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Written submission from Ottawa Riverkeeper

Exposé oral

Mémoire de Garde-Rivière des Outaouais

In the Matter of the

À l’égard des

Canadian Nuclear Laboratories (CNL)

Laboratoires Nucléaires Canadiens (LNC)

Application from the CNL to amend its Chalk River Laboratories site licence to authorize the construction of a near surface disposal facility

Demande des LNC visant à modifier le permis du site des Laboratoires de Chalk River pour autoriser la construction d’une installation de gestion des déchets près de la surface

Commission Public Hearing
Part 2

Audience publique de la Commission
Partie 2

May and June 2022

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PROPOSED NUCLEAR DISPOSAL FACILITY AT CHALK RIVER, ON

Comments on the Licence Amendment -
Required Approvals for Construction of the Near Surface Disposal Facility (NSDF) at the Chalk River Laboratories (CRL) site (CMD 22-H7)

April 11th, 2022

About Ottawa Riverkeeper

Ottawa Riverkeeper, a charitable organization, is a champion and collective voice for the Ottawa River watershed, providing leadership and inspiration to protect, promote and improve its ecological health and future.

We are a citizen-based action group that brings diverse people together to better understand and advocate for the ecological health of the Ottawa River and its tributaries. This includes the acknowledgement of the rights of the Algonquin Anishinabeg Nations within the watershed and a commitment to working together to build good relationships and shared understandings on water protection.

Expert and independent, our organization advocates for responsible and participatory decision-making, public education, access to information, and compliance with protective regulations. Guided by a science-based approach, we provide clear information with the aim to engage the public and empower citizens and decision-makers to ensure clean, healthy, and accessible water for all people and species.

Introduction

In Ottawa Riverkeeper's role as a voice and advocate for the river, our focus in reviewing the proposal for the Near Surface Disposal Facility (NSDF) has been on the potential environmental impacts to our waterways.

The Ottawa River and its watershed is not only a source of drinking water for an estimated 5 million people, but is also one of the great natural marvels of our continent. It is the unceded, unsurrendered territory of the Algonquin Anishinabeg Nation, home to Canada's capital city, and is a crucial habitat for an incredible amount of biodiversity, all of which depends on this source of water for life. This river, like all rivers, should be protected from harm, including contaminants, that could otherwise be avoided.

All systems to safeguard the Ottawa River must be held to the highest standards. This principle was our priority when investigating this proposal. The experts we consulted were specifically selected for their expertise as it relates to the relationship between projects such as this and potential impacts on waterways. Our review is therefore obviously limited in scope, and does not consider all potential impacts of the project, but rather the critically important issue of water.

The experts we consulted have provided many insights and recommendations, and conclude that there has been significant improvement in the proposal since it was last reviewed. However, major issues remain, especially when it concerns regulatory oversight and the scope of waste contained in the project. Below are our findings, informed by the reports of the experts we consulted, which are included in full as appendices.

Ottawa Riverkeeper would like to use this opportunity to reiterate our support for Algonquin communities in the watershed who have asked for meaningful consultations within this decision making process as has been asked for in recent months.

Comments

Our concerns over the ongoing pollution from the operations at Chalk River Nuclear Laboratories compelled us to participate in the Environmental Assessment (EA) for the disposal of nuclear waste at this site in 2017 and, as such, we have an interest in participating in these Commission Hearings for the Licence Amendment (CMD 22-H7) for Construction of the Near Surface Disposal Facility (NSDF) at the Chalk River Laboratories (CRL) site in 2022.

We have consulted two experts to assess the NSDF Environmental Impact Statement (EIS) to help us understand if the proposed technology and selected site will be sufficient to safeguard groundwater, surface water, and the aquatic ecosystem. Wilf Ruland, an experienced hydrogeologist, and Dr. Banu Örmeci, the Jarislowsky Chair in Water and Health and the Director of the Global Water Institute at Carleton University reviewed the EIS to determine if the information is valid and adequate to assess whether the proposed project will have significant adverse environmental impacts. Their detailed reviews are found in Appendices A & B. We had additional support from Pippa Feinstein who provided legal analysis concerning the NSDF EA review and additional research support.

In our opinion, there have been significant improvements to the NSDF since it was first proposed, notably, the expressed intention for only low-level waste (LLW) to be stored in the Engineered Containment Mound (ECM). The modification to the ECM to create separate cells that will be capped as they are filled, should reduce the exposure of the waste to the environment and limit the volume of leachate produced, is also an improvement on the project design. The legal framework surrounding CNL's proposed NSDF also appears to be generally acceptable. And yet, there are several notable concerns we have about the proposal as presented.

Ottawa Riverkeeper is concerned that the CMD 22-H7 and the corresponding Licence Conditions Handbook (LCH) lack the necessary oversight to ensure adequate environmental protections. This concern stems from the minimal legal requirements of environmental protections that CNL provides in the LCH, exemplified through: their failure to characterize the binding REGDOCs appropriately; their adoption of the upper bound LLW thresholds; failure to adopt stricter CSA guidance pertaining to waste characterization; and vague waste acceptance criteria (WAC). These shortcomings within the LCH raise concerns about how effective the Wastewater Treatment Plant (WWTP) will be, the time scale for monitoring and the need for independent verification of the monitoring programs. Stronger measures could have been included within the LCH and were not, which suggests that the proposal does not ensure that the appropriate available protections to avoid significant adverse impacts to the Ottawa River are in place.

Before the licensing amendment can be considered, the NSDF project must first successfully demonstrate that it meets the requirements for an EA. CNSC's guidelines for EIS states that "the proponent will demonstrate that all aspects of the project have been examined and planned in a careful and precautionary manner in order to avoid significant adverse environmental effects".[1] Ottawa Riverkeeper feels strongly that the NSDF proposal does not always meet this guideline and, when considering both the EIS and the licence amendment application, the CNSC must first require that appropriate measures remain to protect the environment and to ensure sufficient oversight is in place.

Licence Amendment and the Licence Conditions Handbook

A consistent concern raised by the experts we consulted was the lack of clarity regarding the waste which is destined to be stored in the proposed Engineered Containment Mound (ECM), specifically, the characterization of legacy waste. As the CNSC staff have noted, legacy waste characteristics data (physical, mechanical, chemical, biological, thermal, and/or radiological) that are currently available are not sufficient to demonstrate compliance with the NSDF WAC.[2] Therefore, CNSC staff conducted a waste characterization compliance inspection on NSDF to verify how waste proposed to be emplaced in the NSDF is being characterized.[3] The inspection covered the waste characterization program, process, and procedures in place, and worked to improve the waste characterization requirements applied to the different NSDF waste streams. Based on the inspection, the CSNC has required that all waste intended for the NSDF that does not have sufficient characterization data must undergo a re-characterization to ensure compliance with the WAC.[4] The details of these waste characterization issues are explicitly stated in the NSDF Reference Inventory Report and the Safety Assessment Report. They indicate that there are significant information gaps associated with legacy waste at the site and that this generates uncertainty involved in disposing of this waste in the NSDF. While the recharacterization of waste with insufficient data is available, they do not eliminate the significant uncertainty that exists. The proposal allows for interpretation within the waste re-characterization process. However, it likely has to be done in compliance with the waste verification process outlined in the WAC and on page 16 of this report,[5] though this is not explicitly stated in the WAC.

The uncertainty on this re-characterization process raises concern regarding how it will be assured that waste disposed in the NSDF meets the already ambiguous definition of LLW. Added to this is a lack of clarification about how LLW will be separated from other wastes, particularly in legacy wastes. CNL has committed to limit the waste to be stored in the ECM to LLW but as Dr. Örmeci notes in Appendix A, “It is possible to control the content and composition of the future waste that is disposed of in the ECM, but this is not likely possible for the legacy waste. Considering the large quantities of the legacy waste, even if the intermediate-level radioactive waste is a small percentage of the legacy waste, it will likely add up to significant quantities. If intermediate-level waste (ILW) is indeed in the legacy waste, it will end up in leachate that is treated at the wastewater treatment plant.”

The LCH references a number of documents and guidelines. The CSA N292.0:19 (*General principles for the management of radioactive waste and irradiated fuel*) and the International Atomic Energy Agency’s (IAEA) general guide GSG-1 provide a concentration range for low-level waste, and the NSDF has used the upper bounds of the low-level waste guidance for beta and gamma emitting long-lived radionuclides, despite claims in the NSDF Project Evaluation that only the lower-bounds of the LLW defined radionuclides would be accepted.[2] Moreover, the difficulties around separating radionuclides in certain circumstances, particularly relating to legacy waste, mean that some “LLW may also contain chemical constituents of potential concern (COPCs), such as residual contamination."[3] Also, it should be noted that the LCH lists REGDOCs as "guidance", despite their binding nature.

We would like to highlight that CSA N292.8:21 (*Characterization of radioactive waste and irradiated fuel),* one of the most detailed waste characterization guidance documents available, does not appear in the licensing material, nor in overarching regulations affecting the NSDF. This omitted document goes into significant detail about how waste characterization is to be planned and implemented. This includes how to interpret waste characterization data. Its omission from being made binding by the LCH is problematic because the proposed waste characterization legal framework is comparatively less strict than this CSA guidance. The licensing basis for the NSDF includes CSA N292.0:19 as well as the WAC, the NSDF Reference Inventory Report, CNL's waste characterization submission and standard, and *REGDOC-2.11.1 Volume 1*, all of which speak to characterization requirements. Yet CNL has chosen to adopt guidance documents which only incorporate short sections on waste characterization – as compared to the 72 pages dedicated to the topic in CSA N292.8:21 – in addition to their own internally drafted documents.

It is greatly problematic that the waste acceptance terms are vague. It is important that we emphasize this matter. All waste that will be placed for disposal in the NSDF must be LLW as defined by CSA N292.0:19 and the IAEA's general guide GSG-1 Classification of Radioactive Waste.[4] CNL's EIS states: "the concentrations of long-lived radionuclides that are proposed in the NSDF licensed inventory are limited, consistent with CSA N292.0 (CSA Group 2019) and IAEA GSG-1 (IAEA 2009) guidance."[5] However, throughout the EIS and its referenced documents, the definitions for LLW include extremely broad thresholds for acceptable radionuclides, they use highly permissive language, and the line between LLW and ILW is not clearly provided. Therefore, despite the fact that the LLW definition does explicitly comply with legal standards at face-value, we remain unsatisfied with CNL's approach to identifying the types of waste, especially with their use of the upper bounds for some wastes, that will be accepted into the NSDF.

Wastewater Treatment Plant

The types of wastes that are stored in the ECM will directly impact the efficacy of the Wastewater Treatment Plant (WWTP). After carefully reviewing the technical documents for the WWTP, Dr. Örmeci raised a number of concerns regarding the processes used within this facility (See Appendix A). "The proposed wastewater treatment system includes chemical precipitation, membrane filtration (micro) and a polishing system but no reverse osmosis. This is the most cost-effective option but may not be the best one. One of the main limitations of chemical precipitation is that it cannot achieve very low concentrations of dissolved metals or radionuclides… The polishing treatment system at the end of the treatment train consists of pH adjustment, ion exchange and GAC, and would remove some of the remaining dissolved metals and radionuclides but not all."

Dr. Örmeci also explains that while a number of techniques are listed as available for chemical precipitation, the report did not specify how these would be used, which can impact the treatment performance and, as a result, the contaminants present in the effluent. Given the uncertainty of which types of contaminants may be present in the leachate noted earlier, this raises further concerns regarding the efficacy of the proposed chemical precipitate technique. While reverse osmosis adds cost and requires additional training to the operations of the WWTP, it is recommended as the safest barrier for providing environmental protections. Once the WWTP is in operation, it will be very difficult to modify should the techniques proposed by CNL not meet the allowable threshold set for contaminants in the effluent. For this reason, a weakness in the EIS is the lack of a contingency plan should the proposed technique not be able to meet these criteria, especially given the uncertainty of the leachate to be treated.

Dr. Örmeci also noted that Section 3.4.2.4. of the Environmental Impact Statement (EIS) Report (Revision 3; May 26, 2021) states that the accumulated dilute wastewater may bypass the wastewater treatment process if it meets the criteria for discharge. Ottawa Riverkeeper strongly believes that CNL should take every necessary step to minimise the impact of the waste present in the ECM and at CRL on the environment and, as a result, on the Ottawa River. Once again, we call on CNSC to ensure appropriate oversight is in place to ensure that precautionary measures are in place.

Monitoring

Minimizing the impact of the waste that is to be stored within the NSDF is not only an important precautionary principle, but should be required given the level of contamination this site currently exhibits. As Wilf Ruland details in Appendix B, section 3, an understanding of the “mapping and inventorying the legacy radioactive and chemical contamination which is found on the Chalk River property - and in particular in the Perch Lake and Perch Creek watershed which will be receiving treated discharges from the ECM.” This is important because: “1) Existing patterns of groundwater and surface water contamination will provide important clues about water flows and contaminant transport directions in the event of a leak or emission of leachate from the ECM;” and “2) The surface water management ponds (SWMPs) and treated WWTP effluent will be flowing into surface water features that are already radiologically impacted by historic site activities and legacy waste areas. This historic contamination reduces the capacity for the environment to absorb and attenuate further contaminant loading from the NSDF.”

Monitoring throughout the lifespan of the NSDF must be a critical part of how the site will be operated. Within the EIS is a description of the importance of sharing monitoring information with the public through the ‘Public Information Plan’. However, Rulland noted that “[t]he ‘Public Information Plan’ which is dated January 2021 can be found on-line, but does not include information relevant to the NSDF project. Moreover, it does not provide for an assured access to all of the NSDF site’s monitoring programs’ test results once these start coming in.” Ruland states that allowing for “[i]ndependent review of monitoring results is a sure way to ensure that the [monitoring] program remains focussed, effective, and up to date - and to ensure that proper attention is paid to adverse monitoring results. It is in the public interest for the proponent to facilitate independent review of the monitoring for the proposed NSDF.”

Ruland also provided a strong rationale for the extension of the monitoring program to include the long term monitoring of leachate levels and quality. The design life of the geomembrane liner extends beyond the proposed period for monitoring. The ECM will not only contain radioactive waste but also chemical contaminants such as aluminum, cobalt, iron, and phosphate - all of which are estimated to be present above their respective effluent targets. It is this waste that, as Ruland points out in Appendix B, section 5, will remain potent and this "chemical potency will necessitate longer-term explicit planning and assessment than has been provided in the final EIS and its supporting documents." This expectation aligns with those for Ontario's landfill operators and should have been included in the EIS.

Insufficient siting of alternative locations for NSDF

A review of the site characterization done for the NSDF as presented in the final EIS is discussed in Appendix B, section 3. The conclusion is that the site is not favourable for the proposed ECM of the NSDF. The site selected for the NSDF at CRL has relatively unfavourable geology which would make the ECM component of the proposed NSDF reliant on engineered features to contain and collect the landfill's leachate and prevent it from contaminating the surrounding groundwater flow system. The ECM is essentially a landfill designed for the disposal of LLW. When selecting a site for the NSDF, CNL has indicated it restricted its site selection to the CNL properties at CRL and Whiteshell, despite a number of criteria that posed constraints. It is not clear why the site selection did not explore additional locations to see if a suitable site could have been secured to provide a more appropriate location.

Summary of Concerns and Subjects for Intervention

Throughout this submission, Ottawa Riverkeeper has raised a number of concerns with the current proposal from CNL for the NSDF.

A. There remain significant shortcomings in the EIS which should have been addressed during the EA decision that a project of this scale necessitates. While EA decisions are related to hearing decisions, these decisions should remain separate. In 2017 an EA was required for the NSDF under the Canadian Environmental Assessment Act, 2012 (CEAA, 2012). However in 2022, the Commission accepted the CNSC staff's assessment that the project would not cause significant harm and the public hearings are now framed as a licensing amendment decision. **We disagree with this finding and would like to speak directly to the environmental assessment of this project and advocate for the following:**

    1. The extension of the monitoring program must include the long-term monitoring of leachate levels and quality from the ECM, and for the project design to include both the radioactive and chemical wastes.
    2. Provisions for the monitoring activities and results be independently reviewed to ensure that the program remains focussed, effective, and up to date and that proper attention is paid to adverse monitoring results. It is in the public

interest for the proponent to facilitate independent review of the monitoring for the proposed NSDF.

3. A reverse osmosis system must be added to the proposed wastewater treatment plant due to the numerous unknowns, estimates, assumptions, and predictions described in Appendix A. This will provide the greatest assurance for meeting the effluent targets for the NSDF. If reverse osmosis is not included in the design, there must be a contingency plan in place in the event that the proposed wastewater treatment plant fails to meet the effluent discharge criteria.

B. Ottawa Riverkeeper has also raised concerns about the CMD 22-H7 and the corresponding LCH. We have highlighted how the LCH contains minimal legal requirements of environmental protections. These include the need to bind REGDOCs and adopt stricter CSA guidance pertaining to waste characterization. We have highlighted that the WAC is too vague, does not include the necessary assurances that recharacterizations will be regularly performed, particularly for legacy waste, and that often the upper boundaries for waste thresholds were adopted which suggests that the appropriate available protections to avoid significant adverse impacts to the Ottawa River are not in place. **These concerns relate to the long-term safety of this facility but also, as these are within the LCH, are an important consideration for the licence amendment.**

Ottawa Riverkeeper insists that CNSC provide increased assurances and oversight through:

1. Permitting only the lower-bounds for radionuclides concentrations within the ECM. This would require re-evaluating the limitations set out in section 5.2 for the radionuclide concentration limits and the external dose limits in section 5.6 of the proposed WAC to reflect the IAEA's general guide GSG-1 which provides a concentration range for low-level waste and select the lower bounds of these ranges.
2. Including CSA N292.8:21 within the LCH as it includes significant detail about how waste characterization is to be planned and implemented as well as how to interpret waste characterization data.
3. Ensuring appropriate record keeping for all materials destined for the ECM. It should be noted that REGDOC 2.11.1 Volume I not only requires CNL to perform waste characterization at various steps of managing the waste but also keep detailed records of the results. However, the Safety Assessment Report (232-03610-SAR-001 Revision 2) contradicts this by stating in Table B-1 that the requirement to keep and retain records does not apply to the NSDF Project. These contradictory statements need to be clarified.

Conclusions

Ottawa Riverkeeper notes several improvements to the NSDF proposal since the initial EA hearings in 2017. These include that the waste to be stored in the ECM will be limited to LLW and that the facility will be composed of smaller cells which will be capped as they are filled, therefore reducing the exposure to rain, snow, and other environmental elements which could come in contact with the material stored at the site. However, the assurance that only LLW will be permitted in the ECM rests on the assumption that the WAC is both sufficiently rigorous and indiscriminately applied. The LCH, including the WAC, is of utmost importance. It is challenging to have confidence in how appropriate safeguards within the proposal will be applied, given the uncertainty we have outlined regarding the waste characterization and how it will be regulated.

Ottawa Riverkeeper believes strongly that regulators must hold proponents accountable and ensure all available steps are taken to minimise the impacts of their industries. While the technical aspects of this project are improving, the proposal for the NSDF lacks the clarity required to understand what types of wastes will be accepted and how contaminant limits have been interpreted. It also does not provide the best available options to minimise the impacts of these wastes on the water.

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[1] Generic Guidelines for the Preparation of an Environmental Impact Statement, section 2.5 (April 22) online (pdf), e-Doc: 4995339.

[2] Canadian Nuclear Safety Commission, "A Licence Amendment Required Approvals for Construction of the Near Surface Disposal Facility (NSDF) at the Chalk River Laboratories (CRL) site Canadian Nuclear Laboratories Chalk River Laboratories: Commission Public Hearing - Part 1" CMD22-H7 (24 January 2022) at 42, e-Doc 6684267.

[3] Canadian Nuclear Laboratories, "Environmental Impact Statement: Near Surface Disposal Facility, Deep River, Renfrew County, Ontario" 232-509220-021-000 (January 2022) at s 3.3.3.3, online (pdf): *Impact Assessment Agency of Canada* <https://www.iaac-aeic.gc.ca/050/documents/p80122/139596E.pdf>.

[4] Canadian Nuclear Safety Commission, *Licence Conditions Handbook for Chalk River Laboratories*, NRTEOL-LCH-01.00/2028, Revision 3 (August 2022) at 53; Canadian Nuclear Laboratories, "Near Surface Disposal Facility Waste Acceptance Criteria" 232-508600-WAC-003, Revision 4 (November 2020) at s 3.3.1; IAEA, Safety Standards, "Classification of Radioactive Waste" (2009) General Safety Guide No 1 at s 2.27; Canadian Nuclear Laboratories, "Environmental Impact Statement: Near Surface Disposal Facility, Deep River, Renfrew County, Ontario" 232-509220-021-000 (January 2022) at s 3.22 & 3.23, online (pdf): *Impact Assessment Agency of Canada* <https://www.iaac-aeic.gc.ca/050/documents/p80122/139596E.pdf>.

[5] Canadian Nuclear Laboratories, "Environmental Impact Statement: Near Surface Disposal Facility, Deep River, Renfrew County, Ontario" 232-509220-021-000 (January 2022) at s 3.24, online (pdf): *Impact Assessment Agency of Canada* <https://www.iaac-aeic.gc.ca/050/documents/p80122/139596E.pdf>.

Appendix A: Evaluation of the wastewater treatment plant for the proposed NSDF

Prepared for Ottawa Riverkeeper

By Prof. Banu Örmeci

April 1, 2022

Below is my final evaluation of the proposed facilities to be constructed and processes implemented to treat wastewater associated with the operation of the Engineered Containment Mound (ECM) at the proposed Near Surface Disposal Facility (NSDF). I have been involved in this project since 2019 and reviewed several reports, documents, and revisions prepared by the Canadian Nuclear Laboratories (CNL). Even though improvements have been made to other parts of the final Environmental Impact Statement (EIS) Report (Revision 3; May 26, 2021), I have not seen significant changes to the planned wastewater treatment approach (Section 3.4.2) since the first version of the EIS. I previously communicated my feedback to the Ottawa Riverkeeper and CNL was able to address some of my concerns. My remaining concerns are summarized below.

- As stated in Table 4.3.2., "the original inventory proposed for NSDF Project in the draft EIS included a small fraction of intermediate-level waste. In response to comments received from the public, CNL made a commitment to limit the inventory to solid low-level radioactive waste only. This change has been reflected in the final EIS (Section 3.3), as well as supporting modeling and assessments such as the PostSA, and the revised Waste Acceptance Criteria.". This is a positive change.

  However, the report also states that "The wastes suitable for disposal in the ECM will include a wide range of bulk materials (e.g., demolition debris or soils) and packaged solid wastes (e.g., waste stored in containers or drums). These wastes have or will arise through CNL activities, including demolition of existing and future buildings; remediation of contaminated soils and related structures; operational and legacy wastes currently in interim storage; commercial sourced inventories; and wastes from the continuing laboratory operations" [page 3-22]. Thus, a large portion of the waste planned for disposal in the ECM will include operational and legacy wastes currently in interim storage, which includes low (LLW), intermediate (ILW) and high-level radioactive waste (HLW). The report states that "Overall, LLW comprises the vast majority by volume of the radioactive waste in storage at the CNL-managed sites. In 2015, approximately 95% of the waste in storage at CNL sites by volume was LLW, 4% was ILW and less than 1% was HLW (Figure 2.2-2)" [page 2-2]. The report also states that the legacy waste was segregated based on handling and storage requirements [page 2-5]; however, it is not clear if CNL can guarantee that there is no ILW or HLW mixed in the legacy waste. It is possible to control the content and composition of the future waste that is disposed of in the ECM, but this is not likely the case for the legacy waste. Considering the large quantities of the legacy waste, even if the intermediate-level radioactive waste is a small percentage of the legacy waste, it adds up to substantial quantities. If ILW is indeed in the legacy waste, it will end up in leachate that is treated at the wastewater treatment plant. This would necessitate a more advanced treatment technology, such as reverse osmosis, that can provide a safer barrier.

- The proposed wastewater treatment system includes chemical precipitation, membrane filtration (micro) and a polishing system but no reverse osmosis. This is the most cost-effective option but may not necessarily the best one when treatment/removal performance is considered. One of the main limitations of chemical precipitation is that it cannot achieve very low concentrations of dissolved metals or radionuclides. Membrane filtration (micro) would effectively remove the precipitates formed during chemical precipitation but not the dissolved metals and radionuclides remaining in the effluent. The polishing treatment system at the end of the treatment train consists of pH adjustment, ion exchange and GAC, and would remove some of the remaining dissolved metals and radionuclides but not all.

  Chemical treatment processes (i.e., precipitation, ion exchange, adsorption as proposed in this system) are cheaper and easier to operate but their performances are affected by the wastewater characteristics and other wastewater constituents. The ECM leachate will contain a wide range of metals and radionuclides, and each would have its own optimum pH range, coagulant type and dose. Below or above the optimum range, it would not be possible to remove these contaminants effectively, and worse they can be dissolved again. Thus, it is difficult to target a mixture of radionuclides and remove them all at the desired levels. Using too many chemicals together could also complicate things further. The report states that ferric chloride, sodium sulphide, sodium hydroxide and sulphuric acid will be used for chemical precipitation [page 3-62] but it is not clear how they will be used or in which order (i.e., simultaneously or sequentially). This would impact the treatment performance.

- Reverse osmosis was evaluated during pilot-scale testing and eliminated. The pilot scale test report states that "Reverse osmosis provided comparable, and in some cases, higher removal efficiencies for heavy metals, but the removal of cesium was lower than that demonstrated by the ion exchange process. Permeate quality from the second stage reverse osmosis system was similar to that of the first stage reverse osmosis system". The report also states that "The average weekly removal efficiency for cesium ranged from 85% to 92%, and the average weekly removal efficiency for strontium ranged from 92% to 99% for the first stage reverse osmosis system. The total average weekly removal for cesium through chemical precipitation, membrane filtration, and reverse osmosis ranged between 72.1% and 92.1% compared to 99.7 % for chemical precipitation, membrane filtration, and ion exchange" [section 4.6, page 21]. I appreciate the effort that went into pilot testing and I also acknowledge that pilot tests are not easy to carry out, especially when done in a short time frame. The equipment and operational conditions need to be optimized first, which takes time. The 20% variance in the total average weekly removal for cesium may indicate operational issues. In addition, high concentrations of cesium and strontium were used in the simulated wastewater, which creates favourable conditions for chemical precipitation and unfavorable conditions for reverse osmosis. It should also be noted that the simulated wastewater only included non-radionuclide cesium and strontium, whereas the actual wastewater would contain a wide range of radionuclides at very low concentrations. Thus, reverse osmosis might have been ruled out early. The operational difficulties (i.e., evaporation of reverse osmosis liquid waste, high cost, high energy requirements) for reverse osmosis mentioned in the pilot scale test report are within the capabilities of this facility to handle. There are several peer-reviewed studies that report very high removal of cessium and strontium with reverse osmosis, and better performance compared to ion exchange and activated carbon.

- The selected treatment methods (i.e., coagulation, membrane filtration) are stated to be the best technologies available that are economically feasible and recommended by the US Environmental Protection Agency (EPA) [page 3-62] as such. The references for these statements should be provided. EPA lists several methods for treating four regulated radionuclides (radium, uranium, and gross alpha particle activity) in drinking water, and reverse osmosis is also one of the best available technologies recommended with more than 99% removal as opposed to 90% removal with precipitation. Furthermore, leachate treatment is more complex and challenging than drinking water treatment and reverse osmosis may provide a better barrier.

- Section 3.4.2.2 states that "Further, carbonaceous 5-day biochemical oxygen demand may require treatment to meet the proposed effluent discharge target. If sampling of wastewater during operations demonstrates that the concentrations of contaminants are approaching levels that need to be treated, the operation of the WWTP can be adjusted so that effluent discharge targets are met (for example by including the appropriate resin in the ion exchange columns)". The above approach could work for drinking water treatment but not necessarily for leachate treatment. The reported successful applications with ion exchange and activated carbon in the peer-reviewed literature are typically for water samples cleaner than leachate.

  The maximum CBOD concentration in wastewater is predicted to be 62 mg/L (Table 3.4.2-3). Section 3.4.2.1 indicates that sewage from operations support centre facilities will be included in the wastewater. Sewage has high CBOD values. Table 3.4.2.3. also indicates that petroleum hydrocarbons may be present in wastewater coming from the vehicle decontamination facility. Therefore, CBOD concentration of the combined wastewater can potentially be higher than the predicted value, and the proposed treatment train may not be able to handle these higher carbon loads. On a side note, I recommend using both CBOD and COD (chemical oxygen demand) in assessing the wastewater quality and treatment performance. CBOD/BOD tests rely on the activity of aerobic bacteria and are not ideal for toxic or radioactive water samples, and will result in lower CBOD/BOD values.

- Section 3.4.2.4. states "The accumulated dilute wastewater is sampled. If it meets all requirements for discharge, it may be transferred directly from the collection tank to the final effluent tank(s)". How can it be ensured that dilution is not used further to bypass wastewater treatment? Dilution is not treatment. If, for example, more rain is allowed to mix with collected surface water runoff, it will be diluted more and meet the effluent criteria. CNL should strive to minimize any dilution that may occur after the collection of surface runoff and other wastewater samples.

- Understandably, many assumptions were used in estimating/predicting wastewater generation, wastewater characteristics, radionuclide and non-radionuclide constituent concentrations in wastewater, and their removal efficiencies [sections 3.4.2 and 3.3.1]. It is stated that the treated effluent will meet federal and/or provincial criteria for the protection of the environment and human health. However, it is likely that some of these assumptions, models, and projections will not hold true. What happens then? What is the contingency plan if the wastewater treatment facility cannot meet the effluent discharge targets? There should be a clear and effective contingency plan that can be implemented very quickly if the wastewater treatment plant fails to meet the effluent targets. Holding the treated effluent in a storage tank before discharge can only be a solution to address daily operational issues.

Recommendation:

The proposed wastewater treatment plant may or may not achieve the effluent targets due to the unknowns, estimates, assumptions, and predictions mentioned above. The ultimate goal here is to safely treat the radioactive wastewater and protect the environment and public health. Addition of a reverse osmosis system would most likely achieve this. It is a more expensive system to build and operate, but it provides a safer barrier. If reverse osmosis is not included in the design, there must be a contingency plan in place in the event that the proposed wastewater treatment plant fails to meet the effluent discharge criteria.

Appendix B: Independent Review of Hydrogeological Issues Pertaining to the Final Environmental Impact Statement for the Proposed Near Surface Disposal Facility (NSDF) at the Chalk River Nuclear Site

Prepared for:

Ottawa Riverkeeper (ORK)

Prepared by Wilf Ruland (P. Geo.)

766 Sulphur Springs Road
Dundas, Ontario
L9H 5E3
(905) 648-1296
deerspring1@gmail.com

April 8th, 2022

1) Introduction

I am a hydrogeologist, and I have worked as an environmental consultant for 35 years (2 years for a larger firm in Germany, and 33 years independently in Canada). I am a specialist in groundwater and surface water contamination issues, and have dealt with many such issues over the course of my consulting career.

I have provided testimony as an expert witness on hydrogeological issues before various boards - including the Environmental Review Tribunal, the Environmental Assessment Board, the Joint Board, the Ontario Municipal Board, the Niagara Escarpment Commission, and the Canadian Nuclear Safety Commission. A copy of my Curriculum Vitae is available upon request.

I have reviewed and provided comments on numerous environmental assessments (EAs) and Environmental Impact Statements (EISs) over the course of my career. I have reviewed environmental assessments for numerous landfills, and reviewed plans for the development of near surface disposal facilities for low level nuclear waste in Port Hope and Port Granby Ontario. All of these make me well qualified to consider the issues being discussed in this matter.

I have been retained by Ottawa Riverkeeper (ORK) to review water- and leachate-related documentation pertaining to the proposed Near Surface Disposal Facility (NSDF). The NSDF is intended to provide disposal capacity for 1 million cubic meters of low level nuclear waste (LLW) on a 37 hectare project footprint located on the much larger Chalk River Laboratories (CRL) property.

This review of the final Environmental Impact Statement (final EIS) provides my comments and recommendations regarding this matter, including an update on improvements made to the NSDF proposal since the initial draft EIS was issued in 2017.

In this review I will provide a description of the NSDF project and comments on the adequacy of:

- the description of the NSDF site and its surroundings including the local geology, hydrology and hydrogeology;
- the proposed site design and operations in terms of containing and isolating the radiological wastes to be disposed in thee NSDF;
- the assessment of potential groundwater quality and surface water quality impacts related to inorganic, organic, and radiological contaminants at all stages of the NSDF project including site preparation and construction, operations, closure, and the very long post-closure period;
- the proposals for mitigation of any foreseeable impacts;
- the groundwater and surface water monitoring plans and contingency plans;
- the overall merits of the NSDF proposal and overall adequacy of the final EIS.

In order to carry out this work, I have reviewed a series of documents and the most important of these are listed as references in **Appendix 1** of this review.

I also met by video conference with CNL staff (on April 1st) to discuss a variety of questions and potential concerns I had regarding the final EIS and the potential for impacts on groundwater and surface water from the proposed NSDF.

2) Overview of the NSDF Proposal

The final EIS provides a detailed description of the Near Surface Disposal Facility (NSDF) proposal, including the following key aspects:

- the planned construction (on the grounds of the Chalk River Laboratories) of a permanent landfill for disposal of low-level radioactive wastes (LLW), with a capacity of 1,000,000 m3 of such wastes;
- the disposal of these wastes in the NSDF, over a 50-year operational period;
- containment and collection of leachate generated within the NSDF, with treatment of the leachate at a dedicated waste water treatment plant (WWTP);
- closure of the NSDF and capping with an impermeable cover, which is intended to effectively prevent the further production of leachate for hundreds of years;
- the proponent's proposed groundwater and surface water monitoring of the DGR facility is for at least 300 years after closure; and
- the containment of the low-level radioactive wastes for a minimum of 550 years, after which their radioactivity will be spent.

A significant portion of the wastes proposed to be securely disposed of in the NSDF is to come from the remediation of "legacy wastes" which are found scattered around the Chalk River facility and its surroundings - including poorly contained waste disposal pits, contaminated soils and vegetation, contaminated and/or redundant buildings and structures, and wastes which are currently being stored at various locations. In the worst cases, these radioactive wastes were simply buried in leaky unlined trenches in sandy soils at the site.

The contaminated-site remediation aspect of the NSDF proposal is particularly welcome, as it would mark a significant and permanent improvement to the Chalk River facility and its environment to have all of the aforementioned various legacy radioactive wastes disposed of in a properly designed and secure facility.

Aside from remediation of legacy issues, the NSDF is also proposed to provide CNL with a long-term secure disposal facility for low-level radioactive wastes (LLW) which are generated over the next 50 years (to about 2075).

This review provides an overview of key issues regarding the environmental impact assessment set out in the final EIS, including site characterization, various aspects of the NSDF design, the impact assessment, monitoring, and contingency plans.

3) Site Characterization

a) Introduction

A significant amount of investigation and characterization of the NSDF site and its surroundings has been done and presented by the proponent, and this marks a significant improvement from the initial draft EIS. Overall the site characterization has been very well done and adequately presented in the final EIS, which provides a solid description and understanding of the hydrogeology and hydrology and aquatic habitat of the NSDF site and its surroundings.

b) Site Topography and Drainage

There is a significant bedrock ridge on the east side of the NSDF site, which runs NNW-SSE. The highest elevations of the ridge are up to about 195-197 meters above sea level (masl).

The proposed Engineered Containment Mound (ECM) which will be receiving the low level waste (LLW) is planned to be situated on the western slope of the ridge, with the ground surface sloping from the area of the ECM toward surface water features to the south and west (at an elevation of around 157-163 masl).

Surface water flow from the NSDF area is generally to the west and south, and any runoff from the ECM site will make its way into the Perch Lake wetlands and from there into Perch Lake. Perch Lake is a shallow 46 hectare feature, which has an average depth of about 2 metres. Perch Lake drains via Perch Creek into the Ottawa River (which is at about 112 masl). Perch Creek is about 1 km long, and in sections is quite steep with waterfalls.

c) Site Geology and Hydrogeology

At the NSDF site, the overburden is thin - in particular in the area of the Engineered Containment Mound (ECM) which will be receiving the LLW. In the area of the ECM footprint the overburden thickness is generally on the order of 2 meters or less, and the overburden is comprised mainly of fine sand horizons and sand/silt till. Beneath the overburden is fractured crystalline Precambrian bedrock.

In such a setting, the bulk of any leakage of leachate from the ECM would migrate south and west in the shallow sand horizons and the upper fractured bedrock beneath the site. This is confirmed by the existing pattern of groundwater contamination on the Chalk River property, which likewise is found in the overburden sand deposits.

Due to the uneven ground and the relatively thin overburden, extensive blasting and considerable grading will be required to prepare the NSDF site for the ECM which is intended to receive and contain the LLW.

d) Reliance on Engineered Features

Overall, the site is not favourable for the siting of a landfill - and it should be noted that the proposed engineered containment mound (ECM) of the NSDF is nothing more than a landfill especially designed for disposal of LLW. From a hydrogeological perspective the optimal site for this radioactive waste landfill would be one with a thick and low-permeability silt/clay overburden.

Because of the relatively unfavourable geology, the ECM component of the proposed NSDF (if approved) will be utterly reliant on engineered features to contain, collect and treat the ECM's leachate and prevent it from contaminating the surrounding groundwater and surface water flow systems. My review of the proposed site design and operations plans (which follows in the next sections of this report) has been carried out with this concern in mind.

e) Existing Radioactive Contamination of Groundwater and Surface Water

The initial draft EIS did not include much in the way of a description of the existing "legacy" groundwater (and surface water) contamination in the area of the NSDF. Such legacy contamination is extensive, and is the result of historic activity and waste disposal practices at the Chalk River facility - with the earliest waste pits dating back to the 1940s.

The final EIS provides an improved discussion and description of current (ambient) radioactive contamination of surface water (in Section 5.7.4.5) and groundwater (in Section 5.7.4.6). This includes maps and tables which together provide a picture of the areal distribution of key radioactive contamination parameters including tritium, gross alpha, gross beta, strontium, cobalt-60 and Caesium-137.

More details are provided in groundwater and surface water supporting technical documents. I did not have the time to undertake a detailed review of these documents, but overall my sense is that CNL has done a thorough job of mapping and inventorying the legacy radioactive and chemical contamination which is found on the Chalk River property - and in particular in the Perch Lake and Perch Creek watershed which will be receiving treated discharges from the ECM.

This aspect of the EIS is important for several reasons:

1) Existing patterns of groundwater and surface water contamination will provide important clues about water flows and contaminant transport directions in the event of a leak or emission of leachate from the ECM.

2) The surface water management ponds (SWMPs) and treated WWTP effluent will be flowing into surface water features that are already radiologically impacted by historic site activities and legacy waste areas. This historic contamination reduces the capacity for the environment to absorb and attenuate further contaminant loading from the NSDF.

Helpful in this regard are the observations of tritium levels in the Perch Lake / Perch Creek watershed. Tritium is the critical contaminant in the surface water system, and tritium levels in Perch Lake and Perch Creek are elevated but in a long-term declining trend.

4) Evaluation of Project Alternatives

The evaluation of project alternatives is provided in Section 2 of the final EIS, and as per EIS Table 2.5-1 it includes evaluation of alternatives for:

a) facility type;
b) facility design;
c) facility location;
d) site selection;
e) leachate treatment options;
f) effluent discharge options, including type of effluent discharge.

Section 2 introduces a number of design improvements for the NSDF proposal. The most significant of these improvements are:

- the elimination of the plan to bring intermediate level radioactive wastes (ILW) into the NSDF;

- the plan to augment the preferred option of discharge to the groundwater system (via an exfiltration gallery) with a discharge line that would allow discharge of treated ECM effluent directly into Perch Lake on a year-round basis in the event of capacity issues with the exfiltration gallery.

I have reviewed and I support both of these significant design modification alternatives.

Overall I have reviewed all of the work done on evaluating and deciding between the alternatives presented in Section 2 of the final EIS, and I have no real issue with any of this work.

5) Proposed NSDF Design and Operations

The project description including the details of the proposed site design and operations are provided in Section 3 of the final EIS.

Project design changes which have been made since the original draft EIS was issued are described in Section 3.1.4 of the final EIS. I support the hydrogeology- and hydrology related changes which have been made.

a) Overview of Key Design/Operations Features

My understanding of the key features of the proposed NSDF site design and operations (much of which is based on the information provided in Section 3 of the final EIS) includes the following:

- 1,000,000 m3 of only low level radiological wastes (LLW);
- no hazardous wastes as defined by Ontario Regulation 347;
- a waste to cover soil ratio of 4:1;
- 10 LLW disposal cells with an average size of 1.2 hectares, giving an inferred overall waste footprint of about 12 hectares;
- a maximum waste thickness of 18 meters;
- a theoretical design life for the engineered containment mound (ECM) part of the facility of at least 550 years;
- an operating life during which wastes will be accepted from about 2025 to 2075;
- 90% of the wastes to come from the Chalk River facility and its surroundings, with the rest to come from off-site sources;
- a double liner system for the base of the ECM (see Figure 3.4.1-4), designed to contain the landfill's leachate;
- the double liner system is to include a geosynthetic clay liner (GCL) and high density polyethylene (HDPE) geomembrane in the primary liner, and a HDPE geomembrane and GCL and 0.75 m of compacted clay in the secondary layer;
- a separation distance of 0.25 meters is proposed between the water table and the ECM base;
- a leachate collection system above the primary liner, designed to collect the leachate and remove it from the ECM;
- design hydraulic conductivity of the base liner systems of 10 -9 m/s;
- maximum permitted depth of leachate accumulation on the primary liner of 0.3 m;
- leachate flow paths to a collection line will be a maximum of 50 meters (which suggests a spacing of up to 100 meters between collection lines);
- an impermeable cover which includes a 2 mm thick HDPE liner supported by a GCL liner to go over the waste cells (see Figure 3.4.1-8);
- waste cells are to be filled and covered progressively;
- a dedicated wastewater treatment plant or WWTP (described in Section 3.4.2.4), designed to treat the leachate which is collected from the ECM through the operating life of the NSDF and beyond;
- the WWTP design and operation is to use the "best available treatment technology that is economically available";
- WWTP leachate treatment targets provided Tables 3.4.2-2 and 3.4.2-3 of Section 3.2.2.2;
- anticipated average annual treated leachate discharges at full development (just prior to site closure) of about 11 million Litres (11,000 m3) per year;
- discharge of WWTP effluent in batches, after prior confirmation testing.

Overall, the design and proposed operations of the NSDF are prudent and appropriate for a facility intended to contain LLW.

There are three key design aspects of the overall NSDF which are critical to the success of the proposal:

- the base liner and leachate collection system for the ECM;
- the impermeable cover for the ECM;
- the leachate treatment provided by the WWTP.

I will be discussing each of these issues in more detail in the following sections of this review.

<u>b) Base Liner Containment and Leachate Collection System</u>

The base liner and leachate collection system for the ECM are relied upon to keep the leachate generated by the radioactive wastes in the ECM from leaking out and causing contamination of the surrounding environment.

The proposed base liner and leachate collection system are described in the final EIS in Section 3.4.1.4., with a liner cross-section provided on Figure 3.4.1-4.

There will actually be 5 separate low-permeability components to the base liner system:

- 2 high density polyethylene (HDPE) geomembrane liners (2 mm);
- 2 geosynthetic clay liners (GCLs);
- a 0.75 metre thick compacted clay liner.

Section 3.1.1.1 of the final EIS states that a comprehensive HDPE geomembrane liner testing and evaluation program was carried out. I requested the report on the liner testing/evaluation program (Rowe 2019), and it was provided by CNL.

The report provides an impressive overview of state-of-the-art liner technologies and the cutting edge testing methods which have been applied to candidate HDPE liners for the NSDF.

CNL has also indicated that a Construction Quality Assurance (CQA) Program will be applied during liner construction - and a September 25, 2019 report on the CQA Program was provided by CNL at my request.

Based on my review of the report on the liner testing and evaluation program and my review of the CQA report, I am confident that state of the art liner installation, construction and testing technologies are being applied to the NSDF project.

If all of the recommendations of both of the above reports are followed, then I am confident that the 550 year design life of the base liner system will be met or exceeded. CNL staff have confirmed that the recommendations of these reports *"are captured and implemented through CNL's various Management System processes"*.

c) Final Cover Issues

I have a couple of concerns related to the final cover of the ECM:

- the "impermeable" cover will prevent any significant reductions in the chemical toxicity of the wastes, such that the wastes will still be chemically potent for many centuries;
- continued chemical potency of leachate will necessitate very long-term planning for dealing with chemical contamination from the ECM's leachate many centuries from now.

i) Impermeable Cover Means Leachate Stays Chemically Potent

The ECM can be thought of as a landfill, albeit one with somewhat more "exotic" (radioactive) waste. A key concept in landfill science is the "contaminating lifespan" of a facility - the timespan over which the wastes inside the landfill will need to be contained, in order to prevent the landfill's leachate from causing unacceptable groundwater and/or surface water contamination.

The ECM will have both a "radiological" contaminating lifespan and a "chemical" contaminating lifespan.

Radiological Contaminating Lifespan

The wastes in the ECM are low-level radioactive wastes (LLWs). They are being landfilled in the ECM in order to provide safe containment for several centuries - during which time the radioactivity of the wastes will decline to harmless levels through radioactive decay. I have no concerns about this aspect of the NSDF.

Chemical Contaminating Lifespan

One of my main concerns about the site design pertains to the final cover of the site. The issue of the "impermeable" ECM cover and the implications of that cover for the long-term impacts of the NSDF on its surroundings need to be carefully considered.

At a conventional landfill, the cover is usually composed of relatively lower permeability silty clay soils - but some amount of rainfall is able to seep through the cover and leach chemicals out of the waste. This is the process that forms "leachate".

At a conventional landfill this ongoing seepage of rain through the cover, followed by formation of leachate - which is collected and pumped out of the landfill for treatment - results in the ongoing reduction of chemical concentrations in the landfill's wastes.

These reductions in chemical concentrations will not be occurring in the ECM for many centuries, because its cover is designed to entirely keep rainwater out and to isolate the low level radioactive wastes inside. The HDPE liner in the cover is projected to perform as an effective hydraulic and diffusion barrier for the 550-year design containment period of the ECM.

The 550-year design life of the HDPE liner is based on an estimate of how long leachate from the site needs to be contained before it becomes radioactively harmless. If one accepts that the liner will be impermeable and will last for 550 years, then a new question arises - will the wastes in the ECM be chemically harmful even after their radioactivity has been reduced to harmless levels?

This issue of long-term chemical potency of the wastes has not really been addressed in the final EIS. It is my professional opinion that chemical potency will necessitate longer-term explicit planning and assessment than has been provided in the final EIS and it supporting documents.

Parameters which may particularly drive this decision making are those non-radionuclides which are projected to be at higher concentrations in the ECM leachate than their respective water quality related regulatory limits:

- aluminum, which is estimated to be present at 3 times the effluent target
- cobalt, which is estimated to be present at 3 times the effluent target
- iron, which is estimated to be present at 417 times the effluent target
- manganese, which is estimated to be present at 48 times the effluent target
- phosphate, which is estimated to be present at 130 times the effluent target
- several PAHs which are estimated to be present above their respective effluent targets.

The above list is based on a series of assumptions and calculations about the composition of the incoming wastes which may or may not be conservative.

Given that the NSDF proposal covers 50 years worth of wastes which haven't even been generated yet (in addition to the legacy wastes), it would be prudent for CNL to explicitly plan for the potential need to monitor the ECM for far longer than the 300-year post-closure institutional control period.

ii) Longer-Term Monitoring Needed to Assess Chemical Potency of Leachate

To reliably establish the long term chemical potency of the ECM leachate and the need for ongoing leachate containment after the proposed 300-year Institutional Control period, it is important to identify this issue now and make firm plans for an assessment of chemical potency of the wastes at the end of the 50 year Operations period in 2075. If a solid assessment is done at that time, it can be used to inform further decision making in the centuries to come. Page 35 of the NSDF Waste Acceptance Criteria indicates that such an inventory of metals and organics is to be done at closure, which is excellent.

6) Wastewater Treatment and Impacts of Effluent on Surface Waters

a) Introduction

Given the redundancies in the base liner design, I believe that the vast majority of the ECM's leachate will be contained and prevented from leaking out of the facility's base for hundreds of years.

This is a good thing, but only if the wastewater treatment plant (WWTP) which is part of the proposal is a state-of-the-art facility with effluent criteria which are protective of the natural environment. Fortunately the final EIS provides outstanding assurances regarding this aspect of the NSDF proposal.

b) Batch Discharges

Instead of discharging to the natural environment on an ongoing basis, the WWTP effluent will be discharged in batches - with prior testing confirming that the effluent quality of each batch meets the site's discharge criteria. This ensures that only effluent which has been "pre-cleared" through prior testing will be allowed to discharge to the environment.

As long as the effluent discharge criteria are appropriately protective of surface water quality, this is an optimal precautionary way to deal with the WWTP effluent.

c) WWTP Effluent Quality Discharge Criteria

Effluent quality discharge targets for the NSDF's WWTP are provided in Table 3.4.2-2 and Table 3.4.2-3. With the possible exception of tritium, I am generally satisfied with the targets set out in Table 3.4.2-2 and Table 3.4.2-3.

If achieved, these targets (which are based on Canadian and/or Ontario surface water quality guidelines) will be protective of downstream surface water quality and aquatic organisms in the Perch Lake and Perch Creek watersheds. There is certainly no possibility of impacts on the Ottawa River.

d) WWTP Effluent's Tritium Impacts on Downstream Surface Waters

Tritium in particular is shaping up to be a significant potential issue in the NSDF's WWTP effluent, given that tritium levels will be very high in many of the proposed ECM's incoming wastes - and in the absence of mitigation measures, this would translate into very high tritium levels in the ECM's leachate.

The WWTP is unable to provide any treatment of tritium so whatever concentrations of tritium are found in the leachate coming into the WWTP will roughly correspond to the tritium levels in the effluent.

CNL will attempt to deal with high-tritium wastes in two quite effective ways:

- by screening out wastes with excessively high tritium levels;
- by packaging high-tritium wastes with the aim of considerably delaying tritium releases from the wastes, allowing for significant reductions in radioactivity through radioactive decay before the tritium becomes available for leachate formation.

However even with these measures being implemented, there may still be challenges in meeting the CNL commitment to an upper tritium limit in Perch Creek of 7,000 Bq/L.

The final EIS provides some information regarding existing levels of radiological contamination in the East Swamp wetland and the downstream surface waters of Perch Lake and Perch Creek which will be receiving effluent from the WWTP.

Based on the information in the final EIS (in Table 5.7.4-8, which shows average annual tritium levels in these locations), it is clear that elevated tritium levels are already found in the East Swamp wetland and especially in downstream surface water features including Perch Lake and Perch Creek (where tritium levels of several thousand Bq/L are common).

Table 1 on the next page of this review summarizes those 2014 to 2018 tritium levels which are currently found at various points downgradient and downstream of the discharge points for the WWTP effluent, based on the information provided in the final EIS.

Elevated tritium levels are already present in Perch Lake and Perch Creek. This means that there is only a limited capacity for additional tritium loading, if the final EIS commitment to an upper tritium limit in Perch Creek of 7,000 Bq/L (which is based on the Ontario Provincial Water Quality Objective for tritium) is to be achieved.

Instead of just providing average levels, it would have been helpful if seasonal high and low tritium levels could have been presented in the final EIS. This is because there will be times of year (perhaps during drier summer base flow periods) when the creek has higher tritium levels, and during which the addition of tritium-laced WWTP effluent will be at risk of pushing the creek over the tritium limit of 7,000 Bq/L.

There are however two favourable conditions which are working in the proponent's favour:

- there is a long-term trend of declining tritium levels in Perch Creek
- the discharges from the WWTP (which will average about 1 m3/hour) are a small fraction of the flows through the Perch Lake / Perch Creek watershed (252 m3/hour).

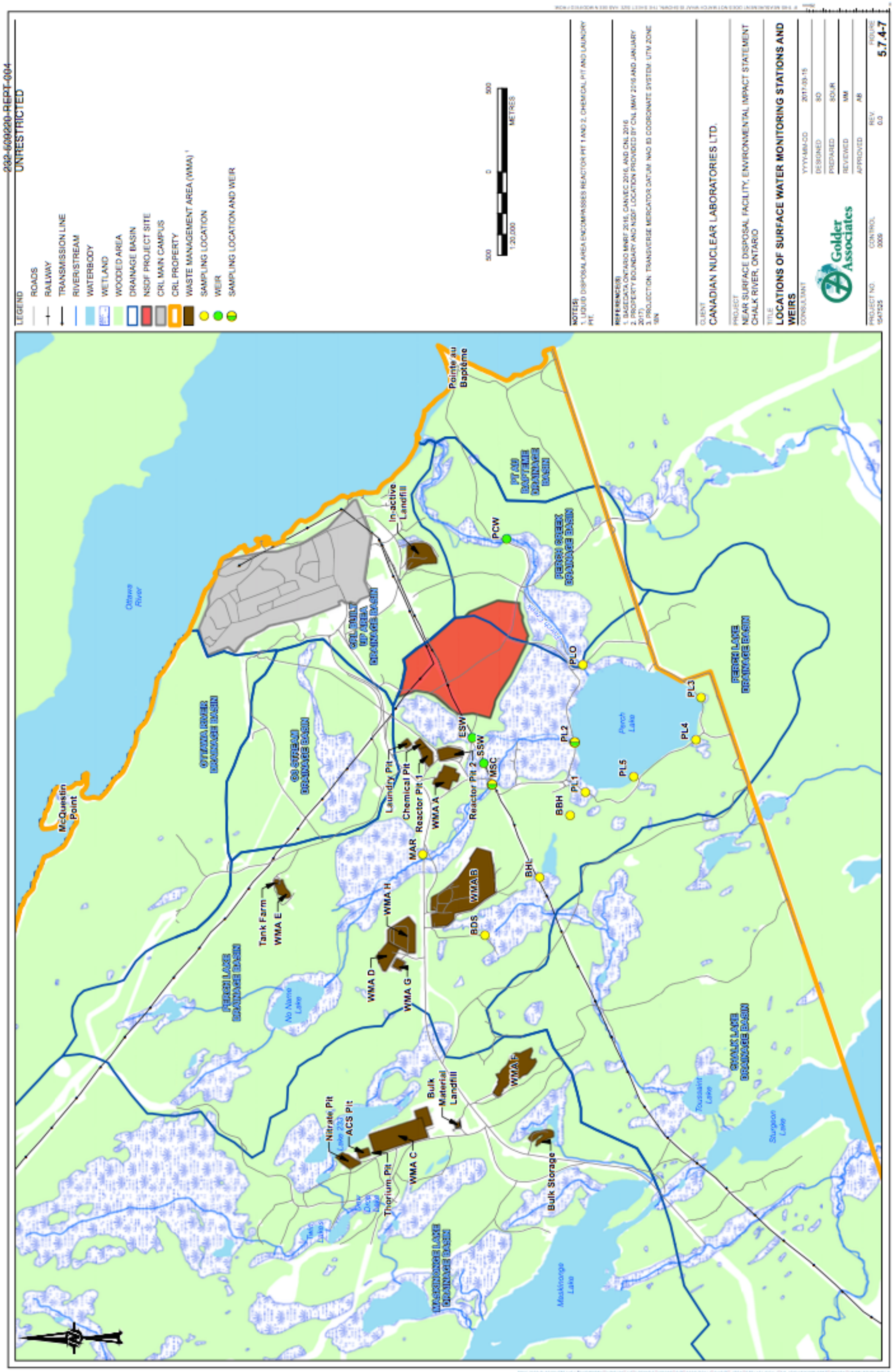
Table 1:

Current Average Tritium Levels Downstream/Downgradient of NSDF

Monitoring Locations (see Figure 1 map on next page)	Tritium Levels	Reference
Background Tritium Levels in Undeveloped NSDF area	48 to 399 Bq/L	Tables 5.3.2-5 and 5.3.2-6
Tritium Levels in Groundwater in East Swamp WMAs	no disclosure provided in final EIS	
East Swamp Weir (ESW)	286 to 348 Bq/L	Table 5.7.4-8
Perch Lake Inlet (PL2)	1,354 to 3,249 Bq/L	Table 5.7.4-8
Perch Lake Outlet (PLO)	1,367 to 2,780 Bq/L	Table 5.7.4-8
Perch Creek - Weir (PCW)	2,056 to 4,233 Bq/L	Table 5.7.4-8

Note:
- Bq/L = Becquerels per Litre
- tritium levels are annual readings (2014 to 2018)

Figure 1 - Chalk River / NSDF Surface Water Monitoring Stations



For any other parameter considered in the final EIS, the fact that background levels in the watershed are elevated would not be a concern. This is because the effluent quality discharge targets adopted in EIS Table 3.4.2-2 and Table 3.4.2-3 are based on regulatory limits for each of the parameters being considered - except tritium.

Tritium alone is handled differently in the final EIS. The Provincial Water Quality Objective (PWQO) for tritium is 7,000 Bq/L, but the effluent discharge target has been set 51 times higher at 360,000 Bq/L. This means that CNL is seeking permission through the final EIS to discharge waste water from the WWTP which is up to 50+ times higher than the surface water limit established by the province of Ontario through the PWQO for tritium.

It appears that the proponent has little choice in the matter as a significant proportion of the NSDF's intended waste stream is very high in tritium, and there is no way to remove tritium from the WWTP effluent. Fortunately the ecological risk benchmark for tritium is 17,400,000 Bq/L - almost 50 times higher than the effluent discharge target of 360,000 Bq/L. This provides a massive factor of safety for downstream aquatic species.

The question arises as to why the Provincial Water Quality Objective (PWQO) for tritium has been set at only 7,000 Bq/L - as normally the PWQO are established to protect aquatic life.

It turns out that the PWQO for radionuclides including tritium have been set at their drinking water limits - which for tritium is 7,000 Bq/L. Given that access to the Perch Creek watershed is restricted, there is no risk of human consumption of the water.

For the above reasons, I am satisfied that the issue of tritium in downstream surface waters has been properly handled in the final EIS - and that tritium in WWTP effluent will pose no threat to the health of either humans or aquatic species.

<u>e) Summary</u>

From the description of the treatment processes which are indicated to be part of the NSDF's WWTP, it can be anticipated that excellent treatment of waste water would be provided - except tritium.

Comprehensive effluent discharge quality criteria are provided in the final EIS, and given the plan for batch discharges (only following prior confirmatory effluent testing) this will provide significant protection to downstream surface water quality for every parameter considered - including tritium.

7) Groundwater Quality Impact Assessment

a) Introduction
The NSDF proposal if approved and implemented would bring with it an immediate net improvement in local groundwater quality.

This is because Phase 1 of the NSDF project involves the excavation and remediation of numerous poorly controlled radioactive legacy waste areas in the Perch Lake watershed, with the excavated radioactive wastes then being sealed away inside the state-of-the-art NSDF engineered containment mound (ECM).

The excavation and removal of the various legacy waste areas will bring with it an immediate and permanent improvement in soil and groundwater quality in the vicinity of those areas - as well as a progressive improvement to downgradient groundwater quality, as the various groundwater contamination plumes slowly dissipate once their legacy waste source areas have been removed.

The NSDF proposal brings with it two kinds of potential impacts on groundwater quality:
- due to the "polishing" of WWTP effluent in the proposed exfiltration gallery during the Operations phase of the NSDF;
- due to the leakage of leachate from the site when the base liner and/or cover of the NSDF have degraded and are failing (many centuries after closure of the site).

b) Exfiltration Gallery
As discussed previously, during the Operations phase leachate is to be collected and removed from the ECM - with treatment of the leachate being provided by a purpose-designed and -constructed WWTP.

The effluent criteria for the WWTP are already protective of water quality in the downstream surface water system, but CNL has built in an additional factor of safety by making provision for the treated WWTP wastewater to be polished through use of a groundwater "exfiltration gallery" (the rough equivalent of a big septic field).

The final EIS does not clearly present the details of the exfiltration gallery and how it is expected to work. But applying basic hydrogeological understanding to the situation allows predictions of the effects of the exfiltration gallery.

The exfiltration gallery will be constructed and operated in a manner similar to a septic bed - it will consist of a large bed of uniform sand, with a network of distribution pipes running through it. WWTP effluent will be fed into the system, and then will trickle through the gallery's piping and flow into the sand bed. From there it will flow downward into the underlying groundwater flow system and slowly move through the wetland soils toward Perch Lake.

Directing the WWTP effluent through the exfiltration gallery makes good sense, as it will allow polishing of the effluent to occur as it moves slowly toward Perch Lake.

The exfiltration gallery and downgradient groundwater system will provide at least some treatment/reductions of various inorganic WWTP effluent parameters (such as heavy metals) through groundwater attenuation processes. The greatest benefit will accrue to the radiological contaminants such as tritium in the effluent, as significant dilution and radioactive decay will occur in the decades it takes for the effluent to make its way from the gallery to Perch Lake.

As said, the final EIS' descriptions of the exfiltration gallery's design and proposed operation are sparse, but I was able to find the following:

- the location of the exfiltration gallery is shown on Figure 3.1.1-1, which has an arrow labelled "Exfiltration Gallery" pointing to a location at the north end of the NSDF);

- the precise dimensions of the exfiltration gallery have not been provided, although page 3-64 of the final EIS indicates that the footprint of the exfiltration gallery will be "approximately 1,000 m2";

- CNL staff have shared information indicating that the exfiltration gallery will be a meter or two above the water table, and that it will be able to handle batches of effluent up to 550 m3 (550,000 Litres) in volume;

- a contingency plan for the exfiltration gallery is that when/if needed, a pipeline can take all WWTP effluent and discharge it directly to a diffuser at the bottom of Perch Lake.

There would clearly be minor local impacts on groundwater quality in the area downgradient of the exfiltration gallery, given that the gallery is being used to polish treated effluent from the WWTP. In effect the exfiltration gallery would be a minor sacrificial wastewater treatment area.

The critical contaminant would almost certainly be tritium, with its effluent discharge criterion of 360,000 Bq/L - which is over 50 times higher than the Ontario Drinking Water Quality Standard (ODWQS) of 7,000 Bq/L.

So groundwater quality in the area of the exfiltration gallery (and downgradient) would be somewhat impaired, and it would not be usable for drinking or irrigation purposes (note that no such uses are intended). The localized impairment of groundwater quality around and downgradient of the exfiltration gallery would be more than offset by the major improvements in groundwater quality in and downgradient of the historic legacy waste areas which are to be remediated during the first phase of the NSDF project.

c) Groundwater Impact Assessment for the ECM

Having carefully considered the information and analyses presented in the hydrogeological impact assessment in Section 5.3.2 of the final EIS, I accept that the ECM will accomplish its primary objective - to provide safe long-term containment of low level radioactive wastes (LLW).

The containment provided by the state-of-the-art liner system coupled with the almost impermeable cover should serve to safely contain the LLW (and minimize their leachate) for the centuries needed for their radioactivity to dwindle to a manageable minimum through radioactive decay processes. So when it comes to the issue of radioactivity, the groundwater impacts of the ECM should be minimal due to the centuries-long containment provided by the ECM.

The issue of the ECM wastes' chemical toxicity (and their related chemical "contaminating lifespan") was considered in the final EIS' hydrogeological impact assessment (in Section 5.7), which identified 4 potential contaminants of concern - copper, lead, aluminum, and uranium). It was concluded that there would be no significant groundwater impacts - I agree with this conclusion.

8) Surface Water Quality Impact Assessment

a) Introduction

If the base liner of the ECM works as designed, then direct groundwater impacts of the LLW being accepted for disposal will be prevented - both in terms of radiological contamination and chemical contamination.

The liner will provide very effective containment of the ECM's leachate, keeping it out of the groundwater system. This raises the possibility of surface water impacts, which are the subject of this section of my review.

b) Safeguards for Protection of Surface Water Quality

The ECM's leachate will be collected and treated in the WWTP. Discharges of the treated WWTP leachate have the potential to cause downstream surface water impacts, however CNL has developed a variety of significant safeguards for surface water quality into its plans for the NSDF:

- Contaminated and uncontaminated water will be kept strictly separate, with uncontaminated water being diverted to the NSDF stormwater management system by means of temporary berms.

- Surface water diversion berms and ditches will be appropriately sized to handle the peak flows of a 100-year plus climate change storm flow.

- Filled portions of the active ECM cells will be covered by a temporary cover as soon as practical to limit contamination of clean rainwater falling on the site.

- Active waste disposal areas will incorporate use of a weather cover to prevent rainfall from contacting the wastes and creating leachate.

- The NSDF project will include 3 equalization tanks that have sufficient capacity (5,700,000 Litres each) to contain ECM leachate from more than 2 back-to-back 100-year storms.

- The WWTP provides multi-level treatment processes for the ECM's leachate.

- Effluent quality discharge targets have been adopted as set out in EIS Table 3.4.2-2 and Table 3.4.2-3, that (with the exception of tritium) are based on regulatory limits that are protective of surface water quality at the point of discharge.

- Treated leachate from the WWTP will be held back in the equalization tanks until testing has confirmed that the discharge criteria are met. This is set out in the following statement from page 5-198 of the final EIS, which states that:

  > *"Treated effluent will be sampled and confirmed that it meets the effluent discharge targets before release to the environment."*

- Treated leachate will be discharged to either a groundwater exfiltration gallery (which will provide further polishing) or at times of peak flows will be discharged to the bottom of Perch Lake via a pipeline and diffuser system.

- CNL has committed to a target of 7,000 Bq/L tritium for Perch Creek.

<u>c) Surface Water and Aquatic Environment Impact Assessments</u>

Section 5.4 of the final EIS assesses impacts of the NSDF project on the surface water environment, and Section 5.5 assesses impacts of the NSDF project on the aquatic environment.

Having carefully considered the information and analyses presented in the impact assessments in Sections 5.4 and 5.5 of the final EIS, I accept that during its operational life and for centuries thereafter the NSDF will generally be protective of the surface water and aquatic environments for all parameters.

The variety of safeguards outlined in the previous section of this review will have the combined effect of minimizing any impacts of various radioactive and non-radioactive contaminants on the surface water and aquatic environments. In particular there is no risk of negative impacts on water quality or aquatic life in the Ottawa River.

9) Monitoring and Contingency Plans

Given the significance of the NSDF project and the possibility of unacceptable water contamination, strong monitoring programs for leachate quality, WWTP effluent quality, downgradient groundwater quality, and downstream surface water quality would be key components of any approval of the proposal.

I am pleased to report that a supporting document for the final EIS now includes the needed details of monitoring (aka "follow up" programs) for testing of leachate quality, WWTP effluent quality, groundwater quality and surface water quality. The document is entitled "Draft EA Follow-Up Monitoring Program for the NSDF" (hereafter referred to as the draft EAFMP) and it was issued by CNL in 2021.

I have carefully reviewed the various monitoring programs in the draft EAFMP and am generally in agreement with the details of what has been proposed. Following my review there are only two issues which require further consideration:

a. the duration of the proposed post-closure monitoring period (up to 300 years) seems arbitrary and too short, and I am not aware of any justification for proposing to terminate the monitoring programs at that time time.
b. independent and proponent-funded review (including public access to all monitoring information) is needed for the NSDF monitoring programs;

These issues are discussed in more detail below.

a) Post-Closure Monitoring, and the Arbitrary 300-Year Monitoring Period

As discussed previously, the current design of the proposed ECM will minimize the amount of leachate generation for hundreds of years - by capping the site with a heavy duty, impermeable cover. With very little rainfall infiltrating and very little leachate being generated, the wastes inside the ECM will retain much of their chemical "potency" compared to a conventional landfill in which the chemicals are more rapidly "leached out" (due to the effects of rainfall infiltrating a more permeable cover and dissolving chemicals from the wastes).

The final EIS indicates that water quality monitoring will continue throughout the 300-year "post-closure institutional control period". This proposed duration of monitoring for a period of 300 years is arbitrary, and seems far too short given that the ECM will represent a potential source of groundwater and/or surface water chemical contamination for much longer than that.

I understand that the radioactivity in the ECM's LLW will largely be spent after 300 years, however the chemical potency of those wastes will only be slightly diminished and may still pose a real threat to downstream surface water quality. It is not clear why the commitment by the proponent to monitor the NSDF is not open-ended, or at least of a much longer duration.

CNL staff have indicated that the wording of Section 3.1.2 of the final EIS allows for monitoring to extend beyond 300 years - the operative text is reprinted below:

"Post-closure Phase, with two discrete periods:
- *Institutional Control Period = 2100 to 2400 (300 years is used for planning purposes however the institutional control period will continue as long as necessary as determined by regulatory agencies); and*
- *Post-Institutional Control Period = 2400 and beyond."*

My read of this section is that it allows the Institutional Control Period to be either longer - or shorter - than 300 years, as deemed necessary at the time. Certainly the intention is to <u>not</u> be monitoring the closed NSDF ECM in the Post Institutional Control period. This makes the decision-making process on when to transition from Institutional Control (with monitoring) to the Post Institutional Control period a crucial one. I could not find any guidance in the final EIS regarding this decision.

The proponent's proposed 300-year monitoring duration is inadequate. There is no reason to assume that a plausible ECM containment failure scenario would occur within 300 years. In fact, the most plausible failure scenarios would require a considerably longer period of time for chemical contaminants to make their way out of the ECM and into the downgradient groundwater flow system and/or the downstream surface water flow system.

Ontario's landfill operators are required to calculate the contaminating lifespan of their facility, and to make provision for continued monitoring throughout that contaminating lifespan. The contaminating lifespans of such landfills are measured in centuries, and so are the monitoring commitments for these facilities.

The final EIS does not contain any estimate of the ECM's chemical contaminating lifespan. This oversight should be corrected by CNL, with a contaminating lifespan being estimated for <u>both</u> the radioactive contaminants and the chemical contaminants proposed to be landfilled in the ECM.

CNL has not provided a compelling argument in favour of their proposal to terminate their obligations for monitoring the NSDF after 300 years. If CNL wishes to build termination of their monitoring programs into the NSDF proposal, then estimates of the chemical contaminating lifespan of the ECM should be provided at the time of site closure - with the duration of monitoring tied to the estimated contaminating lifespan.

The final recommendation of the HDPE geomembrane liner testing and evaluation report (Rowe 2019) is instructive with respect to the above concern, indicating that:

> *"CNL personnel involved with the NSDF should be aware that despite a long-GMB service-life, long term monitoring of leachate levels and quality will be required (likely until leachate can be discharged to the environment with negligible impact)."*

b) Independent Review and Public Dissemination of NSDF Monitoring Results

As the proponent, CNL has committed to a decades-long monitoring period during the active site preparation, construction and operations phases of the proposed NSDF facility and to a post-closure monitoring period of up to 300-years.

While I firmly believe that the 300-year monitoring period duration is inadequate (as outlined above), the fact that the proponent has committed to a centuries-long monitoring period for the proposed NSDF means that careful thought needs to be given to facilitation of independent review of that monitoring program.

Independent review of monitoring results is a sure way to ensure that the program remains focussed, effective, and up to date - and to ensure that proper attention is paid to adverse monitoring results. **It is in the public interest for the proponent to facilitate independent review of the monitoring for the proposed NSDF.**

Missing from the final EIS is a meaningful commitment by the proponent to subject the NSDF monitoring program results to independent and proponent-funded review.

In this regard, Section 11.3 of the final EIS states the following:

> *"Recognizing people's interest in understanding and participating in decisions that affect them, CNL will proactively seek, engage and support meaningful discussion with the public and Indigenous Peoples on issues and opportunities related to the NSDF Project, including the environmental assessment monitoring and follow-up programs, through CNL's PIP (CNL 2021), which can be found on the CNL website (www.CNL.ca). The PIP includes specific communications to stakeholders and public access to information related to routine activities as well as new projects such as the NSDF Project."*

The above is akin to a statement of good intentions. The "*Public Information Plan*" which is dated January 2021 can be found on-line, but does not include information relevant to the NSDF project. Moreover, it does not provide for an assured access to all of the NSDF site's monitoring programs' test results once these start coming in. At this point there is "a plan to have a plan" - but that plan (the Public Information Plan), which is cited in the final EIS does not yet have relevant content.

The refinement of environmental monitoring technologies over the long term also needs to be planned for. For example, sampling monitoring wells by hand may well be seen as quaintly antiquated within the centuries-long monitoring period of the NSDF. **A commitment from CNL to adaptively updating the effluent and water quality monitoring programs in concert with technological advances is essential.**

Building into the NSDF monitoring program a provision to subject the monitoring program to regular independent and proponent-funded review, and to make the full monitoring program results readily available to the public and First Nations for such review is an excellent way to ensure the programs remain relevant and up-to-date.

10) Discussion

The NSDF proposal has the potential to mark a major, positive step forward in terms of properly and responsibly managing low level radioactive wastes (LLW) at the Chalk River facility.

The NDSF project can be thought of as a two-part proposal as follows:

Part 1 - Remediation of Legacy Wastes
There is a considerable amount of contaminated and inadequately contained low level radioactive material distributed around the Chalk River facility. There are also numerous radioactively contaminated structures which are ready for decommissioning. The comprehensive clean-up of these low level radioactive wastes (with the wastes being securely disposed of in the ECM) can be considered to be **Part 1** of the NSDF project. This would represent a significant improvement to the environment of the Chalk River facility and its surroundings.

Part 2 - LLW Landfill
The NSDF's ECM is also intended to provide a secure disposal site for low level radioactive wastes (LLW) which will result mainly from CNL operations over the next 50 years. This operation of a LLW landfill for the next 50 years can be considered to be **Part 2** of the NSDF project.

The engineered containment mound (ECM) will provide one well-designed and secure location for both the historical "legacy" wastes as well as CNL's LLW over the next 50 years. There are clear benefits to proceeding with the NSDF, provided that it can be done safely.

I have conducted a weeks-long, detailed review of the NSDF proposal - looking for weaknesses, oversights, or inconsistencies which might undermine the proposal. I have come away from this review impressed by all water-quality related aspects of the NSDF proposal. The NSDF proposal is weakest when it comes to monitoring of the site during and after the 300-year post-closure Institutional Control period, but the shortcomings are minor and easily dealt with during closure of the site.

The proposed design and operations of the NSDF and its related infrastructure have been developed to an appropriate level of detail, and are protective of groundwater and surface water quality - and the health of humans and aquatic species. Overall the design is generally appropriate for a facility intended to contain LLW, with the ECM projected to provide containment of the wastes for long enough to bring the LLW radioactivity down to approaching background levels.

In my professional opinion the final EIS is technically complete and approvable from the perspective of preventing impacts on groundwater and surface water quality - and protecting the health of humans and aquatic species. There will certainly be no impacts on water quality in the Ottawa River.

11) Conclusions

1) The Near Surface Disposal Facility (NSDF) proposal consists of the planned construction (on the grounds of Chalk River Laboratories) of an engineered containment mound (ECM) landfill for disposal of low-level radioactive wastes (LLW), with a capacity of 1,000,000 m3 of such wastes. Coupled with the ECM is a wastewater treatment plant (WWTP) designed to treat the ECM's leachate.

2) A significant portion of the LLW destined for the ECM would come from the remediation of "legacy wastes" in the area of the Chalk River facility, including poorly controlled waste disposal pits, contaminated soils/vegetation, contaminated/redundant buildings and structures, and wastes which are currently being stored at various locations. This aspect of the NSDF proposal would mark a significant improvement to the Chalk River facility's environment, by having these various "legacy wastes" disposed of in a properly designed and secure facility.

3) Key features of the NSDF proposal are described in **Section 2** and **Section 5** of this review. Overall the design of the facility is appropriate for a facility intended to contain LLW, with the ECM projected to contain the LLW for at least 550 years (by then the LLW radioactivity will be approaching background levels).

4) The site characterization work which is presented in the final EIS is discussed in **Section 3** of this review. Overall, the site is not favourable for the siting of a landfill - and it should be noted that the proposed engineered containment mound (ECM) of the NSDF is nothing more than a landfill designed for the disposal of LLW. Because of the relatively unfavourable geology, the ECM component of the proposed NSDF (if approved) would be utterly reliant on engineered features to contain and collect the landfill's leachate and prevent it from contaminating the surrounding groundwater flow system.

5) The evaluation of project alternatives is provided in Section 2 of the final EIS. Section 2 introduces a number of design improvements for the NSDF proposal. These are discussed in **Section 4** of my review. I have reviewed all of the work done on evaluating and deciding between the alternatives presented in Section 2 of the final EIS, and I have no real issue with any of this work.

6) To compensate for the relatively unfavourable geology, CNL has put forward a state-of-the-art ECM design and operations proposal for the ECM which is prudent and appropriate for a facility intended to contain LLW.

7) As set out in **Section 7** of this review the net groundwater effects of the NSDF proposal will be positive - with potential minor negative impacts in the area of the ECM and exfiltration gallery more than offset by significant groundwater quality improvements in the historic "legacy" waste management areas.

8a) **Section 8** of this review considers the net surface water impacts of the NSDF. I accept the conclusions of the final EIS that throughout the operations and closure period, surface water quality and aquatic environment impacts will be kept to an acceptable minimum. In particular there is no risk of negative impacts on water quality or aquatic life in the Ottawa River.

8b) In terms of potential surface water quality issues regarding the NSDF proposal, the critical contaminant is tritium. In this regard, CNL's design and operational safeguards are adequate - in particular given CNL's commitment to an upper tritium level limit in Perch Creek of 7,000 Bq/L.

9a) As set out in **Section 9** of this review, the final EIS now includes details of NSDF monitoring programs for testing of ECM leachate quality, WWTP effluent quality, groundwater quality and surface water quality. I am in general agreement with what has been proposed, although I have identified 2 minor issues which require careful consideration.

9b) The final EIS indicates that water quality monitoring will continue throughout the 300-year "post-closure institutional control period". This proposed duration of monitoring for a period of 300 years is arbitrary, and seems far too short given that the ECM will likely represent a potential source of groundwater and/or surface water chemical contamination for much longer than that. It is not clear why the commitment by the proponent to monitor the NSDF is not open-ended, or at least of a much longer duration.

9c) Missing from the final EIS is a meaningful commitment by the proponent to subject the NSDF monitoring program results to independent and proponent-funded review. Building such a provision into the NSDF proposal (and to make the full monitoring program results readily available to the public and First Nations for such review) is an excellent way to ensure the programs remain relevant and up-to-date.

<u>12) Recommendations</u>

<u>**Recommendation 1)**</u>

All recommendations of the following two EIS supporting documents should be adopted in the final EIS:

- **the comprehensive HDPE geomembrane liner testing and evaluation program report (Rowe 2019);**
- **the Sept. 25, 2019 Construction Quality Assurance (CQA) Program report.**

<u>**Recommendation 2)**</u>

The EIS-recommended termination of NSDF monitoring programs by or before 2400 should not be adopted. Water quality related monitoring programs should be linked to the contaminating lifespan of the ECM wastes, with monitoring continuing until those wastes no longer require containment. Detailed estimates of the ECM radiological and chemical contaminating lifespan should be developed at the time of site closure, with these estimates then providing guidance regarding the duration of site monitoring programs.

<u>**Recommendation 3)**</u>

CNL should make a commitment to subject the NSDF monitoring program results to regular independent and proponent-funded review, and to make the full results of the monitoring programs readily available to the public and First Nations for such review.

<u>**Recommendation 4)**</u>

The proposed design and operations of the NSDF and its related infrastructure have been developed to an appropriate level of detail, and are protective of groundwater and surface water quality - and the health of humans and aquatic species. Overall the design is generally appropriate for a facility intended to contain LLW, with the ECM projected to provide containment of the wastes for long enough to bring the LLW radioactivity down to approaching background levels.

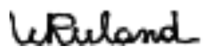
In my professional opinion the NSDF proposal as described in the final EIS and supporting documents is technically complete and approvable from the perspective of preventing impacts on groundwater and surface water quality - and protecting the health of humans and aquatic species.

13) Signature and Professional Stamp

This Review has been prepared in its entirety by Wilf Ruland (P. Geo.). It is based on my honest conviction and my knowledge of the matters discussed herein following careful review of the final EIS for the proposed NSDF, and review or reference to other documents listed in the Reference List.

This Review has been prepared for the use of my clients, Ottawa Riverkeeper (ORK).

Signed on the 8th of April, 2022



Wilf Ruland (P.Geo.)

766 Sulphur Springs Road
Dundas, Ont.
L9H 5E3
Tel: (905) 648-1296
deerspring1@gmail.com

Appendix 1

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