2.6%**	**5.07E-03**	**2.4%**	**1.46E-02**	**2.4%**	**4.10E-02**	**1.9%**

Table 18: Shielded Door Case Best Estimate + 2σ Dose Rates

Dose Point	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[2]
	Dose Rate (µSv/hr)							
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Shielded Door Case 1	1.21E-01	2.10E-01	5.26E-05	7.05E-04	5.10E-03	1.47E-02	4.11E-02	2.48E+00
Shielded Door Case 2	1.25E-01	2.21E-01	5.49E-05	7.46E-04	5.31E-03	1.53E-02	4.26E-02	2.70E+00

The primary impact of the shielded door is to the dose rates immediately to the south of the PCSS. As shown in both Figure 20 and Figure 21, the dose rates outside the PCSS overhead door are reduced compared to the base case. However, given the high overall dose rates from the PCSS, this local effect is not sufficient to reduce the dose rates on the proposed fence lines around the used fuel storage buildings below the acceptance.

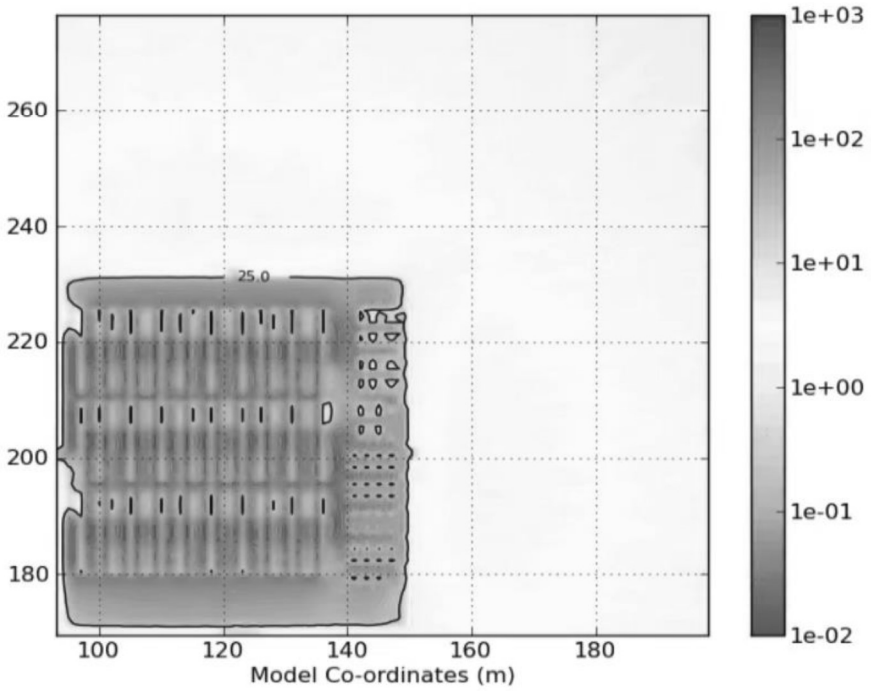


Figure 20: Shielded Door Case 1 Best Estimate Dose Rates (µSv/hr) Around PCSS

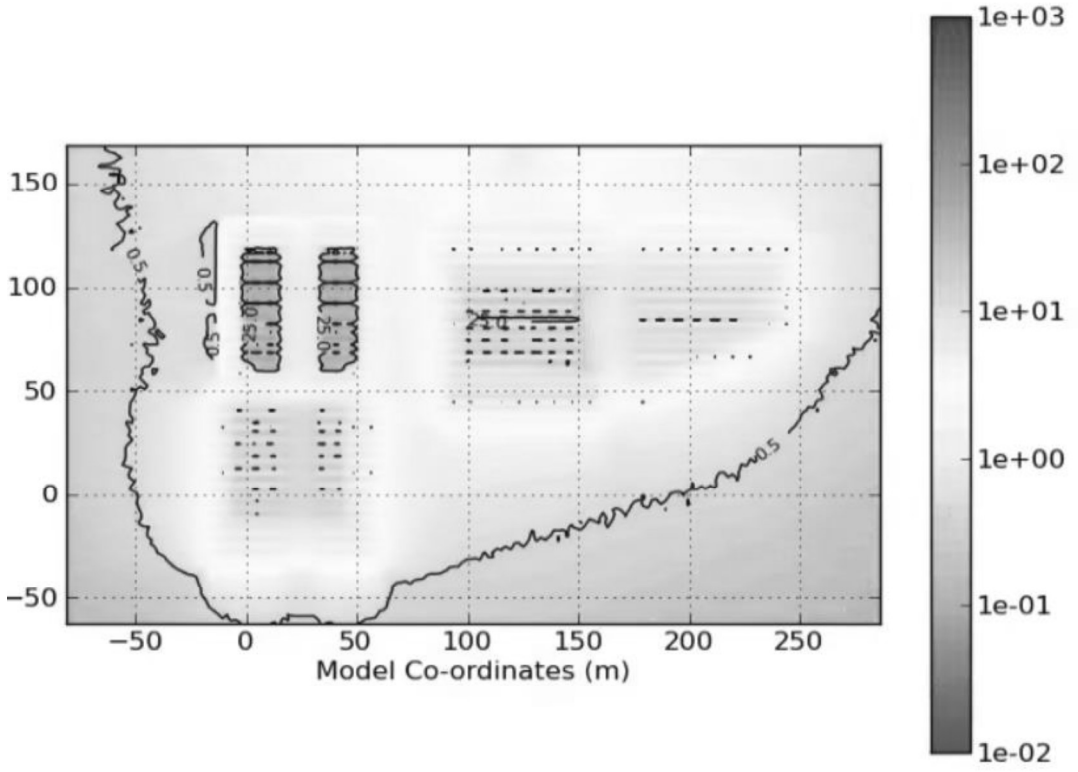


Figure 21: Shielded Door Case 1 Best Estimate Dose Rates (µSv/hr) Around DSC Storage Buildings

5.3.2.4 Sensitivity 3: 10 mrem/hr SG Dose Rate

As described in Section 3.1.2.2, this sensitivity considers SG dose rates reduced from 40 mrem/hr at 1m to 10 mrem/hr at 1 m. The MCNP results for the SGs were reduced by a factor of 4 to achieve this change, while leaving the uncertainty for the SGs unchanged. This was done for the base case as well as the shielded roof and shielded door cases. The best estimate results for this sensitivity are shown in Table 19 and Table 20. The best estimate + 2σ results are shown in Table 21. With the reduction in SG dose rate, the shielded roof cases have dose rates below the acceptance criteria at all dose points. Based on the ratio of dose rates observed between the dose points in Sensitivity 3 shielded roof case and the Sensitivity 1 shielded roof results from Section 5.3.2.2, the required fence line around the PCSS for Sensitivity 3 is estimated to be between 20m and 30m from the PCSS walls. The base case and the shielded door case however remain above the acceptance criteria at multiple points.

Table 19: 10 mrem/hr SG Sensitivity, Land Dose Points

Dose Point	Dose Rate (μSv/hr)					
	PW24	Error	PW26	Error	PW10[2]	Error
Acceptance Criteria	**5.00E-02**	-	**5.00E-02**	-	**5.00E-01**	-
Base Case 1 – Sensitivity	4.17E-02	3.4%	5.98E-02	1.6%	7.66E-01	2.6%
Base Case 2 – Sensitivity	4.63E-02	3.1%	6.98E-02	1.4%	9.39E-01	3.1%
Shielded Roof Case 1 – Sensitivity	2.44E-02	5.4%	2.22E-02	1.4%	3.60E-01	2.9%
Shielded Roof Case 2 – Sensitivity	2.57E-02	5.1%	2.53E-02	1.1%	3.80E-01	2.1%
Shielded Door Case 1 – Sensitivity	4.40E-02	3.4%	6.10E-02	1.6%	8.29E-01	3.0%
Shielded Door Case 2 – Sensitivity	4.84E-02	3.1%	7.18E-02	1.5%	1.04E+00	4.2%

Table 20: 10 mrem/hr SG Sensitivity, Lake Dose Points

Dose Point	Dose Rate (μSv/hr)									
	LS03	Error	LS04	Error	LS05	Error	LS06	Error	LS07	Error
Acceptance Criteria	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-	**1.00E-01**	-
Base Case 1 - Sensitivity	2.52E-05	2.9%	3.87E-04	2.4%	2.64E-03	2.5%	6.65E-03	2.0%	1.79E-02	1.8%
Base Case 2 - Sensitivity	2.75E-05	2.8%	4.25E-04	2.3%	2.87E-03	2.4%	7.20E-03	1.9%	1.94E-02	1.7%
Shielded Roof Case 1 - Sensitivity	1.71E-05	2.8%	2.80E-04	2.4%	1.88E-03	1.9%	4.62E-03	1.5%	1.21E-02	2.3%
Shielded Roof Case 2 - Sensitivity	1.73E-05	2.6%	2.85E-04	2.3%	1.92E-03	1.8%	4.73E-03	1.3%	1.26E-02	2.2%
Shielded Door Case 1 - Sensitivity	2.49E-05	3.1%	3.80E-04	2.1%	2.55E-03	1.7%	6.68E-03	1.6%	1.81E-02	1.8%
Shielded Door Case 2 - Sensitivity	2.71E-05	3.2%	4.20E-04	2.1%	2.76E-03	1.7%	7.25E-03	1.6%	1.96E-02	1.7%

Table 21: 10 mrem/hr SG Sensitivity Best Estimate + 2σ Dose Rates

Dose Point	Dose Rate (μSv/hr)							
	PW24	PW26	LS03	LS04	LS05	LS06	LS07	PW10[2]
Acceptance Criteria	**5.00E-02**	**5.00E-02**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**1.00E-01**	**5.00E-01**
Base Case 1 - Sensitivity	4.46E-02	6.16E-02	2.67E-05	4.06E-04	2.77E-03	6.92E-03	1.86E-02	8.06E-01
Base Case 2 - Sensitivity	4.92E-02	7.17E-02	2.90E-05	4.45E-04	3.01E-03	7.48E-03	2.01E-02	9.97E-01
Shielded Roof Case 1 - Sensitivity	2.70E-02	2.28E-02	1.80E-05	2.93E-04	1.96E-03	4.76E-03	1.27E-02	3.81E-01
Shielded Roof Case 2 - Sensitivity	2.83E-02	2.58E-02	1.83E-05	2.99E-04	1.99E-03	4.86E-03	1.31E-02	3.96E-01
Shielded Door Case 1 - Sensitivity	4.70E-02	6.30E-02	2.65E-05	3.96E-04	2.64E-03	6.89E-03	1.87E-02	8.79E-01
Shielded Door Case 2 - Sensitivity	5.14E-02	7.40E-02	2.88E-05	4.37E-04	2.86E-03	7.48E-03	2.02E-02	1.12E+00

5.3.3 Recommendations

As per the MCNP results shown above in Section 5.3.2, the only cases that were below the acceptance criteria for all dose points were the sensitivity cases that used SG dose rates of 10 mrem/h at 1 m and had a shielded roof on the PCSS. All other cases were over the dose acceptance criteria for at least one dose point. As the PCSS moves further into detailed design, the following recommendations should be considered for any future MCNP analysis:

- Refine source terms for all PCSS waste using more realistic values based on surveys.
- Credit any decay time in the derivation of source terms for each waste type.
- Re-evaluate the fence distances around the PCSS.
- Re-evaluate the layout of waste within the PCSS, and use older less radioactive waste to shield newer waste that has had less decay time wherever possible.

6.0 Malfunctions/Accidents Safety Assessment

6.1 Hazard Identification, Screening and Classification of Bounding Accidents

Hazards were identified and screened following the methodology specified in Section 3.2.1 for the following activities:

1. Construction of the PCSS;
2. On-site transfer of RWCs and SGs; and
3. Handling and storage of the RWCs and SGs.

The results are documented in the following subsections. A pre-screening of the identified hazards was performed for on-site transfer and handling and storage in the PCSS. Some events were eliminated during pre-screening if they can be determined to be not applicable without any additional analyses or they have negligible impacts on the safety of the PWMF. Hazards screened in are further assessed as part of the detailed screening analysis as documented in this section. The results of the pre-screening assessment are presented in Appendix A.

6.1.1 Malfunctions/Accidents during Construction of PCSS

Construction of the PCSS will consist of two stages; that is, site preparation and construction. Site preparation activities will include the following activities:

- Site clearing and grading,
- Fencing,
- Establishing a water management system,
- Creating material laydown areas, and
- General preparation for construction activities.

The construction of the PCSS will include the following activities:

- Surveying,
- Excavation,
- Foundations,
- Steel and equipment erection,
- Install building envelope,
- Hook-ups to existing utilities (power, water, sewer, communications), and
- Commissioning.

The malfunctions and accidents associated with site preparation and construction were identified and screened, and preventative and mitigation measures have been suggested. The results are summarized in Table 22 below. In summary, with the appropriate preventative and mitigation measures in place, the malfunctions/accidents associated with site preparation and construction of the PCSS will be prevented and the consequences, should those events occur, will be minimized and controlled.

Table 22: Malfunctions/Accidents during Site Preparation and Construction

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Fire	The following fire accidents could occur: • Combustion of waste generated during site clearing, such as grass and trees; • Combustion of construction materials; • Fire at a temporary facility or equipment fire; • Fire during a vehicle accident; and • Fire during welding and cutting.	Fire will be limited to a local area. Emergency preparedness program, including fire extinguishers or other equipment, will be in place. This will minimize the consequences of a fire accident, should it occur.

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Vehicle accidents	The following vehicle accidents could occur: • Collision with other vehicles, equipment, temporary buildings, or wildlife; and • Turnover of transportation vehicles such as haulage trucks or front-end loaders.	Safety programs for contractors will include safe driving procedures. All applicable transportation regulations will be followed in the movement of vehicles. Traffic control and speed limits will be in place. All of these will minimize the occurrence of vehicle accidents.
Electrical accidents	Electrical accidents, such as an electrical short circuit or electrical shock, could occur resulting from: • Misuse or poor maintenance of electrical equipment; • Damage to electrical equipment as a result of other project-related activities; • Staff access to live electrical equipment without authorization; and • Severe weather conditions, such as lightning.	Procedures will be in place to ensure the health and safety of workers and equipment, including proper maintenance of electrical equipment, Lock-out or tag out procedure, use of qualified workers and work permits. This will prevent the occurrence of electrical accidents.
Structural instability	Structural instability-related accidents could include: • Toppling of soil and waste rock piles; • Collapse or rolling of stacked pipes; • Collapse of scaffold, elevated plate form and ladder; • Heavy equipment crashes; and • Collapse of buildings under construction.	Safe work code of practice will be followed, including appropriate housekeeping and pipe handling work instruction. All activities will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the occurrence of structural instability events.
Material handling accidents/ equipment failure	Material handling accidents/equipment failure could occur, including: • Material dropping from scaffold or elevated platform, or failure of crane or other lifting equipment; • Loss of control of mobile equipment/equipment collision; • Uncontrolled loading impacting equipment or personnel; • Material rolling or sliding; and • Utility damage (for example, water line, communication system) due to unexpected ground disturbance	Stringent safety requirements or procedures will be followed. For example, cranes will have a significant safety factor in terms of lifting capability. All applicable regulatory requirements related to safe rigging and hoisting will be met. An experienced contractor with a proven safety record in undertaking heavy lifts will be used, where applicable.

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Spill of fuel, lubricants, oils and chemicals used for construction such as cement, paints, solvents or sealants.	Spill of these materials could take place. The scenarios include: • During a vehicle accident, tanker truck or gas tank of the vehicle is damaged and liquids (gasoline, diesel or liquid chemicals) in the tank spill. • The integrity of the on-site liquid storage equipment (tanks) is damaged as a result of extreme weather conditions or mechanical failure causing chemicals, lubricants and oil contained in the equipment to spill into the environment. • Spills could occur as a result of operational errors such as the leak of diesel fuel from a tanker truck or a storage tank while refueling equipment or vehicles.	Spill contingency plans as part of environmental management plan for the preparation and construction work should be in place. This will ensure prompt spill containment and clean-up. Given that the amount of spill could be limited, the effects would be minor or negligible after appropriate clean-up.
Occupational accidents	The following occupational accidents could occur, including: • Falls of workers from scaffold, ladder or elevated work locations, such as building under construction; • Slips, trips or falls on uneven or wet or icy surface; • Injury during welding and cutting or during material handling; • Extreme weather-related injury such as frostbite or heat exhaustion/stroke; • Accidents related to moving/rotating machinery or other equipment or tools; • Machinery-related accidents during the operation of drill, dozer or other equipment or accidents related to the use of hand tools; and • Injury due to falling objects, including from collapse of buildings.	Contractors will have extensive programs, policies and procedures to prevent occupational accidents. For example, workers will be properly trained prior to the execution of the work assigned. All activities will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the potential of occupational injuries.
Explosion/ detonation	Explosions could occur because of: • Inadvertent detonation of explosive used during construction; and • Explosion of pressurized cylinder/tank.	All operations associated with materials that are potentially explosive will be carried out within a regulatory environment and conforming to design and construction protocols. This will minimize the potential of explosion.

Malfunctions/ Accidents	Description of the Scenarios	Preventative and Mitigation Measures/Screening Evaluation
Exposure to substances hazardous to health	Workers could be exposed to substances hazardous to health including toxic or controlled substances used during site preparation and construction.	Workplace Hazardous Materials Information System (WHMIS) will be in place. Workers will be properly trained for the use of these materials. Personal protective equipment will also help minimize the consequence of exposure to substances hazardous to health.

6.1.2 Malfunctions/Accidents during On-site Transfer of RWC and SG

The proposed route for transferring RWC and SG from PNGS to PCSS is illustrated in Figure 22. The malfunction and accidents during on-site transfer of RWC and SG was assessed below.

Note: The green line shows the transfer route assessed before and the red dotted line represents the new portion of the route for the transfer of SGs and RWCs to the PCSS.

Figure 22: Proposed Transfer Route for Transferring RWC and SG to PCSS

6.1.2.1 Drop of RWC or SG due to On-site Vehicle Accidents

The SGs could be transported to the PCSS on a Self-Propelled Modular Transporter (SPMT) or equivalent transfer vehicle. It is assumed that a maximum of twelve SGs will be transferred from the PNGS to the PCSS per year given there will be only one reactor refurbished at a time.

For RWCs, they are expected to be transported individually to the PCSS on a flatbed trailer or equivalent transfer vehicle, with tie-downs applied. It is assumed that a maximum of 25 RWCs will be transferred from the PNGS to the PCSS per year.

On-site transfer will not be conducted during poor weather conditions and the transfer vehicle will travel at a low rate of speed to ensure that the risk due to an on-site vehicle accident is minimized. However, there remains the risk that unforeseen conditions may lead to a collision that causes the transfer vehicle or RWC/SG being transferred to topple and results in the drop of the RWC/SG. Therefore, this event was screened in.

6.1.2.2 Transporter Operator Health-Related Emergency

The transporter operator could have a health-related emergency and lose consciousness during the transfer. However, the transporter operator is normally escorted by at least one additional individual. This second person could intervene to stop the transporter in such an event. Furthermore, the transporter operates at the low speed. Even if operator illness were to result in the transporter leaving the road, a release of radioactivity from a RWC or packed SG is not expected, taking into account the design of the RWC or SG package. . For the worst-case scenario that the transporter toppled over, the radiological consequences would be bounded by the event of RWC or SG drop discussed in Section 6.1.2.1. Therefore, this event was screened out.

6.1.2.3 Fire

The route for transferring RWC and SG from PNGS to the PCSS is illustrated in Figure 22. It is similar to the route assessed in previous work [42] with the exception of the route represented in red dotted line in Figure 22. The potential for an accident due to a fire along the transfer route has been considered. The fire sources directly along the transfer route could include the P-10 gas cylinders outside of the Auxiliary Security Building within the Protected Area and invasive phragmites stands inside the ditches. Recommendations have been made to reduce the fire hazard such as relocation of the cylinder. The portion of transfer route which has not been specifically assessed (red dotted line in Figure 22) only extends less than 200 meters beyond the route which has been assessed. Some photos were recently taken along this portion of the transfer route (Appendix C). Based on the review of these photos, there are no additional fire sources identified along this portion of the transfer route.

The combustible materials originating from the transporter itself, including the diesel fuel in the tank, engine lubricating oil and hydraulic oil, could represent a fire hazard. However, it is expected that such a fire would be of short duration as a result of the fire detection and suppression systems in the transporter design and the expected response of the Pickering NGS Emergency Response Team (ERT).

RWCs will be constructed of non-combustible materials and the waste stored inside them is mostly non-combustible. All SG penetrations and openings will be welded with thick steel plates prior to transport to ensure all internal source term is contained. Furthermore, the outer surface of the RWCs and SGs will be decontaminated prior to transfer. Therefore, release of radioactive materials from RWCs and SGs due to a fire accident was screened out.

6.1.2.4 Adverse Road/Weather Conditions

Similar to the current practice, it is expected that procedural controls will be in place to prohibit on-site transfer under poor road/weather conditions or until potentially slippery conditions can be mitigated with appropriate measures such as sanding or salting of the transfer route. Even if the transporter were to lose traction on a slippery surface resulting in the vehicle leaving the road, a release of radioactivity from a RWC or SG is not expected given the robust design of a RWC or packed SG, which is intended to withstand transportation accident loads. For the worst-case scenario, the radiological consequences would be bounded by the event of RWC or SG drop. Therefore, this event was screened out.

6.1.2.5 Soil Failures/Slope Instability

In the event the on-site transfer of a RWC or SG takes longer than expected as a result of adverse road conditions due to soil failure or slope instability, a release of radioactivity from a RWC or SG is not expected given the robust design of a RWC or packed SG. For the worst scenario, the radiological consequences would be bounded by the event of RWC or SG drop. Therefore, this event was screened out.

6.1.2.6 Earthquake

The Pickering B Design Basis Earthquake (DBE) is defined as an earthquake with a peak ground acceleration (PGA) of 0.05 g and a frequency of reoccurrence once in 1000 years, using the 84th percentile seismic hazard curve for the Pickering site [43].

Since the transporter with a RWC or SG is not on the road 100 percent of the time, the combined occurrence of a DBE and the transporter being on the road simultaneously can be determined based on the following assumptions:

- A maximum of 25 RWCs and 12 SGs are transferred each year between the station and the PWMF PCSS given there is only one reactor being refurbished at a time.
- The greatest distance the transporter needs to travel between the station and the PCSS is less than 1 km.
- The transporter is conservatively assumed to take a longer time during transfer and be on the road for 1 hour to increase time-at-risk.

The frequency of a DBE occurring at a time when a SG or RWC is being transferred is:

$$(12+25)\,\frac{transfers}{year}\times\frac{1\ hour}{8760\ hours\ per\ year}\times(1\ \times 10^{-3}\ events\ per\ year)$$
$$=4.22\ \times 10^{-6}\ events\ per\ year$$

The event frequency is greater than the cut-off frequency of 10^{-6} events per year, therefore this hazard cannot be screened out based on frequency.

If the earthquake occurs during the on-site transfer of a RWC or SG from the Station to the PCSS, the RWC or SG will not topple over due to the forces from the DBE if the seismic design requirement for SG and RWC is similar to that for DSC, for which the required horizontal and vertical PGA is 0.12 g [44], higher than the postulated Pickering B DBE with the peak PGA of 0.05 g. If the seismic design requirement does not meet this criterion, toppling over is likely. In addition, the transporter could topple over during the earthquake event which could affect the RWCs or SGs being transferred. However, this is bounded by the RWC or SG drop event. Therefore, this event was screened out.

6.1.2.7 Tornado

A tornado is a rotating thunderstorm with a vortex of air extending downward from a thundercloud, which normally occurs in unstable atmospheric conditions when warm moist air comes into contact with cold air. The Design Basis Tornado (DBT) has not been addressed for PNGS [45], thus, the DBT defined for the Darlington nuclear site [46] as defined as follows, was considered in this work:

- Rotational wind speed of 322 km/h,
- Translational wind speed of 96 km/h,
- Pressure drop of 9.6 kPa,
- Rate of pressure drop of 5.6 kPa/s and
- Radius of maximum rotational wind speed of 46 m.

These parameters are considered to be large enough to envelope any credible tornadoes in southern Ontario [46]. Based on the PNGS site wind speed frequencies [47], the DBT-definition rotational wind speeds (322 km/h) correspond to a mean frequency of 3.13×10^{-6} events per year. Therefore, the frequency of a tornado occurring at a time when a RWC or SG is being transferred is:

$$(12+25)\,\frac{transfers}{year}\times\frac{1\ hour}{8760\ hours\ per\ year}\times(3.13\times10^{-6}\ events\ per\ year)$$
$$=1.32\times10^{-8}\ events\ per\ year$$

This value is significantly below the cut-off frequency of 10^{-6} per year, therefore this event was screened out.

6.1.2.8 Thunderstorms/Lightning

Thunderstorms can potentially involve lightning striking a SG or RWC on the transporter during on-site transfer. The effects of a lightning strike will increase the temperature of the affected SG or RWC and might result in an increased release of loose contamination from inside the packages; the packages will be cleaned of surface contamination prior to transport.

The impact of a lightning strike on the nuclear waste containers including RWC has been assessed [48]. In an unlikely event of a direct lightning strike to the RWCs during transfer, arcing will occur between the vehicle and the ground, dissipating the lightning energy. It was concluded that the shielding of the RWC will not be compromised and the containment will not be breached. The conclusion is also applied to SGs being transported.

However, the lightning may be hazardous for the driver or the electrical/electronic components of the vehicle. Even if operator incapacitation were to result in the transporter leaving the road, a release of radioactivity from a RWC or a SG is not expected given the design of the RWC or SG. For the worst-case scenario that the transporter toppled over, the dose consequences from this postulated scenario would be bounded by the RWC or SG drop event. Therefore, this event was screened out.

6.1.2.9 Flooding

The only possibility for flooding at the Pickering site would be as a result of extreme local meteorological events. However, procedures will be in place to require that RWCs or SGs not

be transferred during anticipated extremely adverse weather conditions. In addition, sufficient warning time should be available for site staff to prevent this scenario from occurring. For example, a station wide Public Address (PA) announcement will alert staff of heavy rain, electrical storm, or flooding advisory, at a 4-hour frequency until the severe weather advisory has ended [49].

If in an unlikely event, transport of a RWC or SG during an extreme rainfall were to occur, extensive flooding would likely affect the operation of the transporter. However, based on the study for the Darlington site which is applicable to Pickering site, the direct on-site rainfall (Probable Maximum Precipitation or PMP) would result in floodwater to a depth of approximately 20-30 cm [50], which would not be high enough to reach the platform of the transporter. Furthermore, there would be no detrimental effect on the RWCs as they are designed to have sealed containment envelope that prevent the ingress of water [51]. As such, the temporary flooding water would not enter the RWCs or SGs and result in any concern from the radiological safety perspective. Therefore, this event has been screened out.

6.1.2.10 Explosions along the Transfer Route

There are several potential sources of explosion along the transfer route of the RWCs or SGs from the station to PCSS. Therefore, the impact of an explosion along the transfer route must be assessed.

Explosion hazards along the onsite transfer route of the DSCs from the Phase I processing building to the Phase II storage building 4 have been assessed [52]. The following explosion hazard scenarios have been considered:

- Acetylene cylinder detonation
- Propane storage tank Boiling Liquid Expanding Vapour Explosion (BLEVE)
- Vapour cloud explosion (VCE) due to a propane storage tank rupture.

The combined explosion hazard frequency has been determined to be 5.2×10^{-8} per year, assuming about 1000 DSC shipments per year [52]. As shown in Figure 22, the RWC or SG transfer route from the Station to PCSS is partially overlapped with the transfer route of the DSCs which were assessed. Given the total RWC and SG shipment rate will be 37 per year, much less than that for DSCs, it is expected that the explosion hazard frequency will be lower than 5.2×10^{-8} per year, less than the cut-off frequency of 10^{-6}. Furthermore, based on the review of photos which were taken recently (see Appendix C, no additional explosion sources have been identified for the portion of the RWC/SG transfer route which has not been assessed before. Therefore, the explosion hazard was screened out based on frequency.

6.1.2.11 Turbine Missile Strike

The RWC or SG transporter travelling from the station to the PCSS could be potentially impacted by a low trajectory turbine missile originating from the accident unit. The frequency of low trajectory turbine missiles impacting nearby structures, systems and components (SSCs) was estimated to be 6×10^{-6} events per year [50].

It is estimated that RWCs and SGs will be transferred at the rate of 25 and 12 per year, respectively. Therefore, the frequency of turbine missiles impacting a SG or a loaded RWC when they are being transferred from PNGS to the PCSS is:

$$(12+25)\ \frac{transfers}{year} \times \frac{1\ hour}{8760\ hours\ per\ year} \times (6\ \times 10^{-6}\ events\ per\ year)$$
$$= 2.53\ \times 10^{-8}\ events\ per\ year$$

The value is below the cut-off frequency of 10^{-6} per year. Therefore, this hazard was screened out.

6.1.2.12 Aircraft Crash

The aircraft crash frequency calculated for the on-site transfer was 2.53×10^{-10} events per year. The detailed calculations are presented in Appendix B. This value is lower than the cut-off frequency of 10^{-6} events per year. Therefore, this was screened out.

6.1.2.13 Toxic Gas Release - Chlorine Originated from Ajax Water Treatment Plant

The Ajax Water Treatment Plant (WTP), which uses chlorine cylinders for water treatment, is located at approximately 4.0 km from the PCSS. The Screening Distance Value (SDV) for chlorine is 4.4 km [50]. A portion of the RWC and SG transfer route and the PCSS are within this distance. Therefore, this hazard cannot be screened out based on distance.

An airborne chlorine leak from the Ajax WTP could have an impact on the transporter operator ability to keep the transporter safely on the road. The consequences will be similar to the scenario described in Section 6.1.2.2. Therefore, this event was screened out.

6.1.3 Malfunctions/Accidents during Handling and Storage

6.1.3.1 SG Drop during Handling in PCSS

SGs transferred from PNGS will be received, inspected, and moved into the PCSS after surveying and hotspots identification. The SGs will be off-loaded from the SPMT using a hydraulic jacking system or gantry crane system, lowered onto a sliding system and moved to their individual storage location. The total duration of these activities is assumed to be 22 hours per SG taking into account some contingency [36].

The jack and slide system is a simple and safe means for the vertical movement of very heavy loads and an accidental SG drop is not expected during this process. However, a load instability and the drop of the SG from a low height may result when being placed in its final location in the PCSS in the following unlikely events:

- the jacking band or support beams failure;
- hydraulic or mechanical failure of one or more jacks under load, or;
- due to unstable jacks, not positioned on a level surface.

An SG drop assessment has been carried out [53] and it was concluded that a short drop may cause some damage resulting in potential for radiological release, although the steam generator is a robust package with openings covered with thick plates welded in place. Therefore, this event is screened in for further assessment.

6.1.3.2 RWC Drop during Handling in PCSS

The RWCs might be handled in the PCSS using a heavy forklift. The RWC-PTs,

RWC-CTIs and the RWC-EFs may be stacked three high. The event of a RWC drop could occur during handling due to forklift hydraulic system failure and Forklift fork structural failure. The worst scenario could be the drop of an RWC from a 4-meter height onto a reinforced concrete surface.

For RWC-EF, the analysis has shown that some drop orientations resulted in larger gaps and longer gap time during impact [54]. However, it was concluded that these gaps are not sufficiently big to provide a line of sight to the RWC contents or to release any bulk contents. Only a minor amount of fines or dust could be released during such an event.

For RWC-PT/CT/CTI, the analysis has shown that the bolts did not fail due to excessive plastic strain, and gaps between the RWC main body and the shielding panels existed only briefly during the impact and they were very small [55]. It was concluded that the lid and shielding panels of the RWC remain sufficiently attached to the main body, preventing spilling of any bulk contents. Only minor amounts of swarf, fines, or dust will be released as a result of the drop.

The frequency of RWC drop was calculated as 1.6×10^{-5} events/year (6.33×10^{-7} failures/hour x 25 hours/year), taking into account the following information:

- Duration of placing one RWC to its storage location is conservatively assessed at 1 hour;
- Forklift hydraulic system failure is 5.83×10^{-7} per hour and Forklift fork structural failure is 5×10^{-8} per hour, for a total of 6.33×10^{-7} failures per hour [56]
- 25 RWCs will be moved to PCSS in a year.

If rearrangement of RWCs in PCSS is required, the frequency of the event is higher. Given this value is greater than the 10^{-6} cut-off frequency, this event is screened in for further assessment.

A handling accident involving dropping an RWC onto another RWC is also credible if the operator fails to keep the load in balance and the container tilts and drops back onto the RWC below. However, due to the low lift height relative to the lower level RWC, the hazard of dropping an RWC onto another RWC is bounded by drop of an RWC from 4 meters onto the concrete floor. Therefore, this event is screened out.

6.1.3.3 Collision with RWC or Other structures in the PCSS

RWC handling accident due to operator error using the forklift could result in a lifted RWC colliding with another RWC or other structure. However, the consequence of this scenario is bounded by that of the RWC drop since the impact of an RWC drop is expected to be higher compared to the scenario when the forklift collides with another structure within the PCSS. Therefore, this event is screened out.

6.1.3.4 Seal Failure during Storage

The lid/seal of the SG or RWC must fail for a radiological release to occur. However, all SG penetrations and openings will be welded with thick steel plates. Also, the RWC assembly has been designed to maintain its structural, containment, and shielding integrity with no significant degradation for a long design life. Therefore, it is highly unlikely that there would be any sealing failure leading to radiological consequences during their storage at PCSS.

In the unlikely event that the lid/seal of a SG or RWC fails, only gaseous components evolved from the solid crud/deposit materials in the SG or RWC, if any, would be released to the

environment. This postulated release would occur over a long period of time, which would allow for dispersion. Therefore, the worker and public dose would be bounded by the acute release due to the SG or RWC drop accident. As such, this event was screened out.

6.1.3.5 PCSS Fire

A fire hazard assessment has been conducted for similar facilities where RWCs and SGs are stored [37].

For Retube Component Storage Building (RCSB), large diesel-powered forklift trucks periodically located in the unloading area of the building present a credible ignition source. A pool fire resulting from leakage of the forklift truck fuel tank and subsequent hydraulic oil spill was determined to be the bounding fire hazard in the building. However, the evaluations concluded that the fire originating from a heavy-duty forklift truck will not affect the building.

Furthermore, the RWCs were constructed of non-combustible materials and the waste stored inside them is mostly noncombustible. Given the large thermal inertia of RWCs, any fires in the RCSB would take a long time, allowing time for manual suppression, before any overheating could be expected that may result in a release. Therefore, the fire hazard is screened out.

Similarly, the SGSB houses non-combustible waste which will not sustain a fire. The building is considered a low fire hazard as it does not contain any significant quantity of combustible content. The bounding fire hazard will be a pool fire resulting from a transport vehicle diesel fuel leakage/spill.

The fire evaluation concluded that the roof steel structure of SGSB will be impacted by the high temperatures; however, manual activation of the suppression system and the intervention of the Emergency Response Team will prevent the building from collapsing. Furthermore, the outer surface of the SGs has been de-contaminated prior to storage and all source term is located within the SGs. All SG penetrations and openings are welded with thick steel plates to ensure all internal source term is contained. Therefore, the evaluation concluded that even without any suppression or response from the Emergency Response Team, the generator casings would not fail, and the source term remains contained. As such, the fire accident was screened out.

The PCSS will be built similar to RCSB and SGSB discussed above and house a minimal amount of combustible material. The items stored within PCSS, SG packages and RWCs, are large, sealed concrete and steel containers with large thermal inertia. Therefore, it is expected that the conclusions of the FHA for the similar storage facilities apply to PCSS, which can be further confirmed by the FHA for the PCSS when it is available. As such, the fire accident was screened out.

6.1.3.6 Earthquake

For the purposes of the safety assessment, it was conservatively assumed that for the postulated earthquake scenario, the PCSS at its capacity in terms of waste storage could suffer extensive damage and collapse. All RWCs and SGs stored within the PCSS were affected and were considered material at risk. Airborne releases could occur following the breach of RWCs or SGs. Therefore, this event was screened in.

6.1.3.7 Tornado

Similar to the earthquake event, it is conservatively assumed for the purpose of safety assessment that the PCSS is not expected to withstand the forces from a DBT and the collapse of the PCSS may lead to the toppling of the stacked RWCs. The damage to the packages will be similar to the events described in Section 6.1.3.6. Therefore, this event was screened in.

6.1.3.8 Thunderstorms/Lightning

Thunderstorms can potentially involve lightning striking the PCSS. However, the PCSS will be designed to be equipped with appropriate grounding provisions. As such, its structural integrity, appropriate shielding and containment function will be maintained for severe atmospheric conditions, such as lightning. Therefore, this event was screened out.

6.1.3.9 Flooding

Water entry into the PWMF storage buildings originating from a PMP event is possible. However, the outer surface of SGs or RWCs have been decontaminated prior to the storage. In addition, the SG and RWC are sealed tight enough to prevent water from entering even if the water level was high enough to partially submerge a portion of the SG or RWC. For these reasons, PMP flooding does not represent radiological safety concern. Therefore, this event was screened out.

6.1.3.10 Turbine Missile Strike

According to Reference [50], the most significant missile is a large fragment of Disc 3 from a low-pressure turbine. However, the PCSS is located approximately 600 m northeast of Unit 8. The building is separated not only by the distance from the Unit 8 turbine, but also is shielded by various buildings located between the two facilities. Therefore, this hazard was screened out.

6.1.3.11 Explosion

As discussed in Section 6.1.2.10,explosion hazard exists along the RWC and SG transfer route. Based on the assessment [57], the peak side-on overpressure at the distance of 100 m from the sources of the explosion is no more than 7 kPa. As the PCSS is located at least 200 m away from these explosion sources and there are other facilities between the PCSS and these sources, the impact of the explosion on the PCSS can be screened out given the estimated overpressure level at the PCSS will be less than 6.9 kPa, the criterion specified by the US NRC [58]. Furthermore, the maximum thermal radiation due to propane fireball is expected to be less than 18 kW/m^2, less than the potential impact criteria of 35 kW/m^2.

6.1.3.12 Aircraft Crash

The cumulative aircraft crash frequency calculated for the Used Fuel Dry Storage Area (Phase I and Phase II), RCS Area and PCSS for RWCs is 9.78×10^{-7} events per year. For PCSS for SGs, the crash frequency is 8.64×10^{-8} events per year. The detailed calculations are presented in Appendix B. These values are lower than the cut-off frequency of 10^{-6} events per year. Therefore, this was screened out.

6.1.4 Summary of Malfunctions/Accidents Associated with Construction, Transfer, Handling and Storage

Based on the screening performed in Section 6.1.1 to 6.1.3, the following events were screened in for further assessment:

- Vehicle accident during the on-site transfer from PNGS to the PCSS (Section 6.1.2.1)
- Failure of handling equipment when the package being handled in the PCSS (Section 6.1.3.1 and 6.1.3.2)
- Earthquake resulting in PCSS collapse (Section 6.1.3.6)

Both vehicle accident during the on-site transfer and the failure of handling equipment when the package being handled in the PCSS could result in the drop of a SG or a RWC to the ground which was considered a DBA based on its frequency discussed in the previous sections. The earthquake event could result in the collapse of the PCSS which affects all RWCs and SGs stored in the PCSS. During these events, the SGs or RWCs could be partially damaged, resulting in a small amount of radioactive materials being released from the damaged SGs or RWCs to the environment. The workers in the nearby area and the public in the vicinity of the PNGS site could be affected. The detailed assessments of these events and the consequences are carried out and the results are documented in the following sections.

6.2 Radiological Releases

6.2.1 Radiological Releases due to SG Drop

The specific activities of Co-60 in SGs from Pickering B, based on gamma spectroscopy results, are presented in Table 23 [59]. Taking into account the total area of SG tubes of 1.83E+07 cm^2 [60], the highest Co-60 activity per SG in Pickering B is [redacted][3]. Compared with the data from other sources as listed in Table 24, the highest Co-60 activity per SG is [redacted][4]. Therefore, the radionuclide inventory per SG presented in Table 4-9 of [23] represents the bounding inventory of an SG. This is a conservative approach since the reduction of radionuclide inventory due to decay was not credited and the highest Co-60 activity per SG was used as the scaling factor. This inventory data as listed in Table 25 was then used in the dose assessment.

Prescribed information under the General Nuclear Safety and Control Regulations

Table 23: Specific Activity of Co-60 in Pickering B SGs [59]

[redacted]

Prescribed information under the General Nuclear Safety and Control Regulations

Table 24: Co-60 Inventory in Steam Generator [based on Table A-17 of [23]

[redacted]

Prescribed information under the General Nuclear Safety and Control Regulations

Table 25: Bounding radionuclide Activity in Steam Generator (Table 4-9 of [23])

[redacted]

Prescribed information under the General Nuclear Safety and Control Regulations

Steam generators are reasonably robust containers and will survive a short drop with only some damage. Using the guideline given in the IAEA Safety Guide TS-G.1.1 for similar packages, the fraction of steam generator deposit that will be released from the container is assigned to be 1E-02 [36]. The $ARF * RF$ from this event was assumed to be 1.0E-04 which is the same as the value assigned to the suspension of powder due to debris impact. Therefore, a total release fraction of 1E-06 of the steam generator inventory, as summarized in Table 26, is applied to the SG drop scenario. Note the release fraction of 1E-06 applies to all radionuclides considered with the exception of C-14 and tritium. For C-14, it is assumed that all C-14 has been converted to carbon dioxide and is completely released. For tritium, the airborne release fraction is set to 2.7%, consistent with the SG drop scenario in the WWMF safety assessment report [36] [61].

Table 26: Parameters used to Calculate Activity Release from SG

Parameter	Values	Note
Fraction to calculate MAR	1.0E-02	See discussion above
DR	1	Assumed value, conservative
ARF*RF	1.0E-04	See discussion above
LPF	1	Assumed value, conservative

Parameter	Values	Note
Total Release Fraction	• C-14: 1 • Tritium (HTO): 2.7E-02 • Other radionuclides: 1.0E-06	See discussion above

Accordingly, the radionuclide releases following a SG drop scenario were calculated and the results are listed in Table 27. In the dose assessment as discussed in Section 6.2.3, it was assumed that the duration of the release is one hour.

Table 27: Activity Released from SG due to SG Drop

[redacted]

Prescribed information under the General Nuclear Safety and Control Regulations

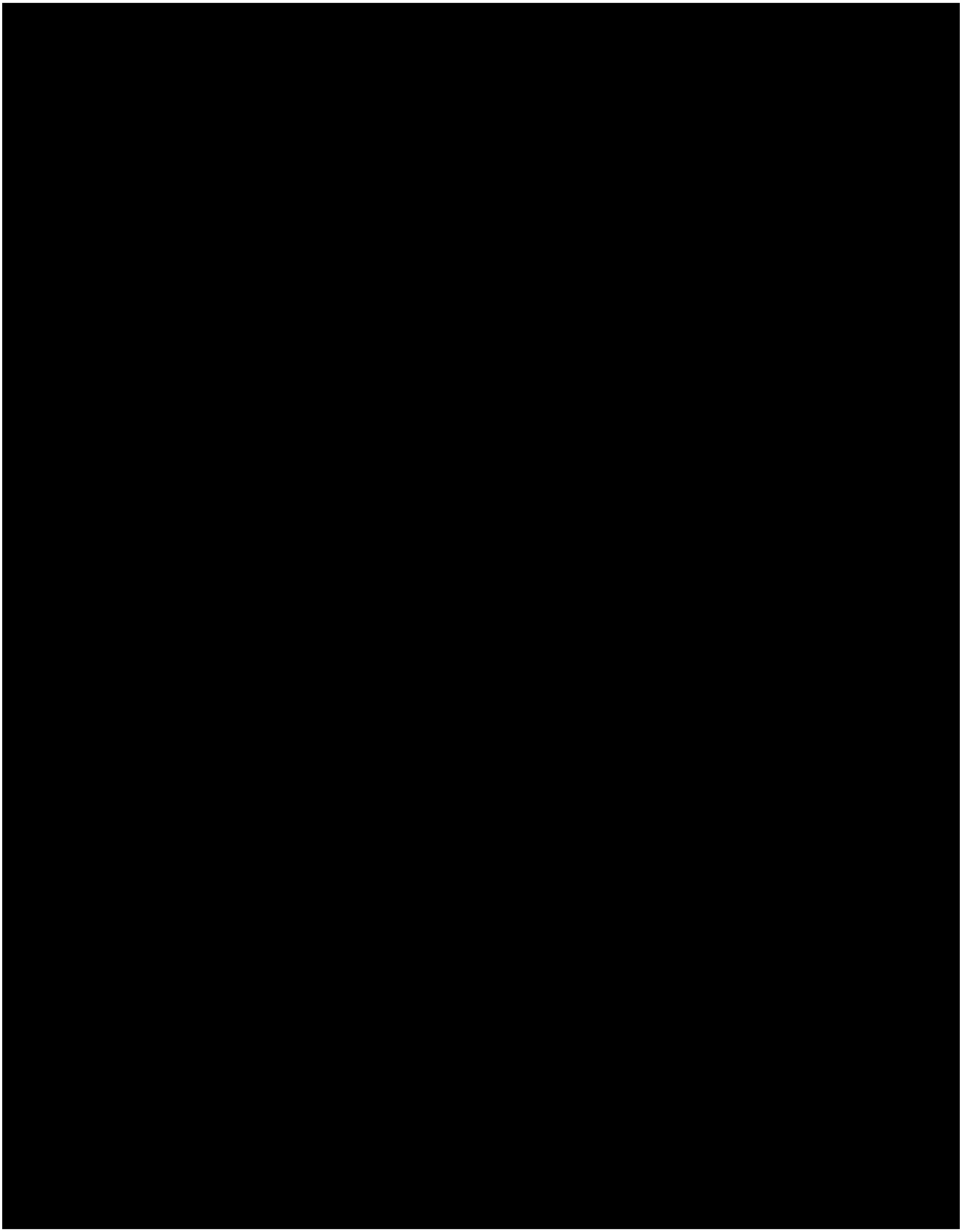
6.2.2 Radiological Releases due to RWC Drop

For the safety assessment, the radionuclide activities given in Table 5-9 of Reference [23] were selected as the limiting inventory for a RWC[5]. This is a conservative approach since the reduction of radionuclide inventory due to decay is not credited. The radionuclide inventory of the RWC is listed in Table 28. In the dose assessment as discussed in Section 6.3.2, it is assumed that the release duration is one hour.

Table 28: Bounding Radionuclide Activity in RWC

Prescribed information under the General Nuclear Safety and Control Regulations

[5] Pickering specific RWC inventory is not available. Therefore, Table 5-9 of Reference [22], which was derived based on the historical data from different CANDU reactors as discussed in Reference [22], represented the bounding RWC inventory and was used in this work.



Retube wastes consist of cuttings of fuel channel components (PTs, CTs), CTIs and EFs. The potential source of airborne releases would come from the metal dust from the cuttings. An experimental study of fine particle (< 850 μm) distribution during volume reduction of PTs indicates that the less than 0.01% of the volume-reduced PTs became fine particles [62]. For conservatism, 0.02% of the base metal and 100% of the oxide deposits in RWCs were assumed to be in the form of fine particles which have the potential to be released to air.

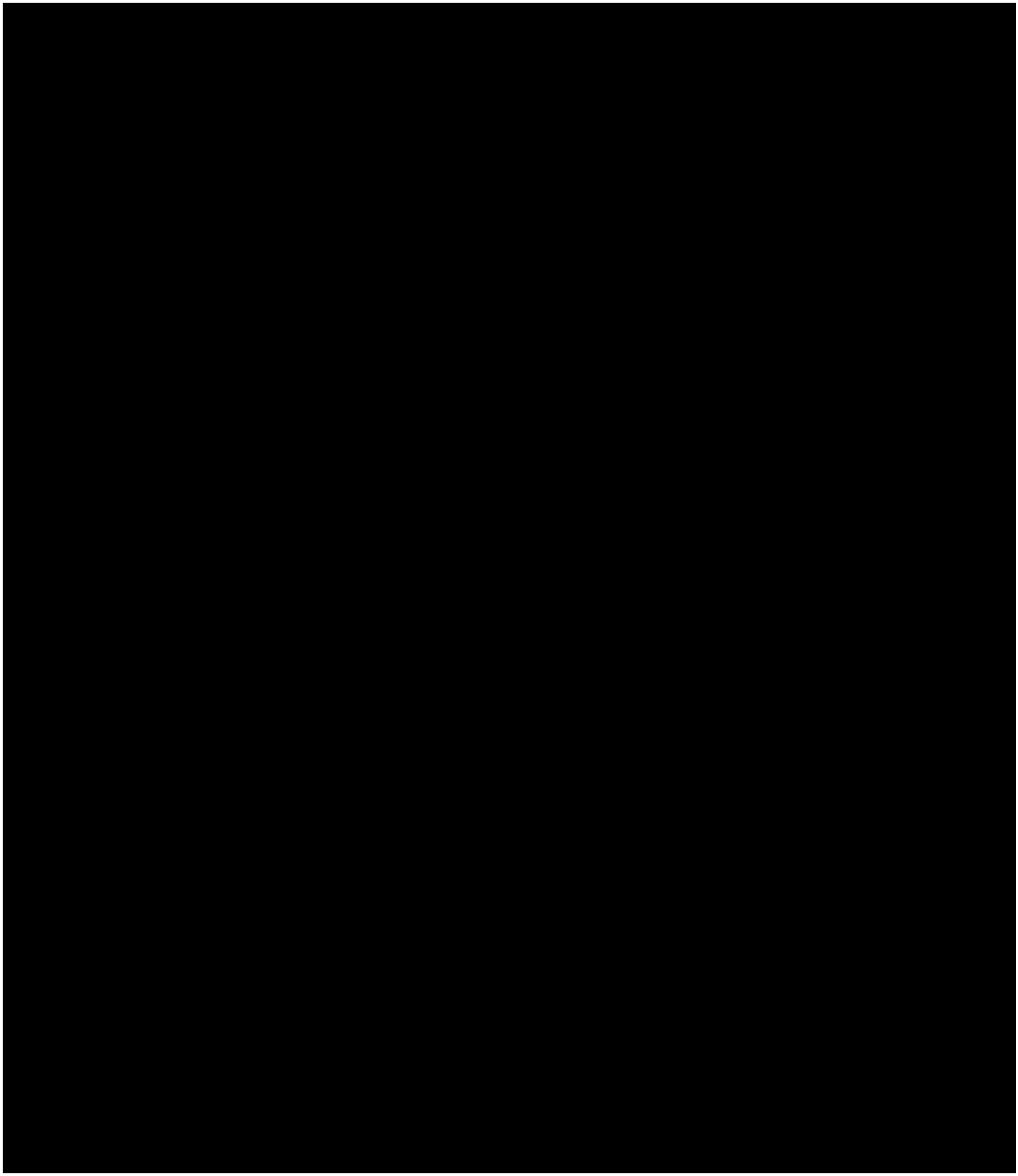
The RWCs are assumed to be reasonably robust containers and will survive a short drop with only some damage. Using the guideline given in the IAEA Safety Guide TS-G.1.1 for similar packages, the fraction of RWC content that will be released from the container is assigned to be 1E-02. The bounding value of 1E-04 for suspension of powder due to debris impact was applied. Therefore, a total release fraction of up to 1E-06 of the RWC fine particles or surface deposit inventory is applied for RWC drop scenario. These parameters are summarized in Table 29. Similar to the SG drop event, the release fraction of 1E-06 applies to all radionuclides considered with the exception of C-14 and tritium. For C-14, all C-14 is assumed to have been converted to carbon dioxide and all of it is released. For tritium, the airborne release fraction is set to 5.4E-06 for base metal and 2.7% for oxide deposit [36] [61] .

Table 29: Parameters used to Calculate Activity Release from RWC

Parameter	Values	Note
Fraction to calculate MAR	Base metal: 2.0E-06	See discussion above.
	Oxide deposit: 1.0E-02	
DR	1	Assumed value, conservative
ARF*RF	1.0E-04	See discussion above
LPF	1	Assumed value, conservative
Total Release Fraction	Base metal: • C-14: 1 • Tritium (HTO): 5.4E-06 • Other radionuclides: 2.0E-10	See discussion above
	Oxide deposit: • C-14: 1 • Tritium (HTO): 2.7E-02 • Other radionuclides: 1.0E-06	

Accordingly, the radionuclide releases following a RWC drop scenario were calculated based on the equation in Section 3.2.2 and the results are listed in Table 30.

Table 30: Radiological Releases from the RWC due to RWC Drop



[redacted]

6.2.3 Radiological Releases due to Earthquake

As discussed in Section, 6.1.3, for the earthquake event, the PCSS was assumed to collapse. All RWCs and SGs stored in the PCSS were assumed to be affected, resulting in airborne releases. For the purposes of the dose assessment, it was assumed that the following amounts of RWCs and SGs were stored in the PCSS when the earthquake event occurred:

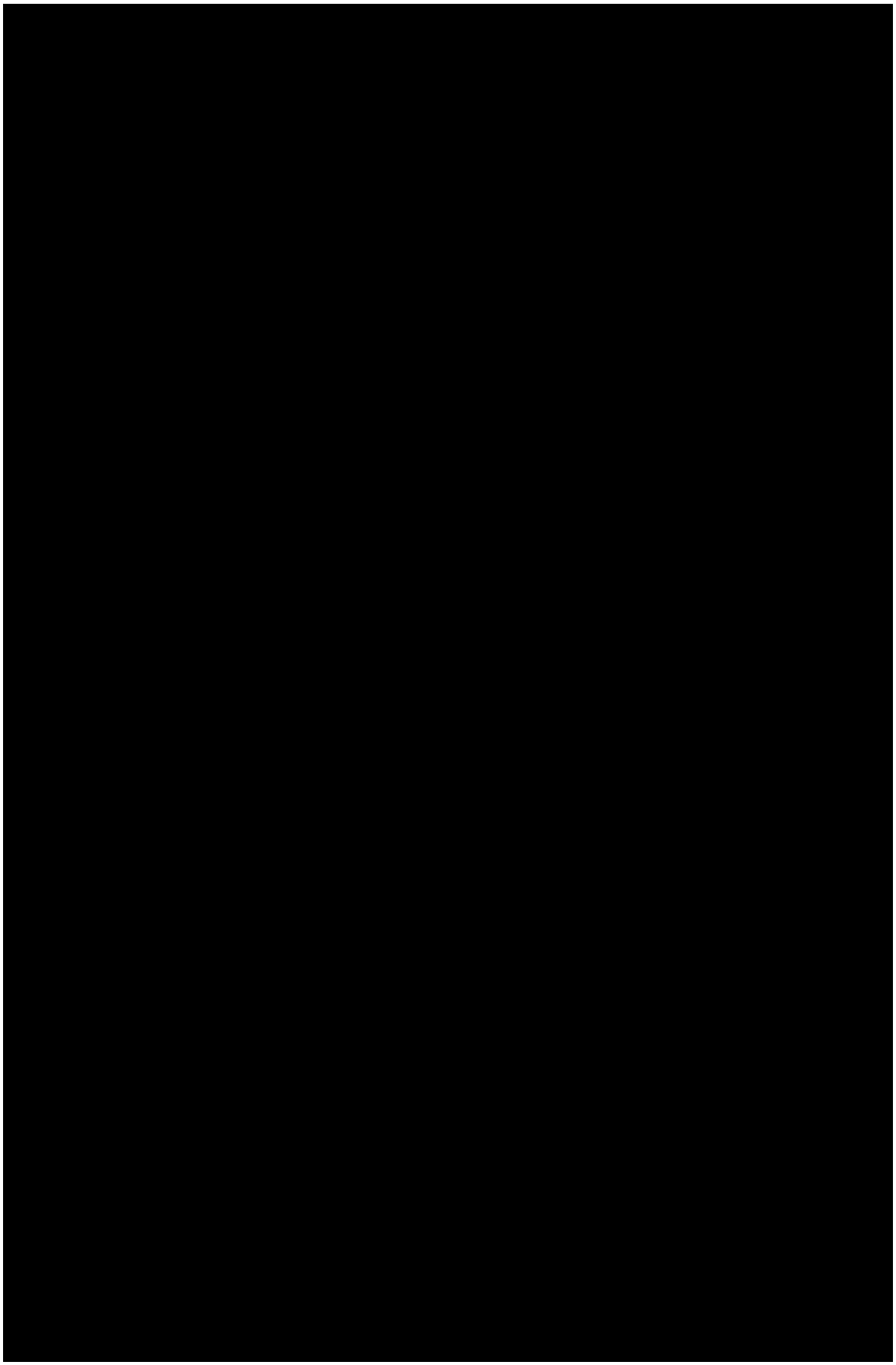
- SG: 48
- RWC-PT: 32
- RWC-CT: 28
- RWC-CTI:16
- RWC-EF: 64

The airborne emissions were estimated based on the same approach used for RWC/SG drop event. The results are summarized in Table 31.

Table 31: Radiological Releases from PCSS resulting from Earthquake Event

[redacted]

Prescribed information under the General Nuclear Safety and Control Regulations



6.3 Doses to Public and Workers from the Postulated Malfunctions/Accidents

6.3.1 Doses to Public from the Postulated Malfunctions/Accidents

Radioactivity release resulting from the drop of a SG or a RWC was analyzed in Sections 6.2.1 and 6.2.2. On this basis, doses to the public resulting from these events were calculated following the methodology specified in Section 3.2.3. The inputs for dose calculation including assumptions are consistent with those summarized in Appendix B of the previous work [3][6]. The results are presented in Table 32 to Table 36. From the tables, the highest dose to public resulting from SG or RWC drop event is 1.6 μSv due to the drop of a RWC-PT, which is less than the acceptance criterion of 1 mSv. The critical group is an adult from the hypothetical group located at landside (east) of Pickering nuclear site exclusion boundary.

Radioactivity release resulting from the earthquake event was analyzed in Section 6.2.3. The dose consequence is presented in Table 37. The highest dose to public is 80 μSv, also less than the acceptance criterion of 1 mSv. The critical group is the same as that for the RWC drop event.

The doses were generally converged with the exception of a few locations such as B_N, B_WSW-Lake and B_NNW. These locations were not converged even with a high bin number (5000) for approximating cumulative frequency distribution. Increasing the number of bins is expected to lower the non-converged doses so the reported doses are conservative.

Table 32: Doses to Public due to SG Drop

	95th Individual Effective Dose (μSv)*	
Receptors	**Adult**	**Infant**
B_N	5.1E-05	7.5E-05
B_NNE	4.2E-02	3.1E-02
B_NE	1.4E-01	1.1E-01
B_ENE	2.2E-01	1.6E-01
B_E	3.2E-01	2.4E-01
B_ESE-Lake	9.9E-02	7.2E-02
B_SE-Lake	6.6E-02	4.9E-02
B_SSE-Lake	3.6E-02	2.7E-02
B_S-Lake	4.6E-02	3.7E-02
B_SSW-Lake	3.5E-02	2.9E-02
B_SW-Lake	1.7E-02	1.3E-02
B_WSW-Lake	6.4E-05	7.0E-05

[6] The only exception is the meteorological data used for ADDAM analysis. As discussed in Section 3.2.3, the five-year data for the period of 2017 to 2021 was used.

Receptors	95th Individual Effective Dose (μSv)*	
	Adult	Infant
B_W-Lake	1.1E-02	8.5E-03
B_WNW	1.3E-02	9.4E-03
B_NW	5.7E-05	3.5E-05
B_NNW	5.8E-05	5.2E-05
IND	4.6E-02	3.4E-02
Fisher	4.5E-02	3.6E-02
Beach	2.2E-02	1.6E-02
UR_WNW	1.0E-02	7.6E-03
UR_NW	4.2E-05	2.7E-05
UR_NNW	3.3E-05	2.1E-05
C2	7.9E-03	5.8E-03
Dairy Farm, NNE	1.1E-03	8.5E-04
Farm, NE	2.7E-03	2.0E-03

Table 33: Doses to Public due to RWC-PT Drop

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_N	1.6E-03	1.6E-03
B_NNE	2.1E-01	2.2E-01
B_NE	7.3E-01	7.4E-01
B_ENE	1.1E+00	1.1E+00
B_E	1.6E+00	1.6E+00
B_ESE-Lake	5.0E-01	5.0E-01
B_SE-Lake	3.6E-01	3.6E-01
B_SSE-Lake	2.1E-01	2.1E-01
B_S-Lake	3.8E-01	3.9E-01
B_SSW-Lake	3.3E-01	3.4E-01
B_SW-Lake	1.0E-01	1.0E-01
B_WSW-Lake	1.5E-03	1.6E-03
B_W-Lake	5.3E-02	5.5E-02
B_WNW	6.1E-02	6.2E-02
B_NW	6.7E-04	7.0E-04
B_NNW	1.1E-03	1.2E-03
IND	2.3E-01	2.4E-01
Fisher	3.7E-01	3.8E-01
Beach	1.0E-01	1.0E-01
UR_WNW	4.8E-02	4.9E-02
UR_NW	5.1E-04	5.3E-04

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
UR_NNW	6.8E-04	7.0E-04
C2	4.0E-02	4.1E-02
Dairy Farm, NNE	6.3E-03	6.3E-03
Farm, NE	1.6E-02	1.6E-02

Table 34: Doses to Public due to RWC-CT Drop

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
B_N	4.6E-04	4.6E-04
B_NNE	6.2E-02	6.3E-02
B_NE	2.1E-01	2.1E-01
B_ENE	3.1E-01	3.2E-01
B_E	4.6E-01	4.5E-01
B_ESE-Lake	1.4E-01	1.4E-01
B_SE-Lake	1.0E-01	1.0E-01
B_SSE-Lake	6.1E-02	6.1E-02
B_S-Lake	1.1E-01	1.1E-01
B_SSW-Lake	1.0E-01	1.0E-01
B_SW-Lake	2.9E-02	2.9E-02
B_WSW-Lake	4.72E-04	4.83E-04
B_W-Lake	1.5E-02	1.6E-02
B_WNW	1.7E-02	1.8E-02
B_NW	3.7E-04	3.7E-04
B_NNW	1.9E-04	1.9E-04
IND	6.7E-02	6.8E-02
Fisher	1.1E-01	1.1E-01
Beach	2.9E-02	2.9E-02
UR_WNW	1.4E-02	1.4E-02
UR_NW	2.8E-04	2.8E-04
UR_NNW	1.2E-04	1.1E-04
C2	1.2E-02	1.2E-02
Dairy Farm, NNE	1.8E-03	1.8E-03
Farm, NE	4.7E-03	4.7E-03

Table 35: Doses to Public due to RWC-CTI Drop

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
B_N	1.1E-05	1.1E-05
B_NNE	1.6E-03	1.6E-03
B_NE	5.3E-03	5.4E-03
B_ENE	7.9E-03	8.0E-03
B_E	1.14E-02	1.14E-02
B_ESE-Lake	3.6E-03	3.6E-03
B_SE-Lake	2.6E-03	2.6E-03
B_SSE-Lake	1.5E-03	1.5E-03
B_S-Lake	2.8E-03	2.8E-03
B_SSW-Lake	2.5E-03	2.5E-03
B_SW-Lake	7.3E-04	7.3E-04
B_WSW-Lake	1.16E-05	1.19E-05
B_W-Lake	3.8E-04	4.0E-04
B_WNW	4.3E-04	4.5E-04
B_NW	5.1E-06	5.1E-06
B_NNW	8.6E-06	8.6E-06
IND	1.7E-03	1.7E-03
Fisher	2.8E-03	2.8E-03
Beach	7.2E-04	7.3E-04
UR_WNW	3.5E-04	3.5E-04
UR_NW	7.5E-06	3.9E-06
UR_NNW	5.2E-06	5.4E-06
C2	2.9E-04	2.9E-04
Dairy Farm, NNE	4.6E-05	4.6E-05
Farm, NE	1.2E-04	1.2E-04

Table 36: Doses to Public due to RWC-EF Drop

Receptors	95th Individual Effective Dose (µSv)	
	Adult	Infant
B_N	1.7E-06	2.2E-06
B_NNE	6.6E-04	8.4E-04
B_NE	2.3E-03	2.9E-03
B_ENE	3.5E-03	4.4E-03
B_E	5.0E-03	6.2E-03
B_ESE-Lake	1.6E-03	2.0E-03
B_SE-Lake	1.1E-03	1.3E-03
B_SSE-Lake	6.0E-04	7.5E-04

Receptors	95th Individual Effective Dose (μSv)	
	Adult	Infant
B_S-Lake	8.4E-04	1.0E-03
B_SSW-Lake	6.8E-04	8.0E-04
B_SW-Lake	2.9E-04	3.6E-04
B_WSW-Lake	1.61E-06	2.03E-06
B_W-Lake	1.9E-04	2.4E-04
B_WNW	2.1E-04	2.6E-04
B_NW	8.6E-07	1.3E-06
B_NNW	8.3E-07	1.2E-06
IND	7.3E-04	9.0E-04
Fisher	8.2E-04	9.9E-04
Beach	3.5E-04	4.4E-04
UR_WNW	1.7E-04	2.1E-04
UR_NW	6.6E-07	9.7E-07
UR_NNW	5.1E-07	7.4E-07
C2	1.3E-04	1.7E-04
Dairy Farm, NNE	1.9E-05	2.4E-05
Farm, NE	4.6E-05	5.8E-05

Table 37: Doses to Public due to Earthquake Event

Receptors	95 Percentile Dose (μSv)	
	Adult	Infant
B_N	7.7E-02	7.3E-02
B_NNE	1.1E+01	1.0E+01
B_NE	3.6E+01	3.5E+01
B_ENE	5.5E+01	5.2E+01
B_E	8.0E+01	7.6E+01
B_ESE-Lake	2.5E+01	2.4E+01
B_SE-Lake	1.8E+01	1.7E+01
B_SSE-Lake	1.0E+01	9.8E+00
B_S-Lake	1.8E+01	1.8E+01
B_SSW-Lake	1.6E+01	1.5E+01
B_SW-Lake	5.0E+00	4.8E+00
B_WSW-Lake	7.5E-02	7.3E-02
B_W-Lake	2.7E+00	2.6E+00
B_WNW	3.1E+00	3.0E+00
B_NW	3.7E-02	4.1E-02
B_NNW	2.7E-02	2.8E-02
IND	1.2E+01	1.1E+01
Fisher	1.8E+01	1.7E+01

Receptors	95 Percentile Dose (μSv)	
	Adult	Infant
Beach	5.1E+00	4.9E+00
UR_WNW	2.4E+00	2.3E+00
UR_NW	2.8E-02	3.4E-02
UR_NNW	1.6E-02	1.7E-02
C2	2.0E+00	1.9E+00
Dairy Farm, NNE	3.1E-01	3.0E-01
Farm, NE	7.8E-01	7.5E-01

6.3.2 Doses to Workers from Postulated Malfunctions/Accidents

Radioactivity release resulting from the drop of a SG or a RWC was analyzed in Section 6.2. on this basis doses to worker resulting from these events were calculated following the methodology specified in Section 3.2.4. The inputs for dose calculation including assumptions are consistent with those summarized in Appendix B of the previous work [3]. The results are presented in Table 38. From the table, the highest dose to individual worker is 5.0 mSv due to the drop of a RWC-PT, which is less than the acceptance criterion of 50 mSv.

Table 38: Doses to Workers due to the Drop of SG or RWC

Event	Doses to Workers (mSv)
Drop of SG	1.0
Drop of RWC-PT	5.0
Drop of RWC-CT	1.5
Drop of RWC-CTI	0.04
Drop of RWC-EF	0.007

For the earthquake event, the PCSS was assumed to collapse. All RWCs and SGs stored in the PCSS were assumed to be damaged, resulting in airborne releases. Assuming the PWMF workers are able to evacuate, the dose consequence to the worker would be similar to the dose calculated for members of the public.

6.3.3 Summary of Dose Assessment for the Malfunctions and Accidents

The dose consequences resulting from the postulated malfunctions and accidents during on-site transfer, handling and storage of the RWCs and SGs in the PCSS are summarized in Table 39 and Table 40, respectively. As discussed in Sections 6.3.1 and 6.3.2, the doses to public and workers are all less than the dose acceptance criteria.

Note that no radioactive materials are involved during site preparation and construction of the PCSS. Therefore, there are no dose consequences resulting from the postulated malfunctions and accidents during that stage. As such, they are not presented in this section.

Table 39: Postulated Malfunction or Accidents during On-site Transfer of RWCs and SGs

Malfunction or Accident	Potential for occurrence (event /year)	Credible event (Y/N) -See Note 1	Classification (see Note 3)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
RWC/SG drop during on-site vehicle accident	See Note 2	Y	See Note 2	1.6E-03	5.0
Vehicle operator health-related emergency	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Fire	See Note 2	Y	See Note 2	0	0
Adverse road/weather conditions	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Soil Failures/Slope Instability	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Earthquake	4.22 E-06	Y	DEC	<1.6E-03	<5.0
Tornado	1.32E-08	N	---	---	---
Thunderstorms /lightning	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Flooding	See Note 2	Y	See Note 2	0	0
Explosions along the transfer route	<5.2E-08	N	---	---	---
Turbine Missile Strike	2.53E-08	N	---	---	---
Aircraft crash	2.53E-10	N	---	---	---
Toxic Gas Release	See Note 2	Y	See Note 2	<1.6E-03	<5.0

Notes:

1. The term credible is used for those events with the frequency of occurrence higher than 1E-06 events per year.
2. The hazard frequency was not calculated for this scenario. The event is considered credible based on its nature or if it is bounded by a credible event. The classification of DEC was assigned to such event for conservatism.
3. As per REGDOC 2.4.4 [19], the following classification was considered for applicability:
   - AOO: an event with a likelihood of occurrence greater than 10^{-2} per year
   - DBA: an event with a likelihood of occurrence less than 10^{-2} per year and greater than 10^{-5} per year
   - DEC: an event with a likelihood of occurrence less than 10^{-5} per year and greater than 10^{-6} per year

Table 40: Postulated Malfunction or Accidents during Handling and Storage in PCSS

Malfunction or Accident	Potential for occurrence (event/year)	Credible event (Y/N)	Classification (see Note 5)	Potential maximum dose to public (mSv)	Potential maximum occupational dose (mSv)
RWC/SG drop during handling in PCSS	>1.6E-05	Y	DBA	1.6E-03	5.0
Collision with RWC or other structures in the PCSS	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Seal failure during storage	See Note 2	Y	See Note 2	<1.6E-03	<5.0
Fire	See Note 2	Y	See Note 2	0	0
Earthquake	See Note 2	Y	See Note 2	8.0E-02	8.0E-02[4]
Tornado	See Note 2	Y	See Note 2	<8.0E-02	<8.0E-02[4]
Thunderstorms/lightning	See Note 2	Y	See Note 2	0	0
Flooding	See Note 2	Y	See Note 2	0	0
Turbine missile strike	See Note 2	Y	See Note 2	0	0
Explosion	See Note 2	Y	See Note 2	0	0
Aircraft crash	9.87E-07 (See Note 3)	N	---	---	---

Notes:
1. The term credible is used for those events with the frequency of occurrence higher than 1E-06 events per year.
2. The hazard frequency was not calculated for this scenario. The event is considered credible based on its nature or if it is bounded by a credible event. The classification of DEC was assigned to such event for conservatism.
3. The calculated cumulative frequency of occurrence considers the Phase I, Phase II sites (SB3, SB4, SB5 and the portion of PCSS for RWCs) and DSM storage area together.
4. For worker dose during the earthquake, refer to the discussion in Section 6.3.2.
5. As per REGDOC 2.4.4 [19], the following classification was considered for applicability:
   - AOO: an event with a likelihood of occurrence greater than 10^{-2} per year
   - DBA: an event with a likelihood of occurrence less than 10^{-2} per year and greater than 10^{-5} per year
   - DEC: an event with a likelihood of occurrence less than 10^{-5} per year and greater than 10^{-6} per year

7.0 ALARA Assessment

The estimated collective doses and maximum individual doses from handling and emplacing of one SG, one RWC-PT/CT/CTI and one RWC-EF exclusive of surrounding waste packages corresponding to maximum package external dose rates at 1 m of 10 mrem/hr appear in Table 41.

There are 60 RWC-PT/CTs, 16 RWC-CTIs, 64-RWC-EFs and 48 SGs. The overall collective doses are 16.5, 3.7, 17.7, and 182.6 person-mSv, respectively, for a total collective dose of 221 person-mSv.

The ALARA assessment considers solely the emplacement activities. The results indicate that both the OPG ECL for a NEW of 1,000 mrem/yr (10 mSv/yr) as well as the regulatory limit for a NEW of 5,000 mrem/yr (50 mSv/yr) require that emplacement of RWCs and SGs in the PCSS would require that the task be divided among several workers. In particular, different work crews should be used for each of the following tasks:

(i) Reception and Emplacement of the RWCs in the PCSS.

(ii) Reception and Emplacement of the SGs on saddles in the PCSS;

A relatively simple method for reducing doses for emplacement activities would be the use of temporary shielding. Shielding blankets could be placed over the waste packages during transfer activities. Temporary shielding walls could also be erected within the PCSS to reduce doses from waste already emplaced whilst new waste is being brought in.

It would prove prudent to investigate whether further efficiencies in work activities could result in lower exposure times. To this end, the use of mock-up trials and/or the investigation of alternative waste package transfer methodologies should be considered.

Table 41: Handling and Emplacement of Single RWCs and SGs

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
1.1	Preparation for RWC-PT/CTs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	60	4.98	5.65E-02	5.65E-02
1.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-PT/CT@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
1.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
1.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-PT/CT package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	60	4.98	5.65E-02	5.65E-02
1.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	60	4.98	5.65E-02	1.13E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
1.6		OPG Supervision	PCSS	Exit Door	1.14E-02	8	1	60	480.00	5.45E+00	5.45E+00
		Total							**495.69**		**5.73E+00**
1.7	Receive 60 RWC-PT/CTs outside PCSS	Receive, inspect RWC-PT/CTs, confirm dose rates	Outside, South side of PCSS	RWC-PT/CT@1 m	1.00E-01	0.25	1	60	15.00	1.50E+00	1.50E+00
1.8		Remove tie-downs for 60 RWC-PT/CTs	Outside, South side of PCSS	RWC on contact	1.39E-01	0.25	2	60	15.00	2.09E+00	4.17E+00
1.9		Perform contamination scan of forklift and personnel prior to exit from PCSS	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	60	4.98	5.65E-02	1.13E-01
1.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-PT/CT@1 m	1.00E-01	0.083	2	60	4.98	4.98E-01	9.96E-01
		Total							**39.96**		**6.78E+00**
1.11	Emplace 60 RWC-PT/CTs in designated location inside PCSS	Move RWC-PT/CT package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-PT/CT@1 m	1.00E-01	0.25	2	60	15.00	1.50E+00	3.00E+00
1.12		Record/verify RWC-PT/CT ID, location & dose rates	inside PCSS among RWCs	RWC-PT/CT@1 m	1.00E-01	0.083	2	60	4.98	4.98E-01	9.96E-01
		Total							**19.98**		**3.99E+00**

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
2.1	Preparation for RWC-CTIs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	16	1.33	1.51E-02	1.51E-02
2.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-CTI@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
2.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
2.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-CTI package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	16	1.33	1.51E-02	1.51E-02
2.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	16	1.33	1.51E-02	3.02E-02
2.6		OPG Supervision	PCSS	Exit Door	1.14E-02	2	1	16	32.00	3.63E-01	3.63E-01
		Total							**36.73**		**4.79E-01**
2.7	Receive 16 RWC-CTIs outside PCSS	Receive, inspect RWC-CTIs, confirm dose rates	Outside, South side of PCSS	RWC-CTI@1 m	1.00E-01	0.25	1	16	4.00	4.00E-01	4.00E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
2.8		Remove tie-downs for 16 RWC-CTIs	Outside, South side of PCSS	RWC on contact	1.78E-01	0.25	2	16	4.00	7.10E-01	1.42E+00
2.9		Perform contamination scan of forklift and personnel prior to exit from PCSS	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	16	1.33	1.51E-02	3.02E-02
2.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-CTI@1 m	1.00E-01	0.083	2	16	1.33	1.33E-01	2.66E-01
		Total							**10.66**		**2.12E+00**
2.11	Emplace 16 RWC-CTIs in designated location inside PCSS	Move RWC-CTI package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-CTI@1 m	1.00E-01	0.25	2	16	4.00	4.00E-01	8.00E-01
2.12		Record/verify RWC-CTI ID, location & dose rates	inside PCSS among RWCs	RWC-CTI@1 m	1.00E-01	0.083	2	16	1.33	1.33E-01	2.66E-01
		Total							**5.33**		**1.07E+00**
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
3.1	Preparation for RWC-EFs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	64	5.31	6.03E-02	6.03E-02

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
3.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	RWC-EF@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
3.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
3.4		Start-up 40T Forklift, adjust forks, place sleeves on forks and move close to RWC-EF package. Assume after every shift.	PCSS	Exit Door	1.14E-02	0.083	1	64	5.31	6.03E-02	6.03E-02
3.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	64	5.31	6.03E-02	1.21E-01
3.6		OPG Supervision	PCSS	Exit Door	1.14E-02	8	1	64	512.00	5.81E+00	5.81E+00
		Total							**528.69**		**6.11E+00**
3.7	Receive 64 RWC-EFs outside PCSS	Receive, inspect RWC-EFs, confirm dose rates	Outside, South side of PCSS	RWC-EF@1 m	1.00E-01	0.25	1	64	16.00	1.60E+00	1.60E+00
3.8		Remove tie-downs for 64 RWC-EFs	Outside, South side of PCSS	RWC on contact	1.43E-01	0.25	2	64	16.00	2.28E+00	4.57E+00
3.9		Perform contamination scan of forklift and personnel	Inside South side of PCSS	PCSS	1.14E-02	0.083	2	64	5.31	6.03E-02	1.21E-01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
		prior to exit from PCSS									
3.10		Align Forklift and remove RWC from flatbed	Outside, South side of PCSS	RWC-EF@1 m	1.00E-01	0.083	2	64	5.31	5.31E-01	1.06E+00
		Total							**42.62**		**7.35E+00**
3.11	Emplace 64 RWC-EFs in designated location inside PCSS	Move RWC-EF package to inside PCSS and place in appropriate location/layer.	inside PCSS among RWCs	RWC-EF@1 m	1.00E-01	0.25	2	64	16.00	1.60E+00	3.20E+00
3.12		Record/verify RWC-EF ID, location & dose rates	inside PCSS among RWCs	RWC-EF@1 m	1.00E-01	0.083	2	64	5.31	5.31E-01	1.06E+00
		Total							**21.31**		**4.26E+00**
6.1	Preparation for RWC-SGs	Start-up PCSS ventilation and lighting system, assume after every shift	Outside PCSS	Exit Door	1.14E-02	0.083	1	48	3.98	4.52E-02	4.52E-02
6.2		Walkdown PCSS to confirm/inspect location for RWC placement.	PCSS	SG@1 m	1.00E-01	0.25	2	1	0.25	2.50E-02	5.00E-02
6.3		Inspect 40T Forklift	PCSS	Exit Door	1.14E-02	0.5	1	1	0.50	5.68E-03	5.68E-03
6.4		Start-up 40T Forklift, adjust forks, place sleeves on	PCSS	Exit Door	1.14E-02	0.083	1	48	3.98	4.52E-02	4.52E-02

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	Activity	Description	Location	Radiation Source and Distance	Dose Rate (mSv/hr)	Duration (h)	Crew Size	Repeated (# of Times)	Total Duration (h)	Individual Dose (mSv)	Collective Dose (person-mSv)
		forks and move close to RWC-SG package. Assume after every shift.									
6.5		Ingress and egress of workers at start and end of each shift	PCSS	Exit Door	1.14E-02	0.083	2	48	3.98	4.52E-02	9.05E-02
6.6		OPG Supervision	PCSS	Exit Door	1.14E-02	15	1	48	720.00	8.18E+00	8.18E+00
		Total							**732.70**		**8.41E+00**
6.7	Emplacement of SGs in west bay of PCSS	Set up the rigging required (jack and slide system) (inside building)	PCSS	PCSS S Walls @1m	1.14E-02	2.5	6	1	2.5	2.84E-02	1.70E-01
6.8		Receive, inspect and place SG in the PCSS	PCSS	SG @30cm side	1.61E-01	0.5	3	48	24	3.86E+00	1.16E+01
6.9			PCSS	SG @1m side	1.00E-01	2	3	48	96	9.60E+00	2.88E+01
6.10			PCSS	SG @5m side	2.82E-02	4	3	48	192	5.41E+00	1.62E+01
6.11		Position SG in the storage location	PCSS	U5 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.12			PCSS	U6 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.13			PCSS	U7 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.14			PCSS	U8 SG @30cm neck	1.61E-01	2.5	2	12	30	4.83E+00	9.65E+00
6.15			PCSS	U5 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.16			PCSS	U6 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01

Estimated Doses for Placement of RWCs and SGs in the PCSS											
Activity No.	**Activity**	**Description**	**Location**	**Radiation Source and Distance**	**Dose Rate (mSv/hr)**	**Duration (h)**	**Crew Size**	**Repeated (# of Times)**	**Total Duration (h)**	**Individual Dose (mSv)**	**Collective Dose (person-mSv)**
6.17			PCSS	U7 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.18			PCSS	U8 SG @1m neck	1.00E-01	4	3	12	48	4.80E+00	1.44E+01
6.19			PCSS	SG @5m side	2.82E-02	4	3	48	192	5.41E+00	1.62E+01
6.20		Supervision	PCSS	SG @5m side	2.82E-02	44	4	1	44	1.24E+00	4.96E+00
		Total							**862.5**		**1.74E+02**
Total Collective Dose											**2.21E+02**
Maximum Individual Dose - assumes 1 worker does each task apart from supervision										**9.60E+00**	

8.0 Conclusions

This report documents the safety assessments that were performed to support the construction of the PCSS on the PWMF site. These safety assessments included a normal operations safety assessment, malfunction/accident safety assessment, and an ALARA assessment.

In the normal operations safety assessment, doses to workers and the public for normal operation of the PWMF were assessed. It was concluded that doses to the public due to chronic emissions from the PWMF were significantly less than the dose acceptance criterion. However, dose to workers and the public due to direct gamma radiation could potentially exceed the dose limit based on the shielding analysis which was conducted based on the current design.

To aid OPG in evaluating different shielding building design options, three configurations were considered for the analysis of the PCSS. The base case considered a PCSS design based on the DWMF RWSB, which has concrete shielding panels and an industrial roof. Two sensitivity cases were then also considered. The first sensitivity case considered a building with a shielded roof based, similar to the SGSB at the WWMF. The second sensitivity considered the same building design as the base case, but with additional shielding added to the area around the overhead door which serves as the main entry point for waste packages into the building. The base case and second sensitivity case (overhead door shielding) exceeded the dose acceptance criteria at dose points PW24, PW26, and PW10. The first sensitivity case (shielded roof) exceeded the dose criteria at PW26 and PW10. For all cases, the SGs were the main contributors to the calculated dose rates. Therefore, for all of the cases the SG source strengths were scaled to be 10 mrem/h at 1 m (which is more realistic as opposed to the conservative 40 mrem/h at 1 m that was originally assumed), and with this scaling the cases with the shielded roof were below the dose criteria at all dose points. Recommendations were made for any future MCNP analysis and these recommendations included refining source terms based on survey results, crediting decay, re-evaluating fence distances around the PCSS, and re-evaluating the waste layout within the PCSS.

In the malfunction/accident safety assessment, hazards were identified and screened for the construction of the PCSS, on-site transfers, handling and storage of the RWCs and SGs. On this basis, the bounding event was identified to be the drop of a SG or a RWC and the radiological consequences of the event were assessed. It was concluded that the doses to worker and public resulting from the event were less than the dose acceptance criteria. The consequence of the earthquake event was also assessed and the estimated doses for all receptors considered were less than the dose acceptance criterion as well.

The ALARA assessment showed that for the emplacement of 60 RWC-PT/CTs, 16 RWC-CTIs, 64-RWC-EFs and 48 SGs, the overall collective doses are 16.5, 3.7, 17.7, and 182.6 person-mSv, respectively, for a total collective dose of 221 person-mSv.. In order to stay below the OPG ECL for a NEW of 1,000 mrem/yr (10 mSv/yr) the emplacement tasks should be divided among multiple workers. Temporary shielding could also be used to reduce dose rates to workers during emplacement activities.

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Appendix A: Hazard Pre-Screening

A.1 Hazard Pre-screening

The pre-screening of hazards associated with PCSS safety analysis as presented below was conducted based on the previous work [A-1] and was updated to take into account the project specific aspects, such as the location and design of the PCSS, and the characteristics of the packages (SG or RWC) to be transferred and stored.

Category	Hazard	Screening Status	Rationale
H-EXT External Hazards – Human Induced			
Mobile Sources			
H-EXT-1	Aircraft Impact	IN	This hazard is expected to cause significant damage to the PCSS and may lead to a radiological release.
H-EXT-2 Rail Transportation Hazards			
H-EXT-2.1	Train Crash	OUT	The screening distance for train derailment is estimated to be 80 m (3-rail-car length) from the crash [A-2]. The CN Rail main line runs north of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3] Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-2.2	Cold Toxic Gas Release	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site, [A-3]. Table 3-1 of Reference [A-2]shows the SDV for Cold Toxic Gases. SDV for Ammonia, Hydrochloric Acid and Hydrogen Fluoride releases is 0.9 km and 1.4 km, respectively. This means that these toxic materials can be screened out based on distance. SDV for Chlorine, Sulphuric Acid and Sulphur Dioxide is 4.4 km. This hazard can be screened out based on frequency (8.81E-07) (refer to Table 3-9 of Reference [A-3]).
H-EXT-2.3	Hot Toxic Gas Release	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. Table 3-2 of Reference [A-2]shows that the maximum SDV is 2.3 km (sulphur dioxide) for hot toxic gases. Therefore, this hazard can be screened out based on the distance from the PWMF.

Category	Hazard	Screening Status	Rationale
H-EXT-2.4	BLEVE – Missile Damage	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site, [A-3]. The BLEVE SDV is estimated to be 1600 m [A-2]. Therefore, the BLEVE hazard from rail derailment can be screened out based on the distance from the PWMF.
H-EXT-2.5	BLEVE – Blast Wave	OUT	The blast waves associated with a BLEVE are localized and not as strong as a Vapour Cloud Explosion (VCE) [A-2]. Since this hazard is bounded by the VCE hazard, it is not included in the screening analysis.
H-EXT-2.6	VCE	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The Vapour Cloud Explosion SDV is estimated to be 460 m [A-2]. Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-2.7	Explosions of Rail Car Containing Explosive	OUT	The CN Rail mainline runs North of the PNGS, at approximately 3 km to the PWMF and the CP Rail mainline is located approximately 6 km north of the site [A-3]. The SDV is estimated to be 700 m [A-2]. Therefore, this hazard can be screened out based on the distance from the PWMF.
H-EXT-3 Road Transportation Hazards			
H-EXT-3.1	Cold Toxic Gas Release, such as: ammonia, hydrochloric acid and hydrogen fluoride, hot toxic gases, BLEVEs, VCEs, and Explosions	OUT	As major roads/highways are slightly further away from the plant than the railway, these offsite road transportation accidents can be screened out based on distance [A-2].
H-EXT-3.2	Cold Toxic Gas Release e.g., Chlorine; Sulphuric Acid, Sulphur Dioxide	OUT	Only 10% of these chemicals are transported on Highway 401 compared to the CN rail line traffic [A-2]. This hazard can be screened out based on frequency (8.81E-08), referring to Table 3-11 of Reference [A-3].
H-EXT-4 Ship Accidents			

Category	Hazard	Screening Status	Rationale
H-EXT-4.1	Small Vessels	OUT	Boats/small vessels are not permitted to dock on the shore near the PWMF. The accidents associated with small vessels are not expected to have an impact on the PWMF. Therefore, this hazard can be screened out.
H-EXT-4.2	Large Vessels	OUT	The normal shipping lanes in Lake Ontario are 10 kilometres away from the shoreline in the vicinity of the plant [A-2]. In addition, there are no commercial wharfs around the Pickering area [A-3]. Therefore, this hazard can be screened out based on the distance from the PWMF.
Fixed Sources			
H-EXT-5	Nearby Nuclear Event	OUT	An accident at the Pickering A, Pickering B or Darlington NGS, resulting in significant releases would progress slowly enough to ensure notification to PWMF personnel such that the required actions could be taken. Any anticipated dose from the PWMF as a result of a significant event at either Pickering A or Pickering B, would be bounded by the dose received from the station itself. Therefore, this hazard can be screened out.
H-EXT-6 Toxic Gas Release			
H-EXT-6.1	Toxic Gas Release – Chlorine originated from Ajax Water Treatment Plant	IN	The Ajax Water Treatment Plant is situated near the Ajax Waterfront Park and uses chlorine cylinders for water treatment. The SDV for Chlorine is 4.4 km [A-2]. The Ajax Water Treatment facility is located approximately 4.0 km from the PCSS. This hazard cannot be screened out based on distance, it will be further evaluated.
H-EXT-6.2	Toxic Gas Release - Chlorine originated from the Duffin Creek Water Pollution Control Plant	OUT	The Duffin Creek Water Pollution Control Plant which uses chlorine for pollution control is located in Pickering at 1.0 km from the PCSS. Due to its proximity, it may be able to release sufficient chlorine to impair the SG/RWC transporter operator. Since the SDV for chlorine is 4.4 km, this hazard cannot be screened out based on distance. However, the annual frequency of a chlorine leak from a fixed storage tank is 2.86E-07 (refer to Table 3-12 of Reference [A-3]), which is below the cutoff frequency of 10E-6, this hazard can be screened out based on frequency.
H-EXT-7	BLEVE	OUT	External fixed sources of BLEVEs have been identified within a radius of 5 km of PNGS [A-3] and it was concluded that none of the sites were within the

Category	Hazard	Screening Status	Rationale
			SDV, which is 1600 m for BLEVE [A-2]. Therefore, this hazard can be screened out based on distance.
Other Sources			
H-EXT-8	Missiles from Military Activity	OUT	This is considered a malevolent act; therefore, it is out of scope per Reference [A-2]
H-EXT-9	Orbital Debris Crashes	OUT	Orbital debris can cause serious damage to the SGs and RWCs. There is no SDV for this hazard type [A-2]. However, based on the annual frequency analysis, this hazard can be screened out for UFDS facilities and DSC on-site transfer due to low frequency [A-5][A-6]. Similarly, this hazard can be screened out for the PCSS based on similar building size and transport route.
N-EXT External Hazards – Natural			
N-EXT-1	Earthquakes	IN	The ground motion associated with this event may exceed the design capacity of the PWMF facility. Earthquake could also affect the RWCs or SGs if they are being transported when the earthquake occurs. This hazard has the potential to lead to a radiological release, and therefore it cannot be screened out.
N-EXT-2 Soil Failures			
N-EXT-2.1	Slope Instability	IN	The PNGS site complies with the specific clauses of the Canadian Foundation Engineering Manual and the National Building Code of Canada (NBCC) ([A-2] and [A-3]). However, potential slope failures/soil instability will impact the onsite transfer of SGs and RWCs. This hazard will be further evaluated.
N-EXT-2.2	Subsidence	OUT	The PNGS site is not situated in a geographical area where subsidence can occur ([A-2] and [A-3]). Therefore, this hazard can be screened out.
N-EXT-2.3	Swelling Clay	OUT	The foundations of PNGS are not on clay layers [A-2]. Therefore, this hazard can be screened out.
N-EXT-2.4	Soil Frost	OUT	This hazard is primarily relevant to the integrity of buried piping [A-2]. This hazard is not anticipated to impact the transfer or storage of the SGs and RWCs and is therefore not applicable to the present assessment.
N-EXT-3 Flooding			

Category	Hazard	Screening Status	Rationale
N-EXT-3.1	Flooding Due to Runoff	IN	A PMP event has the potential to cause damage to the PWMF SSCs and could result in radiological release. Therefore, flooding has been screened in for transportation and storage.
N-EXT-3.2	Flooding Due to River	OUT	Main river courses are located at a distance greater than 2 km from the western (Rouge River and the Petticoat Creek) and eastern (Duffin's Creek) boundary of the PNGS site [A-3]. Based on distance, the potential for these rivers to represent a potential flood hazard to the PWMF site is screened out. Krosno Creek is located immediately to the west of the PNGS and is prone to flooding. Based on Flood Plain Mapping from the Toronto and Region Conservation Authority (TRCA), water surface elevations for Krosno Creek are in the range from 76.26 m (at Liverpool Road) to 77.22 m (at Sandy Beach Road). Ground elevations between the PNGS and the flood zone are approximately 3.6 m and 5.1 m, respectively, above the Regional Flood elevation at these locations, Appendix F of Reference [A-3]. An assessment has been conducted as part of the Fukushima follow-up and it was determined that Krosno Creek would maintain at minimum approximately 2.7 m of freeboard from a potential spill during the flooding due to a PMP event. Based on this, the potential for flooding from this river can be screened out.
N-EXT-3.3	Flooding Due to Waves	OUT	Unlike DSMs which are stored outside, the RWCs and SGs are stored within the PCSS which is away from the shore. As such, flooding due to waves will not directly affect RWCs and SGs. Therefore, this hazard can be screened out.
N-EXT-3.4	Flooding Due to Seiche	OUT	Section 4.4.4 of Reference [A-3]notes that the site requires protection for water surge of up to 0.75 m, as the highest modeled water level at Darlington resulting from surge or seiche is about 0.75 m. The 100-year maximum lake level is 75.6 m [A-3], so the possible maximum level is 76.35m. However, the average shoreline near PNGS is 77 m. This hazard can be screened out.
N-EXT-3.5	Flooding Due to Tsunami	OUT	A tsunami in Lake Ontario is an improbable event, with no associated flood hazard potential [A-2]. Furthermore, the Great Lakes are in a geologically stable, mid-continental region, where the probability of occurrence of earthquakes large enough to generate tsunamis is negligible [A-3]. Therefore, this hazard can be screened out.
N-EXT-3.6	Flooding Due to Sudden	OUT	No large lakes and no man-made water retaining structures creating reservoirs are located within the drainage areas in the vicinity of the PNGS that could influence flooding [A-3]. For this reason, this hazard can be screened out.

Category	Hazard	Screening Status	Rationale
	Releases of Water from Natural or Artificial Storage		
N-EXT-3.7	Flooding Due to Rapid Melting of Snow and Large Blocks of Ice	OUT	Rapid melting of snow and large blocks of ice accumulated on the buildings' rooftop and at site as the temperature rises above the freezing point (late winter/early spring) can cause flooding. However, the event is slow developing [A-3], providing enough time for operational personnel to ensure all PWMF facility are in a safe state. Therefore, this hazard can be screened out.
N-EXT-3.8	Flooding Due to Other Causes	OUT	Other causes of flooding may include underwater landslides and lake ice. Lake Ontario shorelines as a whole are not susceptible to shore slope failure or landslide [A-3]; lake ice can be also screened out as a flood hazard as ice structures are not expected to create or worsen any coastal flood hazard at Pickering [A-3]. Therefore, this hazard has been screened out.
N-EXT-4 Meteorological – Extremes			
N-EXT-4.1	Temperature (extreme high/ extreme low)	OUT	Extreme temperatures are predictable allowing time for operational staff to ensure all PWMF facilities are in a safe state. Procedures are in place to prohibit transfer under poor or slippery road conditions [A-6]. Therefore, this hazard can be screened out.
N-EXT-4.2	Snowpack	OUT	Snowpack and subsequent 48-hour winter PMP would occur gradually, allowing time for the removal of snow for affected structures. The procedures will be developed that waste transfer activities should not be performed during snow-covered conditions and are bounded by a transporter failure incident [A-6]. Therefore, this hazard can be screened out.
N-EXT-4.3	Freezing Rain	OUT	The impact of freezing rain is bounded by the impact of external flood, ice-storms and snowpack. Similar to the current practice, procedures will be developed to prohibit transfer under poor or slippery road conditions. Even if the on-site transfer of SG and RWC takes longer than expected as result of adverse road conditions, the radiological consequence is not expected given the robust design of a RWC or packed SG. Therefore, this hazard can be screened out.
N-EXT-4.4	Extreme Water Temperature	OUT	Operation of the PWMF does not depend on the use of lake water. There is no interaction between the transfer of the RWCs and SGs and the lake water temperature. This event is screened out.

Category	Hazard	Screening Status	Rationale
N-EXT-4.5	Avalanches	OUT	The PNGS is not situated in a mountainous region with large slopes which would lead to an avalanche. This event is screened out.
N-EXT-4.6	Lightning	IN	The effects of a lightning strike will increase the temperature of the affected SG or RWC and might result in an increased release of loose contamination from inside the packages; the packages will be cleaned of surface contamination prior to transport. Therefore, this event is screened in.
N-EXT-4.7	Hurricanes	OUT	Tornadoes are more frequent in the region of concern and the impact of a tornado is considered bounding for high-winds category of hazard. Therefore, the wind speeds from tornadoes are considered a bounding hazard.
N-EXT-4.8	Tornadoes	IN	This hazard is expected to cause significant damage to the PWMF and will impact transport and may lead to radiological release. As per [A-8], the tornado occurrence rate in the Pickering site is 3.13E-06 events per year. This hazard requires further evaluation.
N-EXT-4.9	Sandstorms	OUT	Sandstorms are typically associated with deserts. In the vicinity of the PWMF there are no large sand-bodies, therefore sandstorms are not a credible potential external hazard for Ontario [A-3]
N-EXT-4.10	Ice Storms	OUT	The PCSS conforms to NBCC requirements ([A-2][A-3]) which account for loading due to ice and snow. Waste transfer activities should not be performed under severe weather conditions such as ice storms. Therefore, this hazard can be screened out.
N-EXT-4.11	Frazil Ice	OUT	Operation of the PWMF does not depend on the use of the lake water. There is no interaction between transport and the lake. Therefore, this hazard can be screened out.
N-EXT-4.12	Low Lake Level/Drought	OUT	Operation of the PWMF does not depend on the use of the lake water. Therefore, this hazard can be screened out.
N-EXT-4.13	Meteorites	OUT	Similar to the orbital debris hazard, this hazard cannot be screened out based on qualitative screening. However, based on the annual frequencies of this hazard ([A-5][A-6]), this hazard can be screened out for UFDS facilities and DSC on-site transfer due to low frequency. Similarly, this hazard can be screened out for the PCSS based on similar building size and transport route.
N-EXT-4.14	Geomagnetic storm	OUT	Geomagnetic storm events will impact the power distribution system equipment and may cause loss of off-site power [A-3]. This hazard does not have an impact on the PCSS; therefore, it can be screened out.

Category	Hazard	Screening Status	Rationale
N-EXT-5 Other Hazards			
N-EXT-5.1	Forest Fire	OUT	There is no heavily forested area within 3 km of the site [A-6]. The SDV for this hazard is 1 km [A-2]. Therefore, this hazard can be screened out.
N-EXT-5.2	Corrosion from Salt Water	OUT	This hazard is not applicable in the Great Lakes area [A-2]; therefore, this hazard can be screened out.
N-EXT-5.3	Animals	OUT	This hazard does not have any impact on the PWMF site or on-site transfer [A-6].
H-INT Internal Hazards			
H-INT-1	Turbine Generated Missiles	IN	The SG or RWC transfer route from the Station to the PCSS is in the proximity of the stations' powerhouses. A missile may have an impact on the transfer, handing or storage of the SGs or RWCs.
H-INT-2	Other Mechanically Generated Missile Sources	OUT	PWMF facility: As the Heat Transport pump missiles are assumed incapable of penetrating the RB wall; there is no impact to the PWMF facility. The effects of missiles from other pumps and valves are assumed bounded by turbine missiles. During on-site transfer: Similar to DSC on-site transfer, missile sources originating from hydrogen cylinder/trailers/ stationary tank set, compressed gas bottle storage facility and oil storage tank along the SG or RWC onsite transfer route were screened out based on frequency (Section 5.6.1, 5.6.2, 5.6.3 and 5.6.4 of Reference [A-6]). A transportation accident causing mechanical damage and leading to a pressure vessel burst is bounded by tornado missiles.
H-INT-3	Acetylene Decomposition Explosion Missile	OUT	The effects of this hazard would be bounded by that of tornado generated missiles.
H-INT-4	Missiles Generated by a Hydrogen Explosion at the Tritium Removal Facility	OUT	This hazard is associated with the tritium removal facility at Darlington and not applicable for the Pickering site [A-9].
H-INT-5	Control Rod Ejection Missiles	OUT	This hazard is not applicable due to the design of a CANDU reactor [A-9].

Category	Hazard	Screening Status	Rationale
H-INT-6	Explosions within the PWMF Facility and along the on-site transfer route	IN	No explosive materials will be stored in the PCSS. However, there are potential sources of explosions along the SG/RWC transfer route that may lead to radiological releases.
H-INT-7 Release of Toxic, Radioactive or Corrosive Gases and Liquids from On-Site Storage			
H-INT-7.1	Acute Inhalation Toxicity	Out	It is expected that no acutely toxic materials will be stored in the PCSS. Therefore, this hazard can be screened out.
H-INT-7.2	Corrosion	OUT	It is expected that no corrosive materials will be stored in the processing building. Therefore, this hazard can be screened out.
H-INT-7.3	Oxidizing/Reactive Chemicals	OUT	There is no oxygen gas stored at the PWMF facility. This hazard is screened out.
H-INT-7.4	Asphyxiants	OUT	There will not be any significant quantities of asphyxiating gas (argon and helium) stored in the PCSS. Therefore, this hazard can be screened out.
H-INT-7.5	Release of Stored Energy	OUT	Catastrophic failure of pressure vessels is excluded from consideration. There are no other sources of significant stored energy, such as high-pressure piping, associated with the PWMF.
H-INT-8 Transportation			
H-INT-8.1	Vehicle Impacts – Onsite Vehicle Movements	IN	Vehicle accident during onsite transfer of SGs/RWCs have the potential to lead to radiological release. The accident could consist of a collision resulting in a drop of the RWC or SG, or the transporter leaving the road due to transporter operator health-related emergency. Therefore, this hazard is screened in.
H-INT-8.2	Collision Impacts Within PCSS	IN	Collision with other vehicles/structures within the PCSS has the potential to lead to radiological release. Therefore, this hazard is screened in.
H-INT-8.3	Toxic and/or Dangerous Goods - Onsite Vehicle Movements	OUT	This hazard is bounded by vehicle accidents involving radiological waste.
H-INT-8.4	BLEVE – Blast Wave	IN	The blast waves associated with a BLEVE could occur along the SG/RWC transfer route from PNGS to PCSS. Therefore, this hazard is screened in.
H-INT-8.5	Vapour Cloud Explosion	IN	There are propane storage tanks along the SG/RWC transfer route from PNGS to PCSS, which could result in VCE. Therefore, this hazard is screened in.

Category	Hazard	Screening Status	Rationale
H-INT-8.6	Fire	IN	Fires along the transfer route or originating from combustible materials on the transporter can lead to damage of transporter and packages being transported and potential release of radioactivity.
H-INT-9	Collapsed Structures	OUT	This hazard is bounded by earthquakes.
H-INT-10	Fire – Toxic Effects Only	OUT	The effects of this hazard are bounded by fire.
H-INT-11	Dropped or impacting loads	IN	The dropping of SGs/RWCs during handling can lead to radioactive release. This applies to transport and handling in the PCSS.
H-INT-12	Electromagnetic Interference (EMI) and Radio-Frequency Interference (RFI)	OUT	Proper design ensures that EMI and RFI are not a potential hazard to safety. The Pickering B Hazard Screening report [A-3] states that this hazard was accounted for in the design of the PNGS B. The same design requirements would be expected to be applicable to the PWMF.
H-INT-13	Seal Failure	IN	The failure of lid/seal of the SG or RWC could potentially result in the radiological release.
H-INT-14	Fire within the PCSS	IN	Fire within the PCSS can lead to damage of RWCs and SGs stored and potential release of radioactivity.
H-INT-15	Extended loss of AC power (ELAP)	OUT	An ELAP is a loss of all off-site and on-site AC power sources for an unknown period of time. It could be a significant challenge for the long-term cooling of the reactor core and the spent fuel storage pool. Given that only RWCs and SGs will be stored within the PCSS and that cooling is not specifically required for the safe storage of RWCs and SGs and any operation within the PCSS could be held when an ELAP occurs, the radiological impact of an ELAP on the safe operation of the PCSS is negligible. Therefore, this hazard can be screened out.

A.2 References

[A-1] Ontario Power Generation, “PWMF Safety Assessment Update”, 92896-REP-01320-00015, November 2022.

[A-2] Ontario Power Generation, “OPG Probabilistic Safety Assessment (PSA) Guide – External Hazards Screening,” N-GUID-03611-10001 Vol. 8, R005, November 2018.

[A-3] Ontario Power Generation, “Hazard Screening Analysis – Pickering B”, NK30-REP-03611- 00008 R002, December 2021.

[A-4] Ontario Power Generation, “Dry Storage Module (DSM) Storage Facility Safety Assessment”, 90387, December 1990.

[A-5] Ontario Power Generation, “Hazard Screening Analysis – Pickering Used Fuel Dry Storage”, P-REP-03611-00009, R000, September 2017.

[A-6] Ontario Power Generation, “Hazards Analysis of the Existing Dry Storage Container Transport Route at Pickering Site”, 92896-REP-00120-00005 R000, July 2013.

[A-7] Ontario Power Generation, “Pickering Waste Management Facility Campus Plan”, 92896-REP- 03460-00001 R005, November 2014.

[A-8] Ontario Power Generation, “Pickering NGS “B” High Wind Probabilistic Safety Assessment”, NK30-REP-03611-00020-R002, July 2017.

[A-9] Ontario Power Generation, “OPG Probabilistic Safety Assessment (PSA) Guide – Internal Hazards Screening”, N-GUID-03611-10001, Vol. 9, R003 December 2018.

Appendix B: Aircraft Crash Frequency Calculations

This Appendix presents the aircraft crash frequency calculations for the PWMF site. The calculations were based on the Appendix B of Reference [B-1], including the calculation of the effective area of the target and multiplying that by the aircraft crash rate.

The effective target area A_{eff} is calculated as

$$A_{eff} = A_f + A_s$$

where

$$A_f = (WS + R) * H * \cot\Phi + (2 *\cdot L^*\cdot W^*\cdot WS)/R + L^*\cdot W$$
$$A_s = (WS+R) *S$$

Where

A_f = effective fly-in area;
A_s = effective ski area;
WS = aircraft wingspan;
R = length of the diagonal of the facility;
H = facility height;
$\cot\Phi$ = mean of the cotangent of the aircraft impact angle;
L = length of facility;
W = width of facility; and
S = aircraft skid distance

The values for the aircraft wingspan, mean of the cotangent of the aircraft impact angle and aircraft skid distance were taken from Tables B-16, B-17 and B-18 from Reference [B-2], respectively. The aircraft crash rates for the PNGS site were taken from Table 3-2 of Reference [B-3]. Airports located in a radius of about 35 kilometers from the PNGS were considered in the airfield crash rate calculations.

For the SG transfer vehicle (SPMT), the size (L, W, H) is from page 18 of Reference [B-4]. The size of the RWC transfer vehicles was conservatively considered to be the same as the size of the SPMT. For PCSS, the dimensions of the building were based on References [B-5].

The results of aircraft crash frequency calculations for the PWMF site, taking into the results of [B-6] and [B-7], are presented in Table B-1.

Table B-1: Aircraft Crash Frequency Calculations

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Wingspan	WS, ft	73	50	59	98	110	
Skid distance	S, ft	60	0	1440	1440	447	
Impact angle cotangent	cotΦ	8.2	0.58	10.2	10.2	10.4	
Crash rate	km^{-2} yr^{-1}	5.10E-06	3.60E-07	9.30E-07	1.20E-06	6.60E-08	
DSC On-Site Transfer with Liftking Transporter							
Transporter Length	L, ft		27.83	27.83	27.83	27.83	
Transporter Width	W, ft		10.88	10.88	10.88	10.88	
Diagonal of Transporter	R, ft		29.88	29.88	29.88	29.88	
Transporter Height	H, ft		15.52	15.52	15.52	15.52	
Effective fly area	Af. ft^2		2,034.72	15,569.24	22,533.58	25,110.67	
Effective skid area	As, ft^2		0.00	127,990.26	184,150.26	62,527.31	
Total Area	Aeff, ft^2		2,034.72	143,559.50	206,683.84	87,637.98	
	Aeff, km^2		0.00019	0.013	0.019	0.008	
Probability of a loaded transporter on-site	yr^{-1}		0.017	0.017	0.017	0.017	
Crash Frequency	yr^{-1}		1.17E-12	2.12E-10	3.95E-10	9.20E-12	**6.17E-10**
Phase I (processing building and storage buildings SB 1 and SB 2)							
Facility Length	L, ft		342.00	342.00	342.00	342.00	
Facility Width	W, ft		312.00	312.00	312.00	312.00	
Diagonal of Facility	R, ft		462.93	462.93	462.93	462.93	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Facility Height	H, ft		45.00	45.00	45.00	45.00	
Effective fly area	Af. ft^2		121,800.28	352,129.37	388,008.98	404,205.27	
Effective skid area	As, ft^2		0.00	751,585.13	807,745.13	256,101.55	
Total Area	Aeff, ft^2		121,800.28	1,103,714.50	1,195,754.11	660,306.82	
	Aeff, km^2		0.011	0.103	0.111	0.061	
Crash Frequency	yr^{-1}		4.07E-09	9.54E-08	1.33E-07	4.05E-09	**2.37E-07**
DSM/RCS Area							
Facility Length	L, ft	196.00	196.00	196.00	196.00	196.00	
Facility Width	W, ft	136.80	136.80	136.80	136.80	136.80	
Diagonal of Facility	R, ft	239.02	239.02	239.02	239.02	239.02	
Facility Height	H, ft	16.07	16.07	16.07	16.07	16.07	
Effective fly area	Af. ft^2	84,306.88	40,724.47	88,899.39	104,041.95	109,822.95	
Effective skid area	As, ft^2	18,721.16	0.00	429,147.83	485,307.83	156,011.64	
Total Area	Aeff, ft^2	103,028.04	40,724.47	518,047.22	589,349.78	265,834.59	
	Aeff, km^2	0.010	0.004	0.048	0.055	0.025	
Crash Frequency	yr^{-1}	4.88E-08	1.36E-09	4.48E-08	6.57E-08	1.63E-09	**1.62E-07**
Phase II - DSC Storage Buildings SB3, SB4 and SB5							
Facility Length	L, ft		891.08	891.08	891.08	891.08	
Facility Width	W, ft		553.75	553.75	553.75	553.75	
Diagonal of Facility	R, ft		1049.13	1049.13	1049.13	1049.13	
Facility Height	H, ft		33.19	33.19	33.19	33.19	
Effective fly area	Af. ft^2		369,189.50	731,629.83	781,518.39	804,562.77	
Effective skid area	As, ft^2		0.00	1,595,705.38	1,651,865.38	518,130.54	
Total Area	Aeff, ft^2		369,189.50	2,327,335.21	2,433,383.77	1,322,693.32	
	Aeff, km^2		0.034	0.216	0.226	0.123	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Crash Frequency	yr-1		1.23E-08	2.01E-07	2.71E-07	8.11E-09	**4.93E-07**
PCSS for RWCs							
Facility Length	L, ft	167.00	167.00	167.00	167.00	167.00	
Facility Width	W, ft	157.00	157.00	157.00	157.00	157.00	
Diagonal of Facility	R, ft	229.21	229.21	229.21	229.21	229.21	
Facility Height	H, ft	26.24	26.24	26.24	26.24	26.24	
Effective fly area*	Af. ft^2	51351.05	18331.67	55806.12	65486.37	69355.00	
Effective skid area*	As, ft^2	9066.35	0.00	207512.42	235592.42	75813.81	
Total Area	Aeff, ft^2	60417.40	18331.67	263318.53	301078.79	145168.82	
	Aeff, km^2	0.006	0.002	0.024	0.028	0.013	
Crash Frequency	yr^{-1}	2.86E-08	6.13E-10	2.28E-08	3.36E-08	8.90E-10	**8.64E-08**
Cumulative Frequency for Used Fuel Dry Storage Area (Phase I and Phase II), RCS Area and PCSS for RWCs							**9.78E-07**
PCSS for SGs							
Facility Length	L, ft	167.00	167.00	167.00	167.00	167.00	
Facility Width	W, ft	157.00	157.00	157.00	157.00	157.00	
Diagonal of Facility	R, ft	229.21	229.21	229.21	229.21	229.21	
Facility Height	H, ft	26.24	26.24	26.24	26.24	26.24	
Effective fly area*	Af. ft^2	51351.05	18331.67	55806.12	65486.37	69355.00	
Effective skid area*	As, ft^2	9066.35	0.00	207512.42	235592.42	75813.81	
Total Area	Aeff, ft^2	60417.40	18331.67	263318.53	301078.79	145168.82	
	Aeff, km^2	0.006	0.002	0.024	0.028	0.013	
Crash Frequency	yr^{-1}	2.86E-08	6.13E-10	2.28E-08	3.36E-08	8.90E-10	**8.64E-08**
RWC/SG On-Site Transfer							
Transporter Length	L, ft	60.27	60.27	60.27	60.27	60.27	

Parameters	Unit	Category 1	Category 2	Category 3	Category 4	Category 5	Total Crash Frequency/ Facility
		Light Aircraft	Helicopters	Small Transport	Large Transport	Military Combat	
Transporter Width	W, ft	13.00	13.00	13.00	13.00	13.00	
Diagonal of Transporter	R, ft	61.66	61.66	61.66	61.66	61.66	
Transporter Height	H, ft	15.75	15.75	15.75	15.75	15.75	
Effective fly area	Af. ft^2	20,029.67	3,074.26	21,666.42	28,922.98	31,696.48	
Effective skid area	As, ft^2	8,079.37	0.00	173,744.76	229,904.76	76,730.27	
Total Area	Aeff, ft^2	28,109.04	3,074.26	195,411.19	258,827.74	108,426.75	
	Aeff, km^2	0.00261	0.00029	0.018	0.024	0.010	
Probability of a loaded transporter on-site	yr^{-1}	0.004	0.004	0.004	0.004	0.004	
Crash Frequency	yr^{-1}	5.63E-11	4.34E-13	7.13E-11	1.22E-10	2.81E-12	**2.53E-10**

Note: *Based on the arrangement of RWCs and SGs in the PCSS, it is conservatively assumed that 50% of the PCSS is occupied by RWCs. Only this potion of the PCSS was taken into account the calculation of cumulative crash frequency for safety containers. The crash frequency for the rest of the building used for the storage of SGs was calculated separately.

B.1 References

[B-1] US Department of Transportation, “Accident Analysis for Aircraft Crash into Hazardous Facilities”, DOE-STD-3014-2006, Reaffirmed May 2006

[B-2] OPG, Ontario Power Generation Used Fuel Dray Storage Container Design Requirement, 00104-DR-79171-10000 R03, June 2011

[B-3] OPG, “Hazard Screening Analysis – Pickering B”, NK30-REP-03611-00008 R002, December 2021.

[B-4] Mammoet, “Old Steam Generator Offloading and Laydown Procedure”, W -01098-PLAN-79137-00013 R000, 2007.

[B-5] OPG. Email from Shelaney L. To Eric H. Re PCSS Layout, PV209/RE/0009 R00, July 27, 2023.

[B-6] OPG, "NSS-P Safety Assessment Update," 92896-REP-01320-00015 R00, November 2022.

[B-7] OPG, “Radiological Assessment of Lower Aged Fuel in PWMF SB3 including Conceptual SB5”, 92896-REP-01320-00013 R00, April 2021.

Appendix C: Photos along the Portion of the Transfer Route

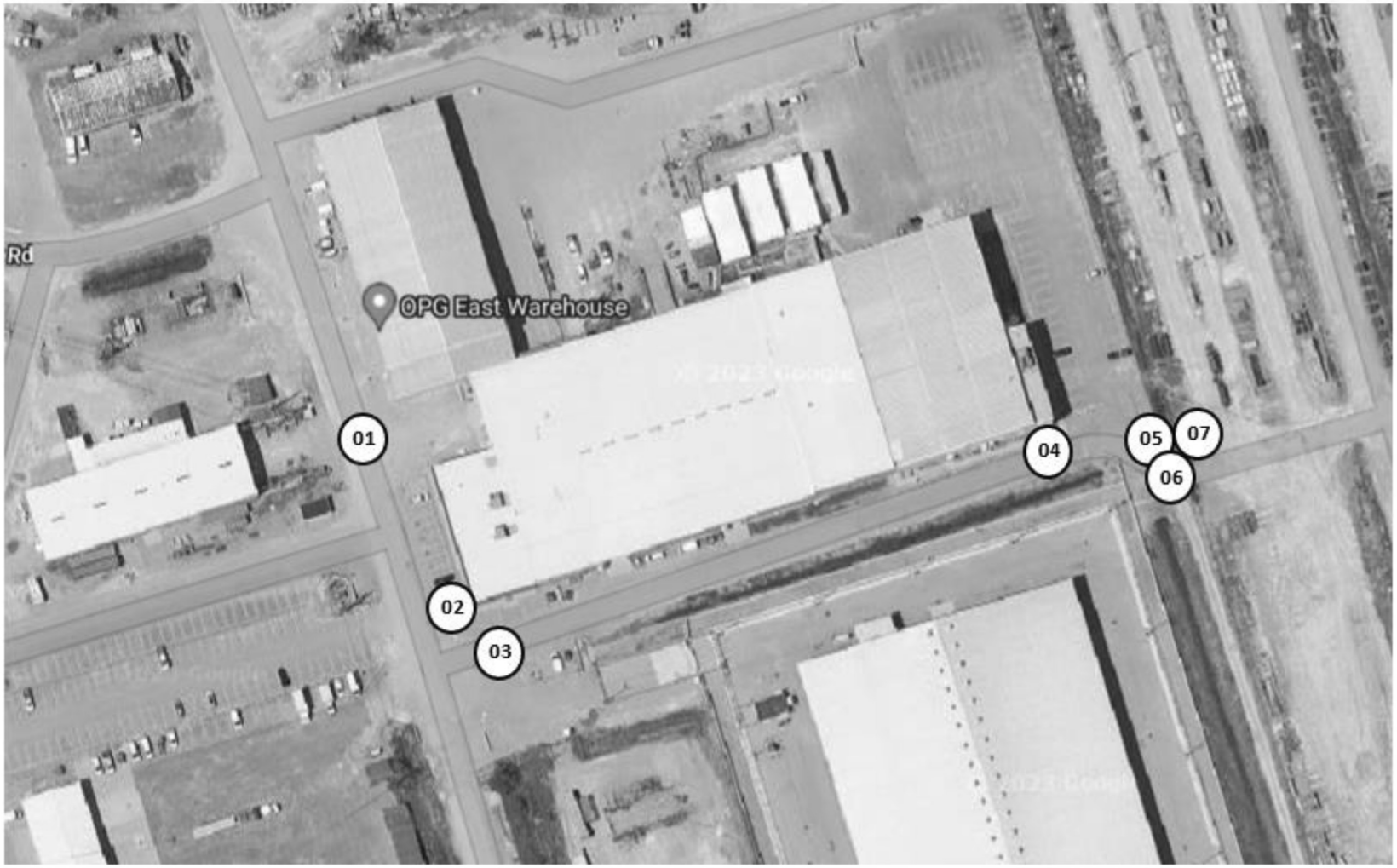

Figure C: Picture Showing the Locations where Photos were Taken along the Transfer Rout)

Figure C-1: Photo Taken at East Complex Warehouse Cross-Walk (Approximate 50m North of Intersection).

Figure C-2: Photo Taken At the Southwest Corner of East Complex Warehouse (Looking Southeast towards Entrance to PWMF Building).

Figure C-3: Photo Taken At the Southwest Corner of East Complex Warehouse (Looking East along the Route)

Figure C-4: Photo Taken At the Southeast Corner of East Complex Warehouse (Looking West towards PNGS).

Figure C-5: Photo Taken At the Midpoint of Curved Section of Route (Looking South) .

Figure C-6: Photo Taken At Eastern End of Route (Looking West).

Figure C-7: Photo Taken At Eastern End of Route (Looking Northeast through the Fence)
Note: PCSS will be built in this area.

Appendix D: Materials used in MCNP Modeling

D.1 Single Container MCNP Models

D.1.1 RWC-PT

For the RWC-PT concept, the container material is simply listed as carbon steel [8]. As the type of carbon steel was not specified, a carbon steel used in the previous full building MCNP model of the PWMF site [5], ASTM A516 Grade 70, was used to allow for easy integration of the new containers into the full building model in the Stage 2 calculation. The PT/CT coupons were treated as 100% zirconium, as this is a thick-walled container and photons are being modelled, it is not necessary to include the exact composition of the PT/CTs. The density of the homogenized PT/CT coupons was determined by taking the assumed mass of 3192 kg of coupons per container provided in Reference [8] and dividing it by the container internal volume of 1.78 m^3 to get a density of 1.79 g/cm^3. The composition of the materials used in the RWC-PT model is shown in Table D-1.

Table D-1: Material Composition of RWC-PT Components

Material	Density (g/cm^3)	Composition (wgt %)
Carbon Steel (ASTM A516 Grade 70)	7.85	C: 0.27% Si: 0.4% P: 0.025% S: 0.025% Mn: 1.2% Fe: 98.08%
Homogenized PT Coupons	1.79	Zr: 100%

D.1.2 RWC-EF

The material specification for the RWC-EF model was left unchanged from those used in the previous shielding analysis for the conceptual design of the RWC-EF [6]. The composition of the container and the End Fitting assemblies is shown in Table D-2 and Table D-3.

Table D-2: Material Composition of RWC-EF Container [6]

RWC-EF Component	Material Specification
External Bolt	ASTM A352 LC3
Fork Lift Pocket Support	A36 Carbon Steel
Internal Shield Plates and Plenum	A36 Carbon Steel
Lid	ASTM A516 Gr. 60
Body	ASTM A516 Gr.60

Table D-3: Material Composition of End Fitting Assemblies [6]

IEFs component	Material Specification
EF body	SS Type 403
Liner Tube	SA268 TP410
Fuel Adapter, Flow Tube, Shield Plug Body	SS Type 410
Wear Ring, Casing, Spider/Safety Stem and Latch	ASTM A564 SS630
Inboard Journal Ring	UNS T30102 AISI Type D2
Outboard Bearing Sleeve	UNS T30102 AISI Type A2
EF Shielding Sleeve	ASTM A519 Gr. 1025 Carbon Steel

D.1.3 Steam Generators

For the Steam Generator models, the materials were taken from the drawing of the SG [10] to the extent possible.

Table D-4: Material Composition of SG Components

Component	Material	Density (g/cm^3)	Composition (wgt %)
Outer Shell	Carbon Steel – ASTM A516 Grade 70	7.85	C: 0.27% Si: 0.4% P: 0.025% S: 0.025% Mn: 1.2% Fe: 98.08%
Homogenized u-tube bundle	Nickel-Copper – ASTM B163 [63]	Material: 8.8 g/cm^3 Component[7]: 1.0399 g/cm^3	C: 0.3% S: 0.024% Si: 0.5%

[7] Homogenized u-tube bundle density was set to 11.82% of the material density to account for the hollow tubes in the bundle. This ratio is consistent with the previous modelling of the WWMF SGs in Reference [8].

			Mn: 2% Fe: 2.5% Ni: 66.676% Cu: 28%
Tubesheet[8]	Carbon Steel Forgings for Piping – ASTM SA105 [64]	Material: 7.86 g/cm^3 Component[9]: 0.929 g/cm^3	C: 0.35% Mn: 0.60% P: 0.035% S: 0.04% Cu: 0.40% Ni: 0.40% Cr: 0.30% Mo: 0.12% V: 0.08% Fe: 97.675%

D.2 Full Building PCSS MCNP Model

The materials used were largely the same as the previously developed model for the PWMF in Reference [5]. A new material was added to represent the rockwool insulation of the industrial roof of the PCSS. This material definition was taken from the shielding analysis of the RWSB at the DWMF [12].

The materials for the RWCs and SGs were incorporated into the model, using the same definitions as described above. The only exception is that the air inside the RWC-EF used when creating the surface source used a slightly different density and definition of air, which was replaced with the same air definition as the rest of the model. The assumed composition of the materials used in the modelling of the PCSS are shown in Table D-5.

[8] Carbon Steel Forgings for Piping - ASTM SA105 from reference [62] contains 0.1 to 0.33% of silicon. However, for a gamma calculation, the omission of a very small amount of silicon in the Tubesheet, which is not part of the source material, is acceptable and hence the composition was not corrected.
[9] The tubesheet density was set to 11.82% of the material density to account for the hollow tubes. This ratio is consistent with the previous modelling of the WWMF SGs in Reference [8].

Table D-5: Composition of PCSS Materials

Material	Density (g/cm^3)	Element	Weight %	Reference
Concrete (shielding panels, floor)	2.35	H	0.56	Same as existing model in [5], first described in [16]
		O	49.83	
		Na	1.71	
		Mg	0.24	
		Al	4.56	
		Si	31.58	
		S	0.12	
		K	1.92	
		Ca	8.26	
		Fe	1.22	
Steel (A516 Grade 70, industrial roof cladding)	7.85	C	0.27	
		Si	0.4	
		P	0.025	
		S	0.025	
		Mn	1.2	
		Fe	98.08	
Rockwool Insulation (industrial roof insulation)	0.1	O	41.72	[12]
		Na	1.699	
		Al	3.45	
		Si	24.74	
		P	0.0655	
		K	1.303	
		Ca	21.64	
		Ti	0.306	
		Mn	0.0465	
		Fe	1.82	

ENCLOSURE 2

OPG letter, K. Aggarwal to C. Salmon, “Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure”

CD# 92896-CORR-00531-01544 P

Predictive Environmental Risk Assessment for Pickering Component Storage Structure

92896-REP-07701-00019 R001

(64 total pages)

ONTARIO POWER GENERATION

Coversheet

Proprietary	
Document Number: **92896-REP-07701-00019**	
Sheet Number: **n/a**	Revision: **R001**

Title:
Predictive Environmental Risk Assessment for Pickering Component Storage Structure

Predictive Environmental Risk Assessment for Pickering Component Storage Structure

92896-REP-07701-00019 R001 (LOF)

2023-11-30

Proprietary

Accepted by: Cammie Cheng Nov 30, 2023

Cammie Cheng
Senior Manager, Environment,
Health and Safety Nuclear

PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT FOR PICKERING COMPONENT STORAGE STRUCTURE

92896-REP-07701-00019 R001 (LOF)

REPORT PREPARED FOR:

Ontario Power Generation
889 Brock Road
Pickering, ON L1W 3J2

REPORT PREPARED BY:

Ecometrix Incorporated
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Mississauga, ON

Ref. 23-3251, R001
15 November 2023

PREDICTIVE ENVIRONMENTAL RISK ASSESSMENT FOR PICKERING COMPONENT STORAGE STRUCTURE

92896-REP-07701-00019 R001 (LOF)

George Alipanopoulos, M.Env.Sc.
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Revision Number	Date	Comments
R000	19-Oct-2023	Initial Issue of report.
R001	15-Nov-2023	Revision of Section 6.1.4.1 and Section 6.1.4.2 to remove text referring to a 1% increase in vehicle traffic.

LAND ACKNOWLEDGMENT

The lands and waters on which the Pickering Nuclear Generating Station (PNGS) is situated are the treaty and traditional territory of the Michi Saagiig and Chippewa Nations, collectively known as the Williams Treaties First Nations.

PNGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. These Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territory, is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

ALDERVILLE FIRST NATION | BEAUSOLEIL FIRST NATION | CURVE LAKE FIRST NATION | GEORGINA ISLAND FIRST NATION | HIAWATHA FIRST NATION | SCUGOG ISLAND FIRST NATION | RAMA FIRST NATION

EXECUTIVE SUMMARY

Ontario Power Generation (OPG), plans to construct the Pickering Component Storage Structure (PCSS) for the storage of low and intermediate level waste, including components such as steam generators, pressure and calandria tubes, calandria tube inserts as well as end fittings.

Since this would be a new activity for the Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) within Pickering Nuclear (PN) site, not covered under the current NSS-PWMF operating licence, a licence amendment to the existing NSS-PWMF operating licence will be required. A predictive environmental risk assessment (PERA) is prepared to be a supporting document to the licence amendment application. The PERA presented in this document meets the requirements outlined in CSA N288.6-22 (CSA, 2022) and REGDOC 2.9.1 (CNSC, 2020).

The PERA will supplement the existing PN environmental risk assessment (ERA) (Ecometrix, 2023a) which has so far not considered the potential for effects from the PCSS.

The potential interactions of the PCSS Project with various environmental components during all phases of the Project were evaluated qualitatively. Based on the qualitative assessment of Project-Environment interactions, the following assessment areas were identified as the focus of the quantitative assessment in the PERA.

- Emissions of dust (total suspended particulates) and particulate matter (PM_{10}, $PM_{2.5}$) to air during site preparation and construction.
- Elevated noise levels during site preparation and construction.
- Gamma radiation from the PCSS during operation.

Human Health Risk Assessment

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their limits; therefore, no further quantitative assessment is required.

The human health risk assessment evaluated the impact on human health of gamma radiation from the PCSS. For exposure of human receptors to gamma radiation from the PCSS, the potential dose to the Sport Fisher, located at the outfall, was evaluated. The estimated dose for the Sport Fisher is 4.38 µSv/a. Considering the existing facilities on the PN site, the dose to the Sport Fisher could be up to 4.94 µSv/a. This estimate represents less than 1% of the regulatory public dose limit of 1000 µSv/a.

Overall, since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential groups to gamma radiation from the PCSS.

Ecological Risk Assessment

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors, noise levels are expected to be elevated temporarily only during site preparation and construction. Most wildlife in the area are already accustomed to noise levels associated with an urban environment (i.e., noise from traffic on local roads and highway 401 and from other nearby industrial and commercial activities). Therefore, no further quantitative assessment is required.

The ecological risk assessment evaluated the impact on ecological health of gamma radiation from the PCSS. For exposure of ecological terrestrial receptors to gamma radiation from the PCSS, the maximum dose rate to any ecological receptors residing in close proximity to the PCSS could be up to 0.012 mGy/d, and up to 2.74E-04 mGy/d for off-site ecological receptors residing at the fenceline. All predicted doses are lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. Therefore, it was concluded that there are likely no adverse radiological effects to the ecological receptors.

The dose also remains well below the radiation benchmark (1% or less) if the maximum dose from the PCSS is combined with the dose to ecological receptors from being exposed to radionuclides through other existing PN operations.

Mitigation Measures and Environmental Monitoring Program

OPG will obtain all required environmental approvals and permits for the Project and will follow typical construction best practices including implementation of an Environmental Management Plan and a Stormwater Management Plan.

OPG's Environmental Policy requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001 Environmental Management System Standard. During site preparation, construction and operation of the PCSS, OPG's EMS will continue to require the assessment of environmental risks associated with the facility's activities, and to ensure that these activities are conducted such that any adverse impact on the natural environment is as low as reasonably achievable (ALARA).

Thermoluminescent dosimeters (TLDs) will be installed around the PCSS to monitor ambient dose rates during operation, and confirm that gamma dose rates remain below the dose rate target of 0.5 µGy/hr. TLD measurements will be summarized in the quarterly reports for the NSS-PWMF.

Based on the results of the PERA, no need for additional mitigation as a result of the PCSS was identified.

Overall, the PCSS will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the PN site. OPG maintains a comprehensive Environmental Monitoring

Program that provides data to confirm that all facilities on the PN site, including the future PCSS, operate in a manner that is protective of human and ecological receptors residing in the surrounding area.

LIST OF ACRONYMS

Acronym	Definition
AAQC	Ambient Air Quality Criteria
ALARA	As Low As Reasonably Achievable
CAAQS	Canadian Ambient Air Quality Standards
CCME	Canadian Council of Ministers of the Environment
CNSC	Canadian Nuclear Safety Commission
CO	Carbon Monoxide
COPC	Contaminant of Potential Concern
CSA	Canadian Standards Association
EMP	Environmental Monitoring Program
ERA	Environmental Risk Assessment
HHRA	Human Health Risk Assessment
ISO	International Organization for Standardization
L&ILW	Low and Intermediate Level Waste
MECP	Ontario Ministry of Environment, Conservation and Parks
NOx	Nitrogen Oxides
NSS-DWMF	Nuclear Sustainability Services – Darlington Waste Management Facility
NSS-PWMF	Nuclear Sustainability Services – Pickering Waste Management Facility
OPG	Ontario Power Generation
PCSS	Pickering Component Storage Structure
PERA	Predictive Environmental Risk Assessment
PM	Particulate Matter
PN	Pickering Nuclear
PNGS	Pickering Nuclear Generating Station
QA	Quality Assurance
RWSB	Retube Waste Storage Building
SO_2	Sulfur Dioxide
TLD	Thermoluminescent Dosimeters
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
UCLM	Upper Confidence Limit on the Mean
WSP	Water Supply Plant

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1.0 Introduction

Ontario Power Generation (OPG) plans to construct and operate the Pickering Component Storage Structure (PCSS) for the storage of low and intermediate level waste, including components such as steam generators, pressure and calandria tubes, calandria tube inserts as well as end fittings.

Since this would be a new activity for the Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF) within Pickering Nuclear (PN), not covered under the current NSS-PWMF operating licence, a licence amendment to the existing NSS-PWMF operating licence will be required. In order to obtain the licence amendment, it will be necessary to demonstrate to the Canadian Nuclear Safety Commission (CNSC) that construction and operation of the PCSS will have no adverse significant environmental impact.

Accordingly, a predictive environmental risk assessment (PERA) has been prepared to be a supporting document to the licence amendment application. The PERA presented in this document meets the requirements outlined in CSA N288.6-22 (CSA, 2022) and REGDOC 2.9.1 (CNSC, 2020). Clause 11.1 of CSA N288.6-22 and Section 4.1.1 of REGDOC 2.9.1 version 1.2 identify the need for a revised predictive environmental risk assessment when there is a proposed major facility change. From OPG's perspective, construction and operation of the PCSS is considered a proposed major facility change that would trigger a predictive environmental risk assessment. The PERA is intended to supplement the existing PN environmental risk assessment (ERA) (Ecometrix, 2023a) and to support any future ERAs and/or PERAs that will be completed for PN, as applicable.

1.1 Indigenous Engagement

OPG recognizes that while the assessment of effects from the PCSS project has been satisfied from the Western scientific perspective, it may not fully address the impact on Indigenous inherent and treaty rights as they are understood today. OPG endeavors to continue to work with Indigenous nations and communities to develop more fulsome and ongoing engagement. OPG plans to share this PERA report with Indigenous nations and communities for feedback.

2.0 Objectives and Scope

The objective of this assessment is to predict any potential adverse environmental effects (alternatively referred to as "effects") associated with the construction and operation of the PCSS.

The scope of the assessment will include consideration of project activities and their interactions with the environment, screening level identification of activities with potential for environmental effects, and prediction of effects from those activities.

The construction activities associated with building the structure will be considered at a screening level, but as further discussed below under project-environment interactions (**Section 5.0**), no environmental impacts from construction are expected. Accordingly, the scope of this assessment will be focused thereafter on the facility operation. Consistent with CSA N288.6:22 (CSA, 2022), the scope of this assessment only considers normal operation of the PCSS and does not assess potential effects associated with accidents.

Decommissioning of the PCSS is out of scope for this assessment. The existing Preliminary Decommissioninog Plan for the NSS-PWMF will be updated to include decommissioning planning for the PCSS.

The predicted effects from the PCSS will be compared to existing effects related to the current PN operations as described in the existing PN ERA (Ecometrix, 2023a).

The need for mitigation measures, or for environmental monitoring related to operation of the PCSS, will be considered based on the predicted effects of the operation.

Cumulative effects due to the operation of the PCSS will be evaluated, along with a comparison against baseline conditions in the existing PN ERA (Ecometrix, 2023a).

3.0 Structure of the Assessment

The PERA is carried out in accordance with ERA guidance as per CSA N288.6-22 (CSA, 2022) and CNSC REGDOC 2.9.1 (CNSC, 2020). The steps in the assessment are illustrated at a high level in **Figure 3-1**.

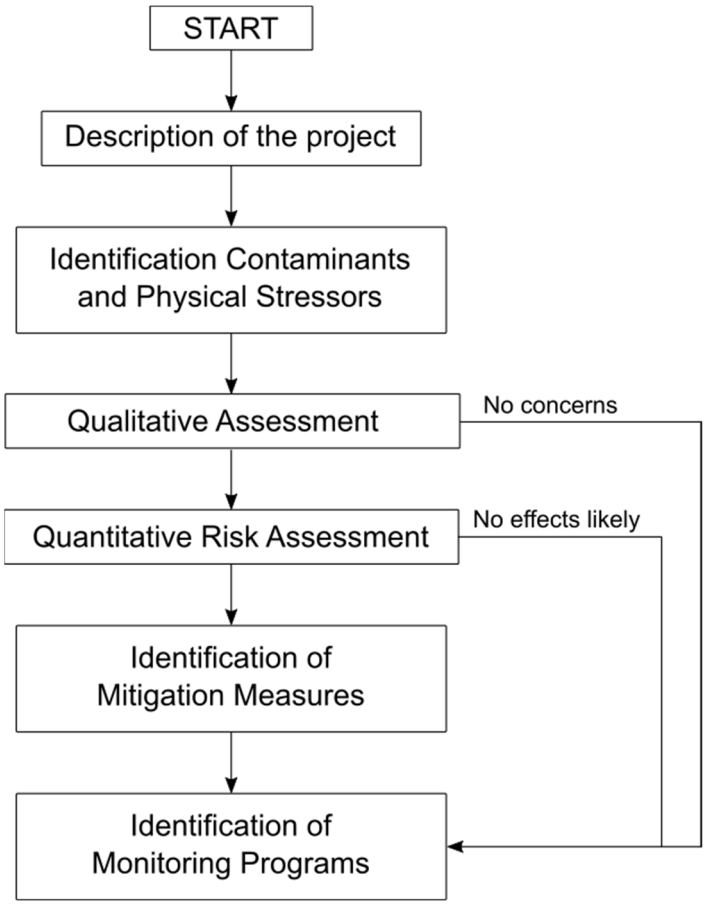

Figure 3-1: Steps in the Predictive Environmental Risk Assessment

A qualitative assessment of potential for environmental effects related to project activities (i.e. of potential project-environment interactions) identifies activities that require a quantitative predictive assessment.

The quantitative risk assessment in **Figure 3-1** includes consideration of risk to both human receptors (HHRA) and ecological receptors (EcoRA). These are two components of ERA as described by CSA N288.6-22 (CSA, 2022).

The mitigation measures mentioned in **Figure 3-1** refer to environmental protection measures associated with the project, which include measures to monitor and/or control emissions, as described in CNSC REGDOC 2.9.1 on Environmental Protection (CNSC, 2020).

The monitoring programs mentioned in **Figure 3-1** refer to the environmental monitoring programs (EMP). Any additions to the existing EMP that may be needed in relation to the operation of the PCSS will be described.

The following sections of this report address the structure outlined in **Figure 3-1**, including:

Section 4.0 Description of the Project (including contaminants of potential concern)

Section 5.0 Potential Project-Environment Interactions, Qualitative Assessment, and Plan for Quantitative Assessment

Section 6.0 Predictive Human Health Risk Assessment

Section 7.0 Predictive Ecological Risk Assessment

Section 8.0 Cumulative Effects Assessment

Section 9.0 Environmental Management

Section 10.0 Quality Assurance

Section 11.0 Conclusions and Recommendations

4.0 Description of the Project

4.1 Project Overview

The Nuclear Sustainability Services – Pickering Waste Management Facility (NSS-PWMF), formerly the Pickering Waste Management Facility (PWMF), sits within the Pickering Nuclear (PN) site to the east of the Pickering Nuclear Generating Station (PNGS). The PN site is located in the Province of Ontario, in the Regional Municipality of Durham, in the City of Pickering, on the north shore of Lake Ontario at Moore Point, about 32 km east of downtown Toronto and 21 km west of Oshawa at latitude 43° 49′ N and longitude 79° 04′ W. The site location and vicinity are shown in **Figure 4-1**. The PN site is owned and operated by Ontario Power Generation (OPG).

The NSS-PWMF has been in service since 1994 and is comprised of two (2) sites. The NSS-PWMF Phase I site is located southeast of PN Unit 8, adjacent to the east side of the station security fence, and contains two used fuel dry storage buildings and a Retube Component Storage area. The NSS-PWMF Phase II site is located approximately 500 m north-east of the power generating facilities in the East Complex, with its own distinct "protected area" (OPG, 2018).

The proposed PCSS will be located adjacent to the northern boundary of the NSS-PWMF Phase II site within the Pickering Site East Complex as shown in **Figure 4-2**. However, ownership and operation of the PCSS will fall under the NSS-PWMF. The PCSS will be used for the storage of low and intermediate level waste from potential refurbishment and/or decommissioning storage requirements, including components such as steam generators, pressure and calandria tubes, calandria tube inserts, and end fittings. Based on the expected waste streams that will be produced, the PCSS is expected to have an area of approximately 26,000 ft^2. The structure will be shielded with concrete walls and enclosed with a roof.

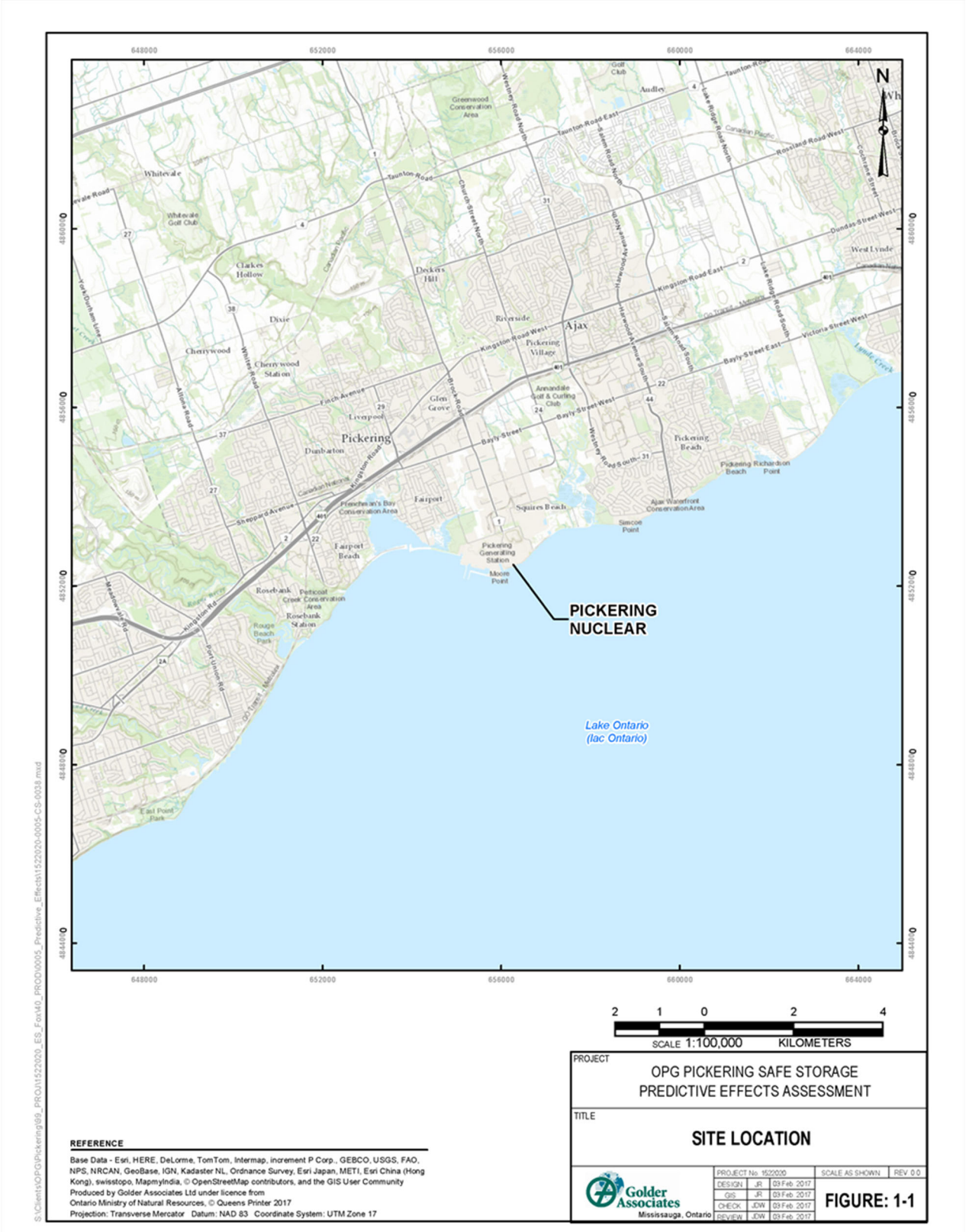

Figure 4-1: PN Site Location and Vicinity

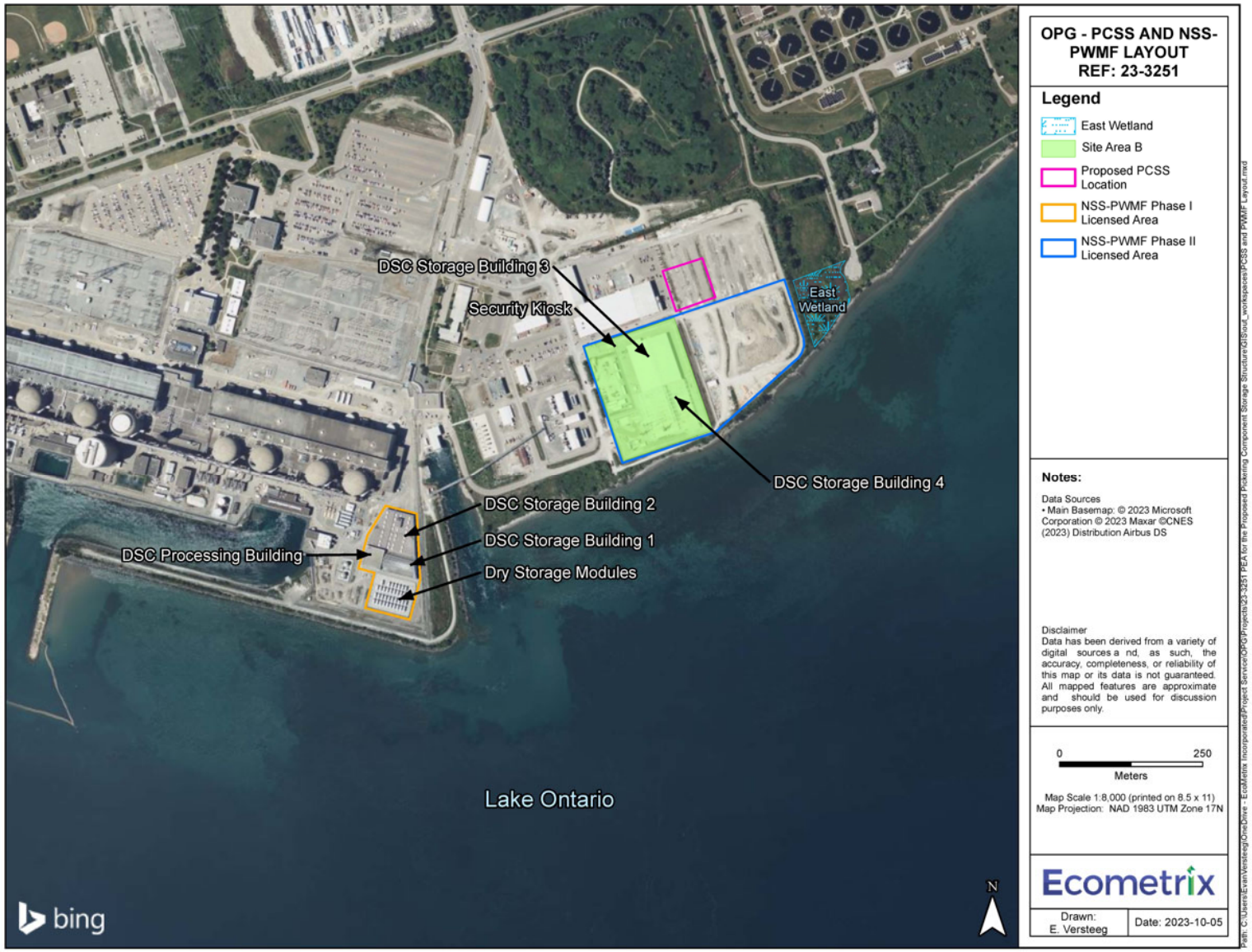

Figure 4-2: PCSS and NSS-PWMF Layout

4.2 Project Activities

Three main phases are associated with the Project and include:

- **Site Preparation:** This phase includes all activities associated with preparing the Project area for construction of the PCSS. Activities may include clearing the site, excavation, grading, and installation of utilities.
- **Construction:** This phase includes all activities associated with constructing the PCSS immediately following site preparation and up to the transfer of wastes to the new structure.
- **Operation and Maintenance:** This phase includes all activities associated with normal operation of the PCSS, and includes accepting and storing wastes and performing regular inspections and maintenance activities.

4.2.1 Site Preparation Phase Works and Activities

Site preparation involves preparation of the site for future construction activities. All site preparation activities are assumed to be completed at approximately the same time before construction of the PCSS begins. For the purposes of this PERA, the following site preparation activities are assumed to occur during pre-construction.

4.2.1.1 Site Clearing and Maintenance of Cleared Areas

Currently, the area of the proposed PCSS (shown on **Figure 4-2**) is being used as a laydown area where tools, materials and other equipment are being temporarily stored. The area is sparsely vegetated, but small patches of shrubbery and plants may need to be removed using conventional equipment including shovels, chainsaws or excavators. Cleared vegetation may be transported off-site for disposal or may remain on the PN site. Following clearing, the area will be maintained to ensure new vegetation does not repopulate the area and that the area remains clear of debris.

4.2.1.2 Excavation

During site preparation, the area will be excavated and levelled as required to establish appropriate grading for future construction of the PCSS. Excavation will take place using conventional equipment such as excavators and bulldozers. Where possible, excavated soil may be used as fill material. Otherwise, soil and other excavated materials may either be stored for future use at the PN site or be disposed of off-site in accordance with applicable regulations.

4.2.1.3 Grading and Compaction

Grading and compaction will be required on the overall site and in the area where backfilling of the structure's foundation has occurred. Conventional construction equipment such as graders and vibratory rollers will be used. Where possible, site grading will direct surface runoff to the

existing drainage infrastructure using industry best management practices for erosion and sediment control.

4.2.1.4 Installation of Utilities

Utilities connected to the new PCSS will include electricity, communication services, and fire water supply. The structure will not have any personal services (i.e. washrooms, office, lunch room, etc.)

4.2.1.5 Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel

During the site preparation phase, construction materials, equipment and trailers will be transported and stored within the PCSS area. This will increase the amount of vehicle traffic (passenger vehicles, heavy construction machinery) moving to and within the Project area. A spill management plan will be in place within the construction island as a result of these activities.

4.2.1.6 Vehicle and Equipment Operation, Maintenance and Refueling

Refuelling by a refuelling truck and maintenance of construction equipment and vehicles will occur on an as-needed basis within the PCSS construction island. A spill management plan will be in place within the construction island as a result of these activities.

4.2.1.7 Stormwater Management and Drainage

The stormwater management system collects, transports, and discharges precipitation that falls onto the NSS-PWMF site. During site preparation, measures will be put in place to minimize the impact of site runoff. These temporary measures may include ditching, sediment basins, berms and hay bales to reduce sediment loadings in runoff. As noted, site grading should direct surface runoff to the existing drainage infrastructure where possible. OPG will employ best practices for stormwater management that would meet Ontario Ministry of Environment, Conservation and Parks (MECP) requirements and industrial sewage works rules.

4.2.2 Construction Phase Works and Activities

The construction phase involves the construction of the new PCSS. For the purposes of this PERA, the following activities are assumed to occur during construction.

4.2.2.1 PCSS Construction

Construction activities and materials will be similar to those used for conventional industrial buildings. Once the PCSS is constructed, the area surrounding the structure will be paved over.

4.2.2.2 Construction Waste Management

Construction activities are expected to produce negligible quantities of conventional construction waste and no radioactive waste. Potential waste streams include gravel, wood, domestic refuse, and potentially small quantities of metal and concrete. On-site waste

management and off-site disposal will be the responsibility of the construction contractor selected by OPG.

4.2.2.3 Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel

During the construction phase, construction materials, equipment, and trailers will continue to be transported and stored within the PCSS area. This will increase the amount of vehicle traffic (passenger vehicles, heavy construction machinery) moving in, out and within the PCSS area.

4.2.2.4 Vehicle and Equipment Operation, Maintenance and Refueling

Refuelling by a refuelling truck and maintenance of construction equipment and vehicles will occur on an as-needed basis within the PCSS area in areas designated for such activities.

4.2.2.5 Stormwater Management and Drainage

Stormwater management during construction will be the same as during site preparation. OPG will employ best practices for stormwater management that would meet Ontario MECP requirements and industrial sewage works rules.

4.2.3 Operation and Maintenance Phase Works and Activities

The operation and maintenance phase is assumed to commence once construction is complete. The operation of the NSS-PWMF is governed by the Waste Facility Operating Licence (CNSC, 2018) and OPG policies and procedures covering all aspects of the waste management systems and structures. The PCSS will be incorporated into the existing NSS-PWMF operating policies and procedures.

4.2.3.1 Transfer of Waste to the PCSS

The PCSS is proposed to store L&ILW associated with the possible PNGS refurbishment project and possibly future PNGS decommissioning activities. The waste streams that would require storage at the PCSS include intact steam generators (SGs), pressure tubes and calandria tubes, calandria tube inserts and end fittings. These materials will be processed (e.g. volume reduced, packaged, etc.) within the PNGS before transfer to the PCSS for secure storage.

4.2.3.2 Operation of the PCSS

Storage of wastes at the PCSS will occur in accordance with approved OPG policies and practices. Radiological monitoring consistent with existing OPG procedures and protocols for other waste buildings within the NSS-PWMF will occur at the PCSS once radiological wastes are received.

The PCSS will require regular inspection and maintenance; maintenance is anticipated to consist largely of lamp replacement for overhead lights, roof inspections and routine scheduled maintenance of mechanical components (e.g., fans, service doors, fire protection systems).

Radioactive contamination is not expected in the PCSS under normal operation. Waste packages must be surveyed and be free of loose external contamination before leaving the Protected Area boundary of the PNGS. Based on knowledge of existing waste buildings, it is expected that negligible quantities of LLW, such as contaminated wipes, floor sweepings, rags and cleaning materials may be produced in the PCSS during operation and maintenance. These wastes will be managed according to approved OPG policies and practices.

Operation and maintenance of the PCSS will require minimal use of potentially hazardous substances. Small quantities of non-radioactive domestic waste typical of a commercial/industrial facility (e.g., cleaning solutions) may be produced during operation and maintenance of the facility.

4.2.3.3 Stormwater Management and Drainage

The infiltration capacity of the NSS-PWMF area may be decreased by the PCSS due to vegetation clearing, grading and compaction, and the paving of surfaces. This may result in an increase in peak flows. To the extent possible, grading will be designed to direct surface runoff towards existing drainage infrastructure. All site grading and other stormwater management activities will be undertaken during the site preparation phase. OPG will employ best practices for stormwater management that would meet Ontario MECP requirements and industrial sewage works rules.

5.0 Potential Project-Environment Interactions, Qualitative Assessment

5.1 Potential Project Environment Interactions

The PCSS has the potential to affect various components of the environment, including the surface water environment, atmospheric environment (air quality and noise), the soil and shallow groundwater (by transfer from air to soil porewater), the terrestrial environment (plants and animals) and human health (workers and members of the public). Based on the description of Project activities (**Section 4.2**) the potential for impact on components of the environment is evaluated qualitatively in this section at a screening level, to identify interactions that warrant further quantitative assessment (see **Table 5-1**).

Workers during site preparation, construction, and operations and maintenance will be working under the existing OPG Radiation Protection Program, and the existing Health and Safety Management Systems. Normal work planning procedures will be followed, and worker doses will be monitored as usual. As such, worker health from the PCSS is not considered further in the PERA.

Table 5-1: Identification of Project-Environment Interactions

Project Activities	Atmospheric Environment (air and noise)	Surface Water Environment (quality and quantity)	Groundwater (quality and quantity)	Geology (Soils)	Radiation and Radioactivity	Terrestrial Environment	Aquatic Environment	Human Health (public)
Site Preparation								
Site Clearing and Maintenance of Cleared Areas	✓	O	O	O	-	✓	O	✓
Excavation (and Storage)	✓	O	O	O	-	✓	O	✓
Grading and Compaction	✓	O	O	O	-	✓	O	✓
Installation of Utilities	✓	-	O	O	-	✓	-	✓
Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel	✓	O	O	O	-	✓	O	✓
Vehicle and Equipment Operation, Maintenance and Refueling	✓	O	O	O	-	✓	O	✓
Stormwater Management and Drainage	-	O	O	O	-	O	O	O
Construction								
PCSS Construction	✓	O	O	O	-	✓	O	✓
Construction Waste Management	✓	O	O	O	-	✓	O	✓
Transportation and Storage of Construction Materials, Equipment, Trailers and Personnel	✓	O	O	O	-	✓	O	✓
Vehicle and Equipment Operation, Maintenance and Fueling	✓	O	O	O	-	✓	O	✓

Project Activities	Atmospheric Environment (air and noise)	Surface Water Environment (quality and quantity)	Groundwater (quality and quantity)	Geology (Soils)	Radiation and Radioactivity	Terrestrial Environment	Aquatic Environment	Human Health (public)
Stormwater Management and Drainage	-	O	O	O	-	O	O	O
Operation and Maintenance								
Transfer of Waste to the PCSS	O	O	O	O	✓	✓	O	✓
Operation of the PCSS	-	-	-	-	✓	✓	-	✓
Stormwater Management and Drainage	-	O	O	-	-	-	O	O

Note:
✓ Indicates direct interaction with the environmental component. Further quantitative assessment required.
O Indicates negligible interaction with the environmental component. No further quantitative assessment required.
'-' Indicates no interaction with the environmental component. No assessment required.

5.2 Qualitative Assessment of Project-Environment Interactions

Table 5-1 summarizes the potential interactions of the Project with various environmental components either as direct or negligible interactions. The following section details these interactions and assesses the risk qualitatively or identifies that the interaction is assessed further quantitatively in **Sections 6.0**, **7.0** and **8.0**.

5.2.1 Atmospheric Environment (Air Quality and Noise)

The atmospheric environment consists of the air surrounding the Project area within which air pollutants and elevated noise levels may be experienced by on-site and off-Site humans or ecological receptors. All phases of the Project are expected to interact with the atmospheric environment.

5.2.1.1 Air Quality

5.2.1.1.1 Radiological Emissions

No radiological air emissions are expected during any phase of the Project. No radiological materials are associated with site preparation and construction. During operation and maintenance of the PCSS, radiological wastes will be contained and stored in the PCSS, and as a result, no radiological emissions are expected during normal operations. Thus, radiological emissions to the atmosphere are considered negligible and are not assessed further in the PERA. Gamma radiation from the PCSS is discussed in **Section 5.2.5**.

5.2.1.1.2 Non-Radiological Emissions

Site preparation and construction are expected to involve the use of both light equipment (e.g., chainsaws) and heavy equipment (e.g., bulldozers, dump trucks, pick-up trucks) that could release non-radiological air emissions (e.g., exhaust emissions) into the atmosphere. Excavation, grading, installation of buried utilities and other sub-surface activities that disrupt the soil surface may contribute to particulate matter (PM) and dust in the air.

OPG will follow typical construction best practices including implementation of an Environmental Management Plan. The construction Environmental Management Plan will include protocols for dust suppression during site preparation and construction to reduce the release of particulates and dust into the atmosphere. The on-site storage of excess soils may also contribute to particulate and dust emissions and may also be subject to dust suppression protocols as required. During construction, building and construction waste materials (e.g., concrete) may also contribute particulates and dust to the atmosphere. Other chemicals including fuel (gasoline or diesel), oils, paints, solvents and cleaners may release volatile compounds into the atmosphere during use or accidental spills. However, the quantity and frequency of these releases is considered negligible as these chemicals will be securely stored, and spills would be managed following site-specific procedures and existing OPG spill management protocol.

Once operation of the PCSS begins, there would be exhaust emissions from vehicles during the transfer of waste materials. Vehicle traffic associated with PCSS operation may be similar to or slightly higher than that associated with current NSS-PWMF operations, but the increased vehicle emissions due to the slightly increased traffic volumes would overall be considered negligible.

Considering the above interactions, non-radiological air pollutants (e.g., particulate matter, dust, exhaust emissions) may impact the atmospheric environment during site preparation and construction, and will be quantitatively assessed in the PERA.

5.2.1.2 Noise

During site preparation and construction, elevated levels of noise may be produced. Both light equipment (e.g., chainsaws, power tools) and heavy equipment (e.g., bulldozers, dump trucks, pick-up trucks) produce loud sounds and vibrations during their operation. In addition, loud banging sounds typical of an active construction site are expected during site preparation and construction.

During operation and maintenance, noise may be produced by trucks transferring waste materials to the PCSS. Vehicle traffic associated with PCSS operation may be similar to or slightly higher than that associated with current NSS-PWMF operations but would overall be considered negligible.

OPG will follow typical construction best practices including implementation of an Environmental Management Plan.

Considering the above interactions, elevated levels of noise during site preparation and construction only may impact the atmospheric environment and will be quantitatively assessed in the PERA.

5.2.2 Surface Water Environment and Aquatic Environment

The surface water environment at PN with respect to the PCSS is described as surface runoff and drainage features on the property, which ultimately drain into Lake Ontario. The aquatic environment at PN with respect to the PCSS is Lake Ontario. A construction Environmental Management Plan will be in place with mitigation measures to minimize adverse impacts to the environment. For example, excavations are expected to be shored or sloped until stable to ensure that any surface water runoff is directed to a sump pit where it will be collected and removed by a sump pump and will subsequently be properly managed and controlled to meet the regulatory requirements. Excavations, stockpiling or backfilling activities will also be rescheduled or suspended to limit work completed during days of heavy rainfall or adverse weather conditions that could impact soil or surface water quality.

Any impacts from the transportation and storage of various components as well as vehicle and equipment operations involved in site preparation, construction and operations may indirectly impact surface water. However, surface water quality entering the surface drainage features will

not likely be impacted, due to the implementation of OPG's existing spill management protocols, which outlines the framework to manage spills, ensuring the implementation of spill prevention, preparedness, clean-up and remediation processes. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

During all Project phases there is no source of contaminants (radiological or non-radiological) that would result in impacts to surface water or sediment. Water would be managed and monitored according to the approved Environmental Compliance Approval for the PN site.

During site preparation and construction surface runoff and drainage will be directed towards surface drainage infrastructure (i.e., new ditches and sewers that connect to the existing stormwater infrastructure).

Sediment may have the potential to impact the surface drainage infrastructure, drainage to Lake Ontario and therefore the aquatic environment. A Stormwater Management Plan will be developed to provide the plans for mitigating erosion and sediment transport during site preparation and construction. Additionally, it is expected that the PCSS Project will utilize construction best practices to mitigate the amount of sedimentation created within the Project area and apply the appropriate control measures to achieve the required contaminant removal efficiency for total suspended solids (TSS) prior to the release of water into the surface water environment. Additional control measures such as diversion ditching, silt fencing, and straw bale barriers will also be used in areas where existing systems or typical control measures do not fully address potential sedimentation issues related to this Project.

A separate Stormwater Management Plan will be developed for the operation and maintenance phase post construction. The assessment of modifications to existing stormwater infrastructure (e.g., the development of a new stormwater outfall, or the installation of new drainage ditches and storm sewers) needed to support the Project will be completed by a civil engineer. It is assumed that any modifications or expansions to the stormwater management system will meet water quality protection criteria as per MECP requirements. As such, no change to existing channel forming flows, flood risk, or erosion potential will be expected during operation and maintenance of the PCSS. Additionally, any shoreline work for potential outfalls, if needed, would be done as per Toronto and Region Conservation Authority approvals. The stormwater management system itself will not represent an adverse effect to surface water quantity.

Considering the above commitments and mitigation measures, no further quantitative assessment is included as part of this PERA. Further detail on mitigations will be developed through the design of the stormwater management system. Therefore, impacts to the surface water environment (through surface water quality) and to the aquatic environment as a result of surface water runoff from the PCSS Project are considered to be adequately managed and will not be assessed further in the PERA.

5.2.3 Groundwater (Quality and Quantity)

Overall, during site preparation, construction, operation and maintenance, any exposed soil can result in constituents in soil, surface water and precipitation infiltrating downwards towards the groundwater table instead of being diverted to surface drainage. Soils interacting with surface water (site drainage) can infiltrate into the water table and impact groundwater quality. However, groundwater quality is not expected to be impacted as a result of these activities as any potential spills will be managed following site-specific procedures and existing OPG spill management protocol. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

Dewatering of groundwater is not expected during excavation activities, however this will be confirmed via a hydrogeological or geotechnical investigation. If dewatering is needed, it will only be done with necessary permissions, intended to be protective against the discharge or re-infiltration of collected groundwater.

Therefore, based on the current understanding that dewatering will not occur, impacts to the groundwater quality and quantity as a result of the PCSS Project will be negligible, and will not be assessed further in the PERA.

5.2.4 Geology (Soils)

Overall, during site preparation, construction, operation and maintenance, any exposed soil can be impacted due to excavations, or the storage, transportation or handling and maintenance of various components related to different phases of the PCSS. Soil and other excavated materials may either be stored for future use at the PN site or be removed off-site in accordance with applicable regulations.

Soil quality is not expected to be impacted as a result of these activities as any potential spills will be managed following site-specific procedures and existing OPG spill management protocol. Potential impacts due to a spill event investigation and associated corrective actions are not considered in this document.

A construction Environmental Management Plan will also be in place with some mitigation measures. For example, excavations are expected to be shored or sloped until stable to ensure any surface water runoff is directed to a sump pit where it will be collected and removed by a sump pump where it will subsequently be properly managed and controlled to meet the regulatory requirements. Also, excavations, stockpiling or backfilling activities will also be rescheduled or suspended to limit work completed during days of heavy rainfall or adverse weather conditions that could impact soil or groundwater quality.

Therefore, impacts to the soil quality as a result of the PCSS Project will be negligible, and will not be assessed further in the PERA.

5.2.5 Radiation and Radioactivity

Increased radiation or radioactivity levels in the environment are not expected during site preparation and construction as these phases do not involve the use of radioactive materials or the modification of facilities that use radioactive materials.

During the operation and maintenance phase, no radioactivity will be released to air or water as all radionuclides are expected to be contained in waste storage containers within the PCSS (**Section 5.2.1.1.1**).

There will be gamma radiation fields emitted during the transfer of waste storage containers and once waste is stored in the PCSS during operation. The design of the PCSS will provide some shielding in the walls, which will be verified upon the completion of the structure design. The effects of direct gamma radiation from operation of the PCSS are assessed conservatively by assuming the full complement of loaded waste storage containers and minimal shielding.

Therefore, gamma radiation fields from the transfer and storage of waste containers at the PCSS during the operation and maintenance phase can impact humans and terrestrial organisms and is therefore considered further for the quantitative assessment.

5.2.6 Terrestrial Environment

The terrestrial environment considers the various terrestrial habitats within and immediately surrounding the PCSS site and the diverse groups of plants and animals that rely on those habitats for survival, including federally and provincially-protected Species at Risk (SAR). Although the PCSS site is highly disturbed and is not considered to contain significant terrestrial habitat, some plant and animal species adapted to urban and disturbed environments may reside within the PCSS site. Interactions between the Project and the terrestrial environment are expected to occur as a result of either direct disturbance of the ground (e.g., excavation) or through the release of air pollutants and noise/vibration from the atmospheric environment.

The PCSS will be constructed within the existing PN site, which consists of numerous buildings, parking lots, paved and gravel areas, and outdoor laydown areas where equipment and materials are stored. There is no significant vegetation within the proposed PCSS site. Vegetation that does exist is sparse and is consistent with rugged vegetation typical of a highly-disrupted, developed environment (e.g., weeds, grasses, small shrubs). These small pockets of vegetation will be removed during site preparation to clear the area for paving and the PCSS structure itself. Denser vegetation consisting of cultural meadows containing species tolerant of poor soil conditions exist to the north and east of the site. Pockets of mineral cultural woodlands containing younger treed communities and mineral cultural thickets are interspersed within the surrounding meadows. Small mineral shallow marshes exist dotted around the PN site to the north, east and west of the proposed PCSS location (Beacon, 2023). To the south, along Lake Ontario, there also exist pockets of meadows, thickets and open shoreline where vegetation is generally sparse. Off-site vegetated areas surrounding the PN site are fragmented by roads, public trails and other infrastructure (Beacon, 2023). Soil organisms that live within the subsurface may be impacted during site preparation as the landscape is drastically altered and

disturbed by excavation and grading. Small mammals and birds are likely present in the proposed PCSS area, and may use the area for shelter or to hunt and scavenge for prey and food. These mammals and birds will be disrupted during site preparation and construction, but are expected to return during normal operations when construction has ceased.

During all phases of the Project, there is the potential for vehicle collisions with wildlife that may result in injuries or road mortalities. Wildlife surrounding the PCSS may be impacted by air emissions (e.g., vehicle exhausts, dust) and loud noises and vibrations during site preparation and construction. During operation and maintenance, wildlife may be exposed to direct gamma radiation fields from the PCSS where waste materials are stored.

During site preparation and construction, various measures outlined in the construction Environmental Management Plan will be followed to minimize impacts to the terrestrial environment and local wildlife. The Environmental Management Plan identifies best practices relating to air and water management, noise control, contaminated and excess soil management, and general wildlife management. Safe driving best practices will be used to avoid vehicle collisions with wildlife.

Since direct interactions between Project activities and the atmospheric environment were identified for the site preparation and construction phases, the subsequent effects on the terrestrial environment will be quantitatively assessed for these phases. In addition, a quantitative assessment of radiation exposures near the PCSS during the operation and management phase will be completed for terrestrial wildlife.

5.2.7 Human Health (Public)

During site preparation and construction, OPG staff will be working under the existing OPG Health and Safety Management Systems. Similarly, on-site contractors are expected to work in accordance with their own health and safety programs and procedures. Once operation of the PCSS begins, OPG staff will be working under the existing OPG Radiation Protection Program. For these reasons, the assessment of potential Project effects to on-site workers are not considered part of this PERA.

Members of the general public will not have direct access to the PCSS as the entire PN site is enclosed by perimeter fencing and is continuously protected by security personnel. However, off-site human receptors at the perimeter of the PN site may be impacted by Project activities. This is primarily expected to be due to loud noises and vibrations associated with site preparation and construction. Human receptors may come into contact with airborne dust at the PN perimeter. As noted in **Section 5.2.1.1.2**, dust suppression techniques used during site preparation and construction is expected to reduce the amount of dust emissions released to the atmosphere. Human receptors at the PN site boundary may be exposed to air constituents associated with engine emissions during site preparation and construction. During operation and maintenance, the general public in close proximity to the eastern boundary of the PN site may be exposed to direct gamma radiation fields emitted from the PCSS.

Since direct interactions between Project activities and the atmospheric environment were identified, the subsequent effects on human health (e.g., dust, engine emissions, noise) will also be quantitatively assessed for the site preparation and construction phases. In addition, a quantitative assessment of direct gamma radiation exposures to the general public at the PN site boundary from the PCSS during the operation and maintenance phase will be completed.

5.2.8 Identification of Contaminants of Potential Concern and Physical Stressors

The environmental stressors investigated further in this PERA include air emissions, noise and radiation.

It is expected that air emissions are released during the site preparation and construction phase that are largely related to engine emissions from construction activities involving both light and heavy equipment. It is expected that the contaminants of potential concern (COPCs) include sulfur dioxide (SO_2), nitrogen oxide compounds (NO_x), carbon monoxide (CO), dust (i.e., total suspended particulates) and particulate matter at 2.5 µm and 10 µm ($PM_{2.5}$ and PM_{10}). Noise is also a potential stressor to human and terrestrial biota associated with the use of light and heavy equipment operations during site preparation and construction of the PCSS.

Finally, gamma radiation fields associated with the storage of radiological wastes can act as a potential stressor to both human and terrestrial biota from the PCSS.

5.3 Quantitative Assessment of Project-Environment Interactions

As previously noted, **Table 5-1** summarizes the potential interactions of the Project with various environmental components either as direct, indirect or negligible interactions. Direct interactions identified in **Table 5-1** and further characterized in **Section 5.2** will be assessed quantitatively in **Sections 6.0** and **7.0.** Additionally, **Section 8.0** will quantitatively assess potential cumulative effects between the PCSS and the existing PN site.

Section 6.0 will quantitatively assess potential risks to human health from air pollutants, dust and noise emissions produced during site preparation and construction of the PCSS, and from gamma radiation released from the PCSS during operation and maintenance.

Similarly, **Section 7.0** will quantitatively assess potential risks to ecological (terrestrial) receptors from air pollutants, dust and noise emissions produced during site preparation and construction of the PCSS, and from gamma radiation fields from the PCSS during operation and maintenance.

5.4 Climate Change Considerations

There is uncertainty related to interactions of climate change with this Project. Changes in climate have the potential to affect meteorological parameters that influence dispersion over the long term (i.e., the life of the Project). This may influence deposition rates and subsequent environmental media concentrations. Considering site preparation and construction activities are anticipated to last for a short duration (less than one to two years), the impact of climate change on meteorological conditions is minimal.

Likely increased frequency and severity of extreme weather events over the coming decades due to climate change may affect the Project. Changes in climate during the lifetime of the Project may result in increased precipitation which would result in additional runoff. Additionally, extreme precipitation events are expected to increase over time. The design of the water management infrastructure would include additional capacity to accommodate climate change, as applicable. Additionally, the Project will be designed using engineering best practices which will account for considerations of extreme weather events. OPG's existing Emergency Management Program addresses actions to be taken to respond to emergencies which would include extreme weather events.

Overall, considering the limited interactions of the Project with the environment, and the existing measures (e.g., Emergency Management Program, consideration of extreme weather events in infrastructure design) to mitigate interactions between the environment and the Project, the impacts of climate change on the Project are considered negligible.

6.0 Predictive Human Health Risk Assessment

6.1 Problem Formulation

The problem formulation provides the objectives, goals, framework and methodology for the risk assessment and consists of identifying the relevant components for the HHRA. These components include the human receptors that may be potentially present in or around the PN Site; the chemical and radiological contaminants in or around the PN Site; and the exposure pathways by which receptors could be exposed to contaminants in the environment. A conceptual site model illustrates all of these relationships, based on the results of the problem formulation.

6.1.1 Health and Safety of On-site Workers

On-site workers, contractors, and visitors are potentially exposed to environmental contaminants, both chemical and radiological, but these exposures are considered and controlled through OPG's Health and Safety Management System and the Radiation Protection Program, and are not considered in this HHRA, as discussed below.

The Health and Safety Management System Program is designed to ensure the protection of employees, contractors and visiting members of the public. The program outlines a systems approach used to manage risks associated with activities, products and services of OPG Nuclear operations. Contractors are required to maintain a level of safety equivalent to OPG staff while working at an OPG workplace. Work at OPG is subject to safe work planning requirements where safety hazards are identified and mitigating measures are communicated through Pre-Job Briefings. Routine or planned work is governed by approved procedures and operating instructions.

During operation and maintenance of the PCSS, OPG's Radiation Protection Program will be applied. The Radiation Protection Program is designed to ensure that doses for employees, contractors and visiting members of the public are below regulatory limits, and As Low As Reasonably Achievable (ALARA), social and economic factors being taken into account. Employee radiation doses are monitored to ensure they do not exceed exposure control levels that are below regulatory limits. Doses to visitors and contractors are also monitored. Only workers classified as Nuclear Energy Workers (NEWs) may perform radioactive work. Visitors are limited to non-radioactive work and escorted by a qualified NEW. Personal information is collected for the purposes of dose reporting.

As human exposures on the site are kept within safe levels through the Health and Safety Management System Program and Radiation Protection Program, on-site receptors are not addressed further in the HHRA. The focus of the HHRA is on off-site members of the public.

6.1.2 Receptor Selection and Characterization

The focus of the HHRA is on potential risk to off-site members of the public. Off-site members of the public are potentially exposed to low levels of airborne or waterborne contaminants. The

most-affected off-site members of the public are defined as the "critical group". Potential critical groups are defined through site specific surveys and their doses are calculated in the OPG Annual Environmental Monitoring Program (EMP) Reports.

Consistent with the potential critical groups identified in the EMP (OPG, 2023) and in the PN ERA (Ecometrix, 2023a), the six potential critical groups are:

- The **C2** potential critical group consists of inhabitants at a correctional institute located approximately 3 km NNE of the PN Site. The C2 group obtains drinking water from the Ajax Water Supply Plant (WSP) and does not consume locally grown fruits or vegetables. The C2 resident is conservatively assumed to be at this location 100 percent of the time over the full year

- The **Industrial/Commercial** potential critical group consists of adult workers whose work location is close to the nuclear site. Members of this group are typically at this location about 23% of the time. They consume water from the Ajax WSP. The closest location for this group is about 1 km NNE of the site.

- The **Urban Residents** potential critical group consists of Pickering and Ajax area residents which surround the PN Site (e.g., Fairport, Fairport Beach, Rosebank, Liverpool, Pickering Village, etc.). The members of this group mostly consume water from the Ajax WSP and also consume a diet composed in part of locally grown produce and some locally caught fish. Members of this potential critical group are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach).

- The **Farm** potential critical group consists of residents of agricultural farms (but not dairy farms) within a 10 km radius of the PN Site. Members of this group obtain most of their water supply from wells but also a portion from the Ajax WSP. Members of this potential critical group consume locally grown produce and animal products, as well as locally caught fish. They are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach).

- The **Dairy Farm** potential critical group consists of residents of dairy farms within a 20 km radius of the PN Site. This group obtains most of their water supply from local wells. They also consume locally grown fruit and vegetables and locally produced animal products, including fresh cow's milk. Members of this potential critical group are also externally exposed to beach sand at local beaches (Beachpoint Promenade, Beachfront Park, or Squires Beach).

- The **Sport Fisher** potential critical group is comprised of non-commercial individuals fishing near the PN site outfalls, 0.5 km south of the PN site. Members of this group were conservatively assumed to obtain their entire amount of fish for consumption from the vicinity of the PN site and spend 1% of their time at the outfall location where atmospheric exposure occurs.

Indigenous communities were considered in the selection of receptors for the HHRA. Information from engagement with Indigenous communities, councils and organizations gathered during preparation of the PN U5-8 Refurbishment Environmental Assessment (EA) (SENES, 2007) did not indicate their use of lands, water or resources for traditional purposes within the Local Study Area (defined for the PN U5-8 Refurbishment EA as extending approximately 10 km from PN). However, it is possible that individuals may carry out these activities in a limited fashion as these activities would be restricted by the urbanization, population density, and preponderance of private land in the area. Through engagement with Indigenous communities, OPG continues to seek to learn about how the lands and waters in the area around PN are being used. Based on OPG's current understanding, it was judged that any influence from PN on the health of Indigenous communities was likely to be bounded by the assessment for potential critical groups located much closer to PN who consume foods local to PN as part of their diet. For example, the farm receptors obtain a large fraction of their fruits, vegetables and animal produce locally, with the nearest location at 6 km from PN. While there may be dietary differences such as more wild game in the Indigenous diet, and more farm produce in the farm diet, both groups will have high local food intake fractions, and overall dietary intakes will be similar. Likewise, the Sport Fishers are assumed to obtain their entire fish diet from the PN outfall. It is expected that Indigenous communities would receive doses that are equal to or lower than those received by these potential critical groups.

Since the majority of the potential critical groups are located greater than 1 km from the PN Site, their exposure to releases from the PCSS site during all Project phases is limited. Of the six potential critical groups, the Sport Fisher is expected to conservatively represent interactions with the PCSS due to their proximity to the site, approximately 0.5 km south of the PN Site at the outfall. The exposure location of this critical receptor group is shown in **Figure 6-1**.

In summary, the Sport Fisher (representative of receptors that are in close proximity to the site boundary) is the human receptor group assessed in this HHRA.

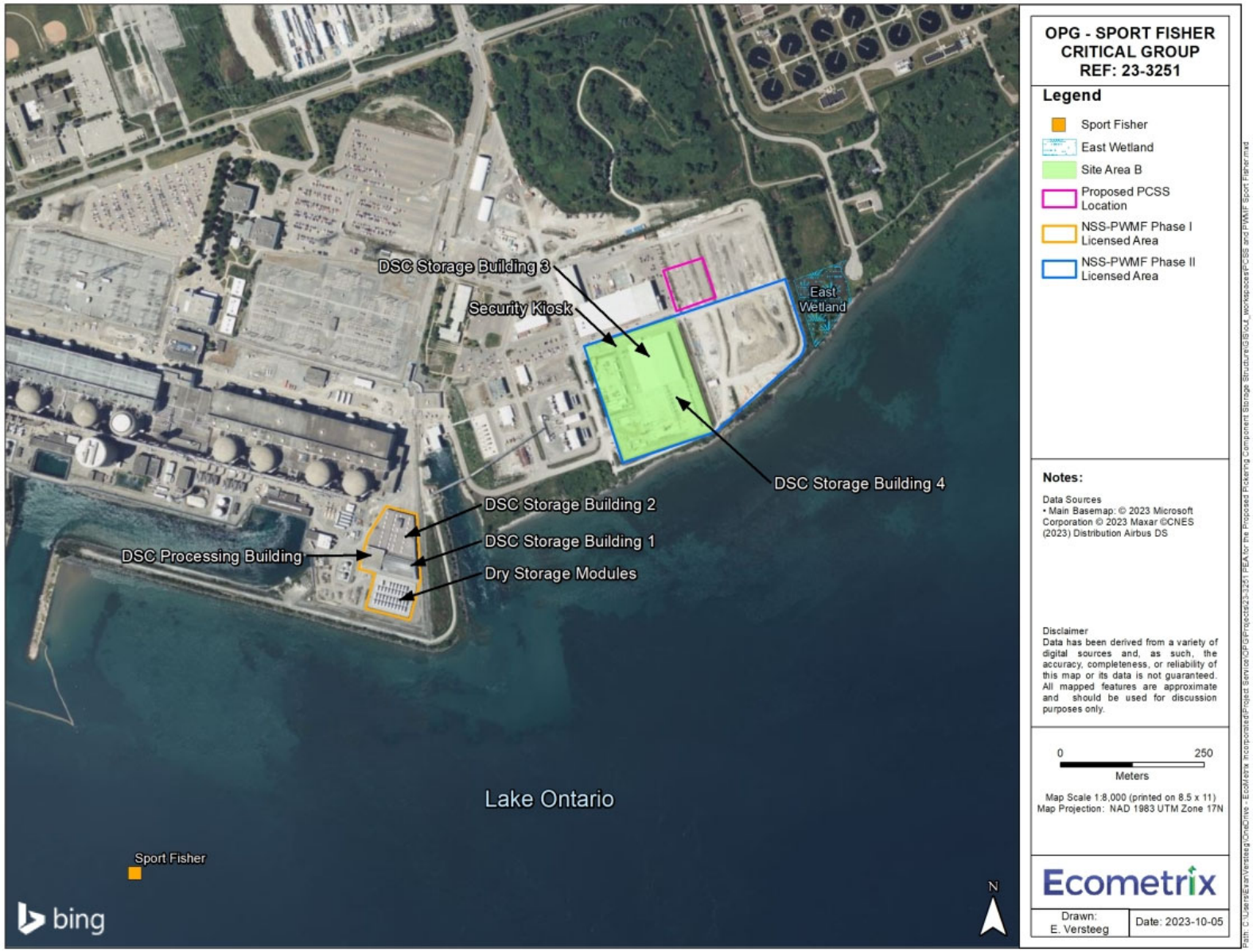

Figure 6-1: Location of Human Receptor – Sport Fisher

6.1.3 Human Health Exposure Pathways and Conceptual Model

As discussed in **Section 5.2**, direct interactions of PCSS with the atmospheric environment were identified. Additionally, human receptors will be exposed to direct gamma radiation from the PCSS. **Table 6-1** summarizes the human health exposure pathways from the PCSS for the human receptors identified for the site.

Table 6-1: Human Health Exposure Pathways

Receptor Group	Environmental Media	Exposure Pathway
Sport Fisher	Air	Radiation immersion (external exposure)
		Noise – noise levels
		Inhalation of particulates and contaminants

6.1.4 Screening Assessment

6.1.4.1 Atmospheric Environment (Air Quality and Emissions)

Air quality around the PN site is dominated by emissions released throughout the Greater Toronto Area and the United States and is typical of the general air quality in Southern Ontario along the Windsor-Quebec corridor. Substances that can produce smog or acid rain dominate air quality impacts and include carbon monoxide, nitrogen oxides, sulfur dioxide, total suspended particulates (TSP), inhalable particulates (PM_{10}) and respirable particulates ($PM_{2.5}$). Ontario's MECP measures air quality at several locations between Toronto and Oshawa. The PN site itself does not significantly contribute to chemical air quality emissions at a regional level (OPG, 2003).

Air quality at the proposed PCSS is expected to be comparable to the current and historic air quality of the local region (i.e., City of Pickering), except for a brief period during site preparation and construction where project activities are expected to contribute higher levels of dust (TSP) and particulates (PM_{10} and $PM_{2.5}$) to the atmosphere.

The screening of air quality COPCs against ambient air quality criteria/standards in this PERA report is consistent with the methodology used in the 2003 PWMF Phase II EA. The PWMF Phase II project involved the construction of a new storage building to increase storage capacity at the PWMF (now the NSS-PWMF) as the PWMF Phase I storage capacity became insufficient over time (OPG, 2003). Air quality modelling conducted as part of the PWMF Phase II expansion is considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings.

The concentration of COPCs in air were compared against Ontario MECP's Ambient Air Quality Criteria (AAQCs) and Canadian Ambient Air Quality Standards (CAAQS) from the Canadian Council of Ministers of the Environment (CCME) to determine whether measured and modelled concentrations of atmospheric COPCs could pose a risk to human receptors over the lifetime of the PCSS project. Concentrations were directly compared to guidelines with the same averaging periods. The AAQCs with averaging times of 24 hours or longer are considered protective of chronic health effects and have been selected for use in this PERA. The air quality guidelines used are shown in **Table 6-2**.

Table 6-2: Air Quality Guidelines

Parameter	AAQC	Averaging Time	CAAQS	Averaging Time
Carbon monoxide	13 ppm	8-Hour	NA	NA
Nitrogen dioxide	100 ppb	24-Hour	17 ppb [a, b]	Annual
Sulfur dioxide	4 ppb	Annual	5 ppb [a, b]	Annual
$PM_{2.5}$	27 µg/m^3 [(a)]	24-Hour	27 µg/m^3 [a]	24-Hour
PM_{10}	50 µg/m^3	24-Hour	NA	NA
Total suspended particulates (TSP)	120 µg/m^3	24-Hour	NA	NA

Notes:
[a] 2020 target
[b] Represents the average over a single calendar year of all 1-hour average concentrations
AAQC – Ontario MECP Ambient Air Quality Criteria (MECP, 2020)
CAAQS – Canadian Ambient Air Quality Standard (MECP, 2019)
Averaging Time - Averaging times for ambient air quality criteria protective against chronic effects are generally 24 hours or longer
µg/m^3 – micrograms per cubic metre of air
ppm - parts per million
ppb – parts per billion
NA – Not available

Consistent with the 2003 PWMF Phase II EA, the overall PN site, inclusive of the NSS-PWMF, is not considered to significantly contribute nitrogen oxides (NOx) or sulfur dioxide (SO_2) to the atmosphere (OPG, 2003). Thus, local air quality measurements of these specific parameters are considered bounding of any air concentrations arising from site preparation, construction and operation of the PCSS. Local air quality measurements were obtained for the last three (3) available years (2018 to 2020) from the Ontario MECP's "Air Quality in Ontario" reports (MECP, 2022, 2023a, 2023b). Air quality data was assessed from the Toronto East and Toronto West monitoring stations (west of the PN site) and the Oshawa station (east of the PN site). The annual average and annual 90th-percentiles for air concentrations of NO_2, SO_2 and CO are shown in **Table 6-3**.

Average annual 1-hour concentrations of NO_2 ranged from 3.50 – 3.79 ppb in Oshawa and 8.41 – 10.55 ppb in Toronto East between 2018 to 2020. Annual 90th-percentile 1-hour concentrations ranged between 7.7 – 8.3 ppb in Oshawa and 17.8 – 21.8 ppb in Toronto East. No exceedances of the annual CAAQS were recorded at the Toronto East and Oshawa stations based on the annual average 1-hour concentrations.

SO_2 and CO are not monitored at every station – the closest station to the PN site where these parameters are measured is the Toronto North monitoring station, approximately 32 km west of the PN site. Between 2018 to 2020, average annual 1-hour concentrations of SO_2 ranged between 0.15 – 0.26 ppb at the Toronto North station, while annual 90th-percentile 1-hour concentrations ranged between 0.3 – 0.5 ppb. The annual average 1-hour concentrations of SO_2 met the CAAQS of 5 ppb (annual averaging period) and the AAQC of 4 ppb (annual averaging period). During the same sampling period, maximum 8-hour annual concentrations of CO ranged between 0.62 – 0.84 ppm, meeting the 8-hour CO AAQC of 13 ppm.

Table 6-3: Select Monitored Concentrations of NO_2, SO_2 and CO at the Toronto East, Toronto North, and Oshawa Monitoring Stations, 2018 – 2020

Parameter	Units	Station	Year	Annual Average 1-hour Concentration	Annual 90th-percentile 1-hour Concentration	AAQC	CAAQS
NO_2	ppb	Toronto East	2018	10.55	21.8	NA	17
		Toronto East	2019	10.24	21.6	NA	17
		Toronto East	2020	8.41	17.8	NA	17
		Oshawa	2018	3.79	8.3	NA	17
		Oshawa	2019	3.50	8.0	NA	17
		Oshawa	2020	3.61	7.7	NA	17
SO_2	ppb	Toronto North	2018	0.26	0.5	4	5
		Toronto North	2019	0.15	0.3	4	5
		Toronto North	2020	0.15	0.4	4	5
CO [a]	ppm	Toronto North	2018	0.62 (8-hour max)	NA	13	NA
		Toronto North	2019	0.71 (8-hour max)	NA	13	NA
		Toronto North	2020	0.84 (8-hour max)	NA	13	NA

Notes:

[a] Carbon monoxide data are 8-hour maximums

AAQC – Ambient Air Quality Criteria

CAAQS – Canadian Ambient Air Quality Standards

Based on expected release of dust and particulates during site preparation and construction activities, the 2003 PWMF Phase II environmental assessment predicted incremental 24-hour air concentrations at two locations (Site Area B and East Wetland) of the PWMF Phase II site (refer to **Figure 4-2** in **Section 4.1** for the locations of Site Area B, the East Wetland and the PCSS). Predicted incremental 24-hour concentrations were added to background 24-hour concentrations of TSP, PM_{10} and $PM_{2.5}$ and compared against 24-hour ambient air quality criteria (**Table 6-4**).

Site Area B is considered representative of the PCSS due to the close proximity of the two sites, and the East Wetland is similarly representative of a receptor at the boundary of the PN site.

Table 6-4: Estimated Total Airborne Dust and Particulates at the Site Area B and East Wetland Boundary During Site Preparation and Construction Compared with AAQC Guidelines

Parameter	Background 24-Hour Concentration (µg/m³) [a]		Predicted Incremental 24-Hour Concentration (µg/m³)	Incremental + Background (90th-Percentile) 24-Hour Concentration (µg/m³)	24-Hour Air Quality Criteria (AAQC)
	Average	90th-Percentile			
Site Area B					
Total Suspended Particulates (TSP)	42	75	7.4	82.4	120
PM_{10}	18	35	2.1	37.1	50
$PM_{2.5}$	11.5	23	0.44	23.4	27
East Wetland					
Total Suspended Particulates (TSP)	42	75	5.3	80.3	120
PM_{10}	18	35	1.3	36.3	50
$PM_{2.5}$	11.5	23	0.41	23.4	27

Notes:

[a] Background concentrations for TSP, PM_{10} and $PM_{2.5}$ were taken from the 2003 PWMF Phase II environmental assessment. These values represent average and 90th-percentile 24-hour concentrations.

Results presented in **Table 6-4** demonstrate that maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ 24-hour concentrations could reach 7.4 µg/m^3, 2.1 µg/m^3 and 0.44 µg/m^3 at Site Area B, respectively. At the East Wetland, the maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ 24-hour concentrations were modelled to reach 5.3 µg/m^3, 1.3 µg/m^3 and 0.41 µg/m^3, respectively. These predicted incremental increases assume reasonable dust suppression measures are used on dry days (i.e., road and surface watering).

The total 24-hour concentrations for TSP, PM_{10} and $PM_{2.5}$ (incremental increases plus 90th-percentile background) are all below the applicable ambient air quality criteria at both modelled locations. Any increases in dust and particulate emissions are expected to be short-term and below the applicable AAQC/CAAQS limits.

The modelling is conservative as it assumed that site preparation and construction activities expected to generate the most intense amounts of dust and particulates would all occur at the same time over a three-month period. It is more likely that site preparation and construction activities would occur more infrequently over a phased construction schedule. Furthermore, the modelled predictions assumed that these project activities would occur at the same time as the worst-case meteorological conditions, which is similarly unlikely to occur over the modelled three-month construction schedule.

Construction traffic was not considered in the air quality modelling as it is expected that the increase in traffic and vehicle emissions would be negligible. (OPG, 2003). The emissions released by a small number of construction vehicles (e.g., backhoes, graders, dump trucks) would be negligible compared to the number of vehicles that currently service the thousands of employees working at the PN site. Relatedly, no off-site impacts to air quality are expected from the negligible increase in construction-related traffic emissions.

Based on the assessment above, no impacts to human health are expected from air emissions of dusts, particulates, or other air pollutants associated with vehicle exhausts including NO_x, SO_2 or CO. Thus, project-related atmospheric emissions as they relate to human health are not assessed further in this PERA report.

6.1.4.2 Atmospheric Environment (Noise)

Site preparation and construction activities are expected to result in increased noise levels. Consistent with **Section 6.1.4.1**, the 2003 PWMF Phase II environmental assessment was considered applicable for the PCSS project. The 2003 PWMF Phase II environmental assessment assumed that equipment and vehicles would utilize noise control devices, be maintained in proper working condition, and that noise emissions from such equipment would be compliant with regulatory noise guidelines. These assumptions are similarly applicable to the PCSS project.

Background noise at the PCSS is assumed to be similar to the overall PN site. The 2022 PN ERA reported an L_{Aeq} (1-hr) of 54 dBA and L_{A90} (1-hr) of 50 dBA at noise monitoring station NM-2 during daytime hours (07:00 – 19:00). The L_{Aeq} (1-hr) represents the average sound energy in A-weighted decibels (dBA) measured over a 1-hour period; the L_{A90} (1-hr) represents the sound

energy (in dBA) exceeded for 90% of the measurement period (i.e., 54 minutes of the 1-hour measurement period). As the L_{A90} describes the noise level exceeded for 90% of the measurement period, it is a more representative measure of background sound levels. This monitoring station is considered representative of daytime background noise levels experienced by a receptor adjacent to the walking trail at the eastern boundary of the PN site.

Similar to the air quality assessment, the 2003 PWMF Phase II environmental assessment predicted noise levels at Site Area B and the East Wetland. The maximum sound level experienced by a receptor at Site Area B exposed to worst-case construction activities was modelled to be 55 dBA. Maximum predicted noise levels at the East Wetland due to construction activities was modelled to be 64 dBA.

The MECP does not have prescribed noise and vibration limits from construction activity. Health Canada recommends that project-related noises do not exceed 75 dBA; above this level, noise is likely to cause sleep disturbance or disturb vulnerable populations (HC, 2017). Both PN baseline and modelled noise levels associated with PCSS construction do not exceed this 75 dBA threshold.

Site preparation and construction activities are expected to be relatively short in duration, and will occur in phases over the course of the overall construction schedule. Work will also be limited to daytime hours when background sound levels are generally higher. As previously noted, the increase in vehicle traffic associated with site preparation and construction is expected to be negligible compared to baseline traffic levels. Therefore, noise effects from a small incremental increase in construction traffic is considered negligible compared to the overall PN site.

Based on the assessment above, no human health effects are expected to occur as a result of sound emissions associated with site preparation and construction of the PCSS. No further assessment of project-related noise as it relates to human health is required in this PERA report.

6.1.4.3 Radiation

The Sport Fisher is the only potential critical group where gamma radiation fields from the NSS-PWMF would likely be measurable. This was confirmed in the 2022 PN ERA (Ecometrix, 2023a) based on a 2017 study. At a distance of 400 m from the NSS-PWMF, the measured air kerma rate was below the detection limit of 0.33 nGy/h. At a distance of 1 km from the PWMF, the air kerma rate was estimated to be negligible. Therefore, the Sport Fisher is expected to experience external exposure to gamma radiation due to the proximity to the PCSS.

The dose rates outside of the PCSS are estimated based on the administrative dose targets for the NSS-PWMF. It is expected that the dose rate outside of the PCSS will be below the target of 0.5 µSv/h and below 100 µSv/a at the PN site boundary. The radiation dose to the Sport Fisher is quantified and considered further in the exposure assessment below.

6.1.5 Summary

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their limits; therefore, no further quantitative assessment is required.

Therefore, based on the Problem Formulation, the focus of the exposure assessment is on exposure of the Sport Fisher to gamma radiation from the PCSS.

6.2 Exposure Assessment

In the exposure assessment, the exposure of human receptors to radiological COPCs is quantified in terms of radiation dose.

The assumed dose rate at the eastern site boundary at the walking trail is 100 µSv/a, equivalent to the administrative dose target for the NSS-PWMF. Based on exposure of 2,000 hours at the site boundary, the maximum dose rate at the eastern site boundary is 0.05 µSv/h. The Sport Fisher is assumed to reside at the outfall (0.5 km south of the PN site) 1% of the time or 87.6 hours per year, which is consistent with the assumptions for the Sport Fisher in the PN ERA (Ecometrix, 2023a). Assuming the Sport Fisher is exposed to the maximum dose rate of 0.05 µSv/h for 87.6 hours (1% occupancy), the predicted total annual dose to the Sport Fisher from the PCSS is 4.38 µSv/a. The dose estimate for the Sport Fisher is conservative, as the Sport Fisher is located farther away than the eastern site boundary, yet is conservatively assumed to have the same maximum dose rate as the eastern site boundary. The dose rates are summarized in **Table 6-5**.

Table 6-5: Predicted Dose Rate for Human Receptors from the PCSS

Receptor	Predicted Annual Dose from PCSS (µSv/a)
Eastern Site Boundary[(a)]	100
Sport Fisher[(b)]	4.38

Notes:

(a) The dose at the Eastern Site Boundary is equivalent to the administrative dose target for the public at the Pickering site boundary and is 10% of the regulatory public dose limit of 1 mSv/a for members of the public.

(b) The dose to the Sport Fisher is based on an occupancy at the Outfall of 1% or 87.6 hours per year, and is consistent with assumptions in OPG's EMP.

6.3 Hazard Assessment

6.3.1 Radiation Public Dose Limit

The public dose limit for radiation protection is 1 mSv/a, as described in the Radiation Protection Regulations under the Nuclear Safety and Control Act (Nuclear Safety and Control Act, 1997). This limit is defined as an incremental dose. It is set at a fraction of natural

background exposure to radiation. Public doses arising from licensed facilities are compared to the public dose limit and higher doses are considered unacceptable.

6.4 Risk Characterization

6.4.1 Radiation

The public dose estimate for the Sport Fisher is 4.38 µSv/a . This dose estimate represents 0.4% of the regulatory public dose limit (1000 µSv/a) for the Sport Fisher. Since the Sport Fisher is expected to receive the highest dose from PCSS, the demonstration that the Sport Fisher is protected implies that other potential critical groups near the PN site are also protected.

Since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential critical groups to gamma radiation from the PCSS.

7.0 Predictive Ecological Risk Assessment

7.1 Problem Formulation

7.1.1 Receptor Selection and Characterization

As discussed in **Section 5.2**, the environmental stressors investigated further in this PERA include air emissions, noise and radiation.

The terrestrial ecological receptors outlined below represent receptors considered in this predictive ecological risk assessment. As it is impractical to assess potential effects on all species of biota at the PN site, a select group of representative species are chosen. These organisms are selected because they are known to exist on the site, represent major taxonomic/ecological groups, represent major pathways of exposure, have ecological significance, or have important intrinsic or economic value. These potential receptors were also considered in the 2022 PN ERA for the PN site (Ecometrix, 2023a). The rationale for receptor selection is described in detail in the PN ERA. The protection of the selected receptors should provide reasonable assurance that all species within the ecosystem are protected.

- Terrestrial Plants:
  - Chokecherry
  - New England Aster
  - Eastern Hemlock
  - Red Ash
  - Sandbar Willow
  - Pine/Grass
- Terrestrial Invertebrates:
  - Earthworms
- Terrestrial Birds:
  - Red-winged Blackbird
  - Red-tailed Hawk
- Terrestrial Mammals:
  - Red Fox
  - Meadow Vole
  - White-tailed Deer

7.1.2 Ecological Receptor Exposure Pathways and Conceptual Site Model

As discussed in **Section 5.2**, direct interactions of the PCSS with the atmospheric environment were identified. Additionally, ecological receptors will be exposed to gamma radiation from the PCSS. **Table 7-1** summarizes the ecological exposure pathways and conceptual site model from interactions with the PCSS for the ecological receptors identified for the site.

Exposure pathways consider the various routes by which radionuclides and/or chemicals may enter the body of the receptor, or for radionuclides, may exert effects from outside the body.

Exposures to environmental media may be primary (i.e., by contact) or secondary (i.e., via constituent transport through the food chain).

Considering the sources of COPCs to the environment are from the air pathway, the main exposure pathway is through inhalation of dust and particulate matter and exposure to noise during the site preparation and construction phase as well as exposure to external gamma radiation from operation of the PCSS. As such, only terrestrial receptors from the PN ERA are assessed.

Table 7-1: Ecological Conceptual Site Model

Category	Ecological Receptor	Exposure Pathway
Terrestrial Plants	Chokecherry	Uptake of COPCs sourced from Air Radiation Immersion
	New England Aster	
	Eastern Hemlock	
	Red Ash	
	Sandbar Willow	
	Pine/Grass	
Terrestrial Invertebrates	Earthworms	No complete pathways[(a)]
Terrestrial Birds	Red-winged Blackbird	Noise Inhalation Radiation Immersion
	Red-tailed Hawk	
Terrestrial Mammals	Red Fox	Noise Inhalation Radiation Immersion
	Meadow Vole	
	White-tailed Deer	

Note:

(a) As earthworms live in the soil, they would have limited exposure to air, noise and gamma radiation fields.

7.1.3 Screening Assessment

7.1.3.1 Atmospheric Environment (Air Quality and Emissions)

Ecological receptors can be exposed to air emissions as a result of site preparation and construction activities for the PCSS. Terrestrial birds and mammals can come into direct contact with COPCs released into the air through inhalation.

Air quality at the proposed PCSS is expected to be comparable to the current and historic air quality of the local region (i.e., City of Pickering), except for a brief period during site preparation and construction where project activities are expected to contribute marginally higher levels of dust (TSP) and particulates (PM_{10} and $PM_{2.5}$) to the atmosphere.

Similar to **Section 6.1.4.1**, the screening of air quality COPCs against ambient air quality criteria/standards in this PERA report is consistent with the methodology used in the 2003 PWMF Phase II EA. Air quality modelling conducted as part of the PWMF Phase II expansion is considered bounding of the PCSS project, as the PWMF Phase II project was greater in scope and involved the site preparation of a larger area and the construction of multiple storage buildings.

Air quality parameters were compared against Ontario MECP's Ambient Air Quality Criteria (AAQCs) as AAQCs are developed to be protective of health and the environment, and are therefore appropriate screening guidelines for ecological receptors (MECP, 2020). The list of ambient air quality guidelines is available in **Table 6-2**. The annual air quality data and the comparison with air quality guidelines can be found in **Table 6-3**, both in **Section 6.1.4.1**.

Based on expected releases of dust and particulates during site preparation and construction activities, the 2003 PWMF Phase II environmental assessment predicted air concentrations at two locations (Site Area B and East Wetland) of the PWMF Phase II site (**Figure 4-2**). Predicted incremental concentrations were added to background concentrations of TSP, PM_{10} and $PM_{2.5}$ and compared against AAQCs.

Site Area B is considered representative of on-site terrestrial receptors at the PCSS due to the close proximity of the two sites. The East Wetland is considered representative of off-site terrestrial receptors at the boundary of the PN site.

Results presented in **Table 6-4** in **Section 6.1.4.1** demonstrate that maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations could reach 7.4 µg/m^3, 2.1 µg/m^3 and 0.44 µg/m^3 at Site Area B, respectively. At the East Wetland, the maximum predicted incremental TSP, PM_{10} and $PM_{2.5}$ concentrations were modelled to reach 5.3 µg/m^3, 1.3 µg/m^3 and 0.41 µg/m^3, respectively. These predicted incremental increases assume reasonable dust suppression measures are used on dry days (i.e., road and surface watering).

The total concentrations for TSP, PM_{10} and $PM_{2.5}$ (incremental increases plus 90th-percentile background) are all below the applicable AAQCs at both modelled locations. Any increases in dust and particulate emissions are expected to be short-term and below the applicable AAQCs.

The modelling assumed that site preparation and construction activities expected to generate the most intense amounts of dust and particulates would all occur at the same time over a three-month period. It is more likely that site preparation and construction activities would occur more infrequently over a phased construction schedule. Furthermore, the modelled predictions assumed that these project activities would occur at the same time as the worst-case

meteorological conditions, which is similarly unlikely to occur over the assumed three-month construction schedule.

Construction traffic was not considered in the air quality modelling as it is expected that the increase in traffic and vehicle emissions would be negligible (OPG, 2003). The emissions released by a small number of construction vehicles (e.g., backhoes, graders, dump trucks) would be negligible compared to the number of vehicles that currently service the thousands of employees working at the PN site. Relatedly, no impacts to off-site receptors are expected from the negligible increase in construction-related traffic emissions.

Based on the assessment above, no impacts to terrestrial receptors are expected from air emissions of dust, particulates, or other air pollutants associated with vehicle exhausts including NO_x, SO_2 or CO. Thus, project-related atmospheric emissions and the potential impact to ecological receptors are not assessed further in this PERA report.

7.1.3.2 Atmospheric Environment (Noise)

Noise levels due to site preparation and construction of the PCSS may potentially cause disturbance to wildlife. Consistent with **Section 6.1.4.2**, noise modelling conducted for the 2003 PWMF Phase II environmental assessment was considered applicable for the PCSS project.

In the 2003 PWMF Phase II environmental assessment, the maximum sound level experienced by a receptor at Site Area B exposed to worst-case construction activities was modelled to be 55 dBA over an assumed three-month construction period. Maximum predicted noise levels at the East Wetland (representative of off-site terrestrial receptors) due to construction activities was modelled to be 64 dBA.

There are no specific noise level thresholds for ecological receptors within regulatory documents. However, considering that noise levels are expected to be temporarily elevated for a maximum of three (3) months during site preparation and construction, it is expected that some wildlife (e.g., small mammals, birds) may be occasionally disturbed due to elevated noise levels; however, most wildlife in the area are likely already accustomed to noise levels associated with an urban environment. This is consistent with assumptions made for the Pickering B Environmental Assessment Terrestrial Environment Technical scope document (Golder, 2007). Noise levels from the PCSS during operations and maintenance are expected to be negligible compared to the noise levels from the rest of the PN site.

Assuming site preparation and construction equipment are adequately maintained and are compliant with regulatory noise limits, construction activities are not expected to result in long-term effects on terrestrial receptors. Site preparation and construction activities are expected to be relatively short in duration, and will occur in phases over the course of the overall construction schedule. Work will also be limited to daytime hours when sound levels are higher than nighttime hours to prevent the disruption of nocturnal wildlife. As previously noted, the increase in vehicle traffic associated with site preparation and construction is expected to be

negligible compared to baseline traffic levels. Therefore, noise effects from a small incremental increase in construction traffic is considered negligible compared to the overall PN site.

Based on the assessment above, given the mitigation measures in place and the temporary nature of the elevated noise levels due to site preparation and construction, noise is not expected to result in adverse risks to terrestrial receptors and is not assessed further in this PERA.

7.1.3.3 Radiation

Ecological receptors in proximity to the PCSS will experience external exposure to direct gamma radiation due to the proximity to the PCSS. The radiation dose to the terrestrial plant, bird and mammal receptors is quantified and considered further in the exposure assessment below.

7.1.4 Summary

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors, noise levels are expected to be elevated temporarily during site preparation and construction, although most wildlife in the area are likely already accustomed to noise levels associated with an urban environment.

Therefore, based on the Problem Formulation, the focus of the exposure assessment is on exposure of the terrestrial receptors to gamma radiation from the PCSS.

7.2 Exposure Assessment

7.2.1.1 Radiation Dose – Terrestrial Receptors

The assessment of external exposure of terrestrial receptors to gamma radiation from the PCSS is based on the estimated administrative dose targets for the NSS-PWMF.

The estimated dose rates outside the PCSS could be up to the administrative dose target of 0.5 µSv/h. It is difficult to translate the human effective dose to a whole body absorbed dose for various wildlife species with different geometries; however, it has been assumed that the whole-body effective dose for humans (µSv/h) is equivalent to the whole body absorbed dose for wildlife (µGy/h).

The dose rate for ecological receptors in close proximity (directly adjacent) to the PCSS could be up to 0.5 µGy/h (0.012 mGy/d). The dose rate to any ecological receptor at the closest PN property boundary would be much lower than 0.5 µGy/h (0.012 mGy/d). Using the assumed dose target for a member of the public at the eastern site boundary of 100 µSv/a (see **Section 6.2**), terrestrial receptors at the PN property boundary exposed for 8760 hours per year may receive a dose of approximately 1.14E-02 µGy/h (2.74E-04 mGy/d).

The above assessment is conservative as it assumes the ecological receptor is always located at the PCSS (24 hours per day, 365 days per year) and does not incorporate an occupancy factor based on the fraction of time a receptor is likely to be in close proximity to the PCSS.

7.3 Effects Assessment

7.3.1 Radiation Dose Benchmarks

Radiation dose benchmarks of 400 µGy/h (9.6 mGy/d) and 100 µGy/h (2.4 mGy/d) (UNSCEAR, 2008) were selected for the PCSS assessment of effects on aquatic biota and terrestrial biota, respectively, as recommended in the CSA N288.6-22 standard. This is a total dose benchmark, therefore the dose to biota due to each radionuclide of concern is summed to compare against this benchmark. The terrestrial benchmark of 2.4 mGy/d was used to assess radiation dose to terrestrial receptors at the PCSS. Aquatic receptors were not assessed as no Project-related interactions with the aquatic environment are expected (**Section 5.2.2**).

7.4 Risk Characterization

7.4.1 Radiation

The maximum dose rate to any ecological receptors residing in close proximity to the PCSS could be up to 0.012 mGy/d, lower than the 2.4 mGy/d radiation benchmark for terrestrial biota. The maximum dose rate to any off-site ecological receptors residing at the closest boundary of the PN site could be up to 2.74E-04 mGy/d, also lower than the 2.4 mGy/d radiation benchmark for terrestrial biota.

Since the dose estimates are a small fraction of the terrestrial dose benchmark, no discernable health effects to terrestrial biota are anticipated due to exposure to radiation from the PCSS.

Additionally, with respect to species at risk, since there were no exceedances of any dose benchmarks for the ecological receptors evaluated, individual species at risk would also be considered protected.

8.0 Cumulative Effects Assessment

In order to ensure radiation releases from the PN site meet radiation safety limits for humans and ecological radiation benchmarks for wildlife, the combined radiation dose from current PN operations (PNGS and NSS-PWMF) must be considered together with the potential radiation release from the future operation of the PCSS.

The Predictive Effects Assessment (PEA) for PN Safe Storage (Ecometrix, 2023b; Golder and Ecometrix, 2017) was not considered in the cumulative effects assessment as the maximum dose from existing conditions on the PN Site would be bounding of the receptors exposed to the PCSS during PN Safe Storage. Emissions from PNGS are not expected to occur at the same time as the predicted doses during PN Safe Storage.

8.1 Human Health

The 2021 PN ERA calculated total doses received by the Sport Fisher from PN and NSS-PWMF operations. As indicated in **Section 6.1.4.3**, based on distance from the facility, the Sport Fisher is the only human receptor likely to receive measurable dose from the PCSS.

The combined radiation dose for the Sport Fisher is presented in **Table 8-1** below. The total dose received by the Sport Fisher from current PN operations (PNGS and NSS-PWMF) and the PCSS was estimated to be 4.94 µSv/a. This is a conservative assessment, as the cumulative dose assumes exposure to the administrative dose target for the NSS-PWMF. The cumulative dose is well below the public dose limit for radiation protection of 1 mSv/a. As the total cumulative dose is only a small fraction (0.5%) of the public dose limit and natural background radiation exposure, no health effects are expected within the general public.

Table 8-1: Cumulative Radiation Dose to the Sport Fisher from PN and PCSS

Receptor	Units	Max Dose from PNGS [a]	Max Dose from NSS-PWMF [a]	Predicted Max Dose from PCSS[b]	Total Max Dose
Sport Fisher	µSv/a	0.5	0.063	4.38	4.94

Notes:

[a] Total radiation dose estimates for the Sport Fisher receptor from the PNGS (Ecometrix, 2023a)

[b] Predicted max dose from PCSS is based on the conservative assumption of exposure to the administrative dose target for the NSS-PWMF. Actual exposure to gamma radiation from the PCSS is expected to be lower.

µSv/a – microSievert per year

8.2 Ecological Health

The 2022 PN ERA also calculated total maximum and UCLM doses received by various terrestrial and aquatic receptors from PN operations. No cumulative effects assessment was done for aquatic receptors in the Outfall and Frenchman's Bay, as radiation releases from the PCSS to the aquatic environment are considered negligible. The combined radiation doses received by ecological receptors are presented in **Table 8-2** below. The maximum combined radiation dose in the terrestrial environment would be 2.75E-02 mGy/d for the red fox. All total maximum and UCLM doses received by terrestrial receptors from both PN and the PCSS were well below (1% or less) the terrestrial radiation benchmark of 2.4 mGy/d. No discernable health effects to terrestrial biota are anticipated due to radiation from PN and the PCSS.

Table 8-2: Cumulative Radiation Dose to Ecological Receptors from PN and PCSS

Location	Receptor	Units	Max Dose from PNGS [a]	UCLM Dose from PN [a]	Max Dose from NSS-PWMF [a]	Max Dose from PCSS	Total Max Dose [b]	Total UCLM Dose [c]	Dose Benchmark	% of Dose Benchmark (Max)	% of Dose Benchmark (UCLM)
Outfall (*Aquatic and Riparian*)	Benthic Fish	mGy/d	2.38E-02	1.49E-03	NA	NA	2.38E-02	1.49E-03	9.6	0.2%	0.02%
	Pelagic Fish	mGy/d	1.56E-02	9.76E-04	NA	NA	1.56E-02	9.76E-04	9.6	0.2%	0.01%
	Benthic Invertebrate	mGy/d	3.82E-02	2.38E-03	NA	NA	3.82E-02	2.38E-03	9.6	0.4%	0.02%
	Ring-Billed Gull	mGy/d	2.79E-02	3.76E-03	NA	NA	2.79E-02	3.76E-03	2.4	1.2%	0.2%
PN Site (*Terrestrial*)	Earthworm	mGy/d	9.07E-04	3.52E-04	NA	NA	9.07E-04	3.52E-04	2.4	0.04%	0.01%
	Grass/Shrub	mGy/d	1.08E-03	5.07E-04	1.2E-02	1.2E-02	2.51E-02	2.45E-02	2.4	1.0%	1.0%
	Pine	mGy/d	9.26E-04	3.55E-04	1.2E-02	1.2E-02	2.49E-02	2.44E-02	2.4	1.0%	1.0%
	Red-winged Blackbird	mGy/d	8.56E-04	3.08E-04	1.2E-02	1.2E-02	2.49E-02	2.43E-02	2.4	1.0%	1.0%
	Red-tailed Hawk	mGy/d	8.30E-04	2.73E-04	1.2E-02	1.2E-02	2.48E-02	2.43E-02	2.4	1.0%	1.0%
	Red Fox	mGy/d	3.46E-03	1.58E-03	1.2E-02	1.2E-02	2.75E-02	2.56E-02	2.4	1.1%	1.1%
	Meadow Vole	mGy/d	8.48E-04	2.94E-04	1.2E-02	1.2E-02	2.48E-02	2.43E-02	2.4	1.0%	1.0%
	White-tailed Deer	mGy/d	8.42E-04	2.62E-04	1.2E-02	1.2E-02	2.48E-02	2.43E-02	2.4	1.0%	1.0%
Frenchman's Bay (*Aquatic and Riparian*)	White Sucker	mGy/d	5.05E-03	4.21E-03	NA	NA	5.05E-03	4.21E-03	9.6	0.1%	0.04%
	Lake Trout	mGy/d	5.03E-03	4.21E-03	NA	NA	5.03E-03	4.21E-03	9.6	0.1%	0.04%
	Frog	mGy/d	3.70E-03	2.87E-03	NA	NA	3.70E-03	2.87E-03	9.6	0.04%	0.03%
	Aquatic Plant	mGy/d	2.13E-03	1.26E-03	NA	NA	2.13E-03	1.26E-03	9.6	0.02%	0.01%
	Benthic Invertebrate	mGy/d	1.85E-03	9.88E-04	NA	NA	1.85E-03	9.88E-04	9.6	0.02%	0.01%
	Bufflehead	mGy/d	7.54E-03	4.06E-03	NA	NA	7.54E-03	4.06E-03	2.4	0.3%	0.2%
	Common Tern	mGy/d	7.58E-03	5.90E-03	NA	NA	7.58E-03	5.90E-03	2.4	0.3%	0.2%
	Trumpeter Swan	mGy/d	3.94E-03	2.26E-03	NA	NA	3.94E-03	2.26E-03	2.4	0.2%	0.1%
	Ring-Billed Gull	mGy/d	1.31E-02	8.09E-03	NA	NA	1.31E-02	8.09E-03	2.4	0.5%	0.3%
	Muskrat	mGy/d	3.09E-03	1.70E-03	NA	NA	3.09E-03	1.70E-03	2.4	0.1%	0.1%

Notes:

Project-related effects from the PCSS and effects from the existing NSS-PWMF are considered negligible for aquatic ecological receptors in the Outfall or Frenchman's Bay, thus no cumulative effects assessment is required.

[a] Total radiation dose estimates for ecological biota at the PNGS (Ecometrix, 2023a)

[b] For terrestrial ecological receptors, total max dose is the sum of the max PN dose, the max NSS-PWMF dose (terrestrial and aquatic/riparian) and max PCSS dose (terrestrial only)

[c] For terrestrial ecological receptors, total UCLM dose is the sum of the PN UCLM dose, the max NSS-PWMF dose (terrestrial and aquatic/riparian) and max PCSS dose (terrestrial only)

UCLM – Upper confidence limit on the mean

mGy/d – milligray per day

NA – Radiation dose to the aquatic/riparian environment is considered negligible

9.0 Environmental Management

9.1 Environmental Management System

OPG's Environmental Policy requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001 Environmental Management System Standard. The EMS provides the structure and processes to ensure implementation and follow-up on the environmental programs needed to comply with the Environmental Policy. As part of OPG's EMS, environmental performance targets, including reportable spills and environmental compliance, are reviewed annually to ensure that opportunities for continuous improvement are identified and implemented. The programs include OPG's approach to ensure compliance with applicable statutory and regulatory requirements.

During construction and operation of the PCSS, OPG's EMS will continue to require the assessment of environmental risks associated with the facility's activities, and to ensure that these activities are conducted such that any adverse impact on the natural environment is as low as reasonably achievable. Additionally, OPG will obtain all required environmental approvals and permits for the Project.

The specific mitigation and emission monitoring measures implemented as part of the PCSS operation are discussed in **Section 9.2**.

9.2 Emission Monitoring and Control

During site preparation and construction OPG will follow the Environmental Management Plan for construction of the PCSS. The Environmental Management Plan will outline the site-specific measures that will be followed to ensure compliance with federal, provincial and municipal legislations, mitigation of potential environmental impacts, and pollution prevention. OPG and its contractors will employ best practices for environmental management which will be outlined in the Environmental Management Plan.

Once the PCSS is operational, additional thermoluminescent dosimeters (TLDs) will be installed around the PCSS to monitor ambient dose rates. The purpose is to ensure that gamma dose rates adjacent to the PCSS remain below the dose rate target of 0.5 µGy/hr. TLD measurements will be summarized in the quarterly reports for the NSS-PWMF.

9.3 Environmental Monitoring Programs

Environmental monitoring at the PN site has been conducted for many years and the environmental performance is reported to the CNSC on a regular basis.

The existing 2022 PN ERA (Ecometrix, 2023a) was developed in accordance with CSA N288.6 to assess the potential risk posed by the existing operation on human and non-human biota. This PERA for the PCSS, estimated the effects of contaminants on the existing environment resulting from the proposed PCSS to be constructed at the NSS-PWMF. The outcome of the ERA, whether baseline or predictive, is to provide risk-based recommendations, either for the EMP or for

environmental control measures. The EMP, in turn provides environmental data for the ERA, and may confirm the effectiveness of control measures. Emission controls for the PCSS are identified in **Section 9.2**, Emission Monitoring and Control.

Project activities during site preparation may result in excess soil that will then need to be managed according to MECP's Management of Excess Soil Guideline. A soil sampling program prior to site preparation activities to characterize soil quality in the PCSS area is recommended prior to site preparation.

Based on the results of the PERA, no additional environmental monitoring as a result of the PCSS has been identified.

10.0 Quality Assurance

All data utilized in this PERA provided by OPG were previously verified by OPG or other contract personnel and provided to Ecometrix for use in the assessment.

All EMP data used in the assessment has been verified by OPG, as described in the Quality Assurance (QA) and Quality Control section of the 2022 PN ERA (Ecometrix, 2023a). The EMP has its own QA program that encompasses activities such as sample collection, laboratory analysis, laboratory quality control, and external laboratory comparison. The station chemistry laboratory also has its own QA program and samples sent to be analyzed externally utilize accredited laboratories.

Throughout the planning and preparation of the PERA, all Ecometrix staff worked under an ISO 9001:2015 certified Quality Management System. All work was internally reviewed and verified. Reviews included verification of data and calculations, transcription in the report, as well as review of report content and formatting. Comments have been dispositioned and addressed as appropriate by report revisions. The review process has been documented through a paper trail of review comments and dispositions.

11.0 Conclusions and Recommendations

The potential interactions of the PCSS Project with various environmental components during all phases of the Project were evaluated qualitatively. Based on the qualitative assessment of Project-Environment interactions, the following assessment areas were identified as the focus of the quantitative assessment in the PERA.

- Emissions of dust (TSP) and particulate matter (PM_{10}, $PM_{2.5}$) to air during site preparation and construction.
- Elevated noise levels during site preparation and construction.
- Gamma radiation from the PCSS during operation.

11.1 HHRA

The screening assessment of air quality and noise indicated that all predicted air concentrations and noise levels are expected to be below their regulatory limits; therefore, no further quantitative assessment is required.

For exposure of human receptors to gamma radiation from the PCSS, the potential dose to the Sport Fisher was evaluated. The estimated dose for the Sport Fisher is 4.38 µSv/a. Considering the existing facilities on the PN site, the dose to the Sport Fisher could be up to 4.94 µSv/a. This represents less than 1% of the regulatory public dose limit of 1000 µSv/a.

Overall, since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernable health effects are anticipated due to exposure of potential critical groups to gamma radiation from the PCSS.

11.2 EcoRA

The screening assessment of air quality indicated that all predicted air concentrations are expected to be below their limits; therefore, no further quantitative assessment is required. While no specific noise level thresholds exist for ecological receptors noise levels are expected to be elevated temporarily during site preparation and construction, and most wildlife in the area are likely already accustomed to noise levels associated with an urban environment. Therefore, no further quantitative assessment is required.

For exposure of ecological terrestrial receptors to gamma radiation from the PCSS, the maximum dose rate to any ecological receptors residing in close proximity to the PCSS could be up to 0.012 mGy/d, and up to 2.74E-04 mGy/d for off-site ecological receptors residing at the fenceline. All predicted doses are lower than the 2.4 mGy/d radiation benchmark for terrestrial biota; therefore, no adverse effects are anticipated.

The dose also remains well below (1% or less) the radiation benchmark if the maximum dose from the PCSS is combined with the dose to ecological receptors from being exposed to radionuclides through other existing PN operations.

11.3 Recommendations

Implementation of an Environmental Management Plan during site preparation and construction activities will help mitigate any potential environmental impacts. The Environmental Management Plan will outline procedures relating to air (dust) and water management, noise control, contaminated and excess soil management, and general wildlife management. OPG and its contractors will employ best practices for environmental management which will be outlined in the Environmental Management Plan.

In addition to the Environmental Management Plan, the following plans or documents are recommended to describe mitigations that will prevent or manage impacts to human health and/or terrestrial/aquatic environments:

- A stormwater management plan for site preparation and construction (to provide the plans for mitigating erosion and sediment transport to the surface water environment, and impacts to groundwater from the stormwater management system);
- A stormwater management plan for post development including design requirements;
- Spill management protocol;
- Geotechnical or Hydrogeological Investigation to confirm dewatering requirements;
- Health and Safety Management Systems for protection of on-site workers and contractors; and
- Radiation Protection Program (during operation).

As indicated in Section 9.2, to quantify ambient dose rates, during the operation phase, TLD monitoring should be performed at the PCSS. Results would be reported quarterly as part of the NSS-PWMF reporting requirements.

No other additional monitoring is considered to be warranted.

12.0 References

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CNSC (Canadian Nuclear Safety Commission), 2018. Waste Facility Operating Licence - Pickering Waste Management Facility. Report No. WFOL-W4-350.00/2028. February.

CNSC (Canadian Nuclear Safety Commission), 2020. Environmental Protection. Environmental Principles, Assessments and Protection Measures. Report No. REGDOC-2.9.1 Version 1.2. September.

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Golder (Golder Associates Ltd.), 2007. Terrestrial Environment Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30- REP- 07701– 00009. March.

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OPG (Ontario Power Generation), 2023. 2022 Results of Environmental Monitoring Programs for Darlington and Pickering Nuclear. Report No. N-REP-03443-10029, R000. April.

SENES (SENES Consultants Limited), 2007. Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment. Report No. NK30- REP- 07701–00002. December.

UNSCEAR, 2008. Sources and Effects of Ionizing Radiation, Report to the General Assembly with Scientific Annexes. United Nations Scientific Committee on the Effects of Atomic Radiation.

Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested

CD# 92896-CORR-00531-01544 P

Submission Title: **Pickering Waste Management Facility - Application for Waste Facility Operating Licence WFOL-W4-350.00/2028 Amendment to Construct and Operate the Pickering Component Storage Structure**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed
	None	

Regulatory Management Action (REGM): 4 REGMs

No.	Description	Date to be Completed
1.	Submit the design requirements, environmental management plan, and construction verification plan for the PCSS to CNSC staff. **(REGM # 28267121)**	Prior to the commencement of construction activities.
2.	Submit the updated safety analysis for the final design of the PCSS to CNSC staff. **(REGM # 28267123)**	Prior to the commencement of construction activities.
3.	Submit the PCSS final commissioning report for CNSC staff acceptance. **(REGM # 28267122)**	Prior to operation of PCSS.
4.	Prior notification to CNSC staff on the updated PWMF Operating Policies and Principles for the PCSS. **(REGM # 28267257)**	Prior to operation of PCSS.

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None	

Concurrence Requested: OPG is requesting the Canadian Nuclear Safety Commission to amend the PWMF, WFOL-W4-350.00/2028, to construct and operate the PCSS for interim storage of L&ILW from Pickering NGS by February 2025.