August 16, 2017

**BY EMAIL**

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To Ms. Frigault,

**RE: COMMENTS CONCERNING THE PROPOSED NEAR SURFACE DISPOSAL FACILITY PROJECT AT THE CHALK RIVER LABORATORIES**

**CEAA Reference number 80122**

Please find attached comments from Ottawa Riverkeeper regarding the proposed near surface disposal facility (NSDF) at the Chalk River Nuclear Laboratories. Appended are detailed comments from two independent experts we hired with the limited intervener funding we received to participate in the decision-making process concerning the NSDF.

This is a very important decision and Ottawa Riverkeeper appreciates the opportunity to review the proposed project and the draft environmental impact statement. We encourage the proponents and the regulators to reflect on the immense responsibility they have to protect the people and aquatic ecosystem of the Ottawa River Watershed.

Sincerely,

M. Brown

Meredith Brown, *Riverkeeper*

# PROPOSED NUCLEAR DISPOSAL FACILITY AT CHALK RIVER, ON

Comments on the draft Environmental Impact Statement
CEAA #80122

August 16, 2017

Ottawa Riverkeeper, a Canadian charity, 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.

The objects of our registered charity are:

- to achieve a healthy, ecologically sustainable Ottawa River available for the enjoyment and benefits of its Ontario, Quebec and First Nations communities;

- to employ a professional Riverkeeper to facilitate the maintenance and enhancement of Ottawa River ecological integrity through monitoring, original research, public and agency communications and support for enforcement;

- to work independently as well as co-operatively with individuals, businesses, community groups and all levels of government on both sides of the river;

- to develop and maintain an expert understanding of:
    - the river's ecological values, processes and special features, and
    - the protective framework offered by various federal, provincial and municipal jurisdictions and rights of First Nations;

- to facilitate the enforcement of existing ecological protection regulations;

- to encourage, where appropriate, the creation of additional measures to sustain and enhance the ecological health of the river; and

- to encourage and develop programs and projects that increase community awareness, stewardship and habitat restoration along the Ottawa River.

Ottawa Riverkeeper is a member of Chalk River Nuclear Laboratories' (CNL) Environmental Stewardship Council (ESC). The ESC was started by Atomic Energy Canada Limited – Chalk River in 2006 on a recommendation of the Canadian Nuclear Safety Commission. Through participation in the ESC Ottawa Riverkeeper has learned a great deal about operations at CNL and the wastes that have accumulated at the site over its lifetime. Learning from experts about the legacy wastes buried on site, contaminated groundwater plumes and the contaminated riverbed has been distressing yet extremely important to inform our comments on this project. It has opened our eyes to the importance and urgency around dealing with all wastes at this site in a responsible and safe manner.

Recognizing that water is an essential element that sustains and connects all life, and further recognizing that the misuse of freshwater poses a threat to human health, as well as to local fauna and flora, Ottawa Riverkeeper's review of the proposed near surface disposal facility at Chalk River Nuclear Laboratories is focused on the protection of water and the aquatic ecosystem.

According to the 2016 Census, there are over 5 million people who live in the cities of Ottawa, Gatineau and Montreal – the 3 largest cities that draw drinking water from the Ottawa River. There are many smaller communities such as Pembroke, Arnprior and Hawkesbury (to name a few) that also rely on the Ottawa River to provide a source of safe drinking water to their communities and have limited capacity to test their drinking water for radionuclides.

The Ottawa River is home to 93 species of fish alone and the watershed is home to a rich, diverse community of species that are connected by water and a complex food web. When we pollute or poison invertebrates, amphibians, plankton or mammals, it has lasting impacts throughout our ecosystem, recognizing that humans are at the top of the food chain. The proponent and regulators have an immense responsibility to protect the people and aquatic ecosystem of the Ottawa River Watershed.

In our opinion the operators at CNL strive to meet all regulations and derived release limits. However, regardless of best intentions the accumulation of wastes at the CNL site has been polluting nearby ground and surface water for many years. Plumes of radioactive waste that are steadily advancing are described in AECL's 2014 Comprehensive Decommissioning Plan and have been disclosed to the ESC in several presentations over the past 5 years.

Our concerns over the ongoing pollution from the operations at Chalk River Nuclear Laboratories compelled us to participate in the Environmental Assessment for the disposal of nuclear waste at this site. We have hired two experts to assess the proposal 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. Ole Hendrickson, an ecologist have reviewed the Environmental Impact Statement 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 1 & 2 and include a total of 25 recommendations that Ottawa Riverkeeper stands behind. *After reviewing the EIS as well as our experts' comments we would like to be clear with our opinion that the EIS is not sufficient in details to determine whether the project will have significant adverse impacts on the environment.* We have summarized some of the findings that reflect our greatest concerns:

### A. Proposed Site

We strongly believe the proposed site is not favourable for the following reasons:

- Close proximity to the Ottawa River - contaminated leachate will be released into nearby surface water that is directly connected to the Ottawa River.
- Unfavourable site geology & hydrogeology (see Appendix 1 for extensive detail)
- Close proximity to Waste Management Areas A & B where legacy wastes have caused extensive pollution of groundwater and vegetation.
- The site is subject to frequent seismic activity and the potential for multiple damaging seismic events is highly likely.

**B. Proposed Technology**

We strongly believe the proposed technology is inadequate for the following reasons:

- Holding intermediate level waste (ILW) in an above ground mound is contrary to International Atomic Energy Agency (IAEA) standards.
- This technology exposes the waste to precipitation for 50 years, creating large volumes of liquid radioactive wastes (leachate) that are extremely difficult to contain and treat, therefore creating a considerable risk of polluting Perch Lake and the Ottawa River.
- This technology is designed to contain hazardous wastes and has not been adequately tested to contain nuclear wastes for hundreds of years let alone a thousand years.
- The longevity of synthetic geotextiles and the capped engineered mound remains to be adequately tested after being exposed to the elements and natural forces for centuries.

**C. Wastewater Treatment**

- The onsite wastewater treatment plant (WWTP) will be a critical process to reduce risks associated with this project. Technologies for treating liquid radioactive wastes are in early stages of development and are very complicated. We know that tritium cannot be removed from the effluent stream and will subsequently be released into Perch Lake and the Ottawa River. Although CNL is confident they can meet their derived release limits for tritium, over time there will be a significant and steady amount of tritium released into the environment, making its way into the drinking water source for over 5 million people. Dilution is not going to adequately reduce the risks associated with many of the waste products in the effluent. Wastes ultimately removed from the liquid waste stream at the WWTP will have to be placed back into the NSDF, only to get rained on and continually produce liquid radioactive waste that needs to be collected and treated at the WWTP. This treatment technology will never relieve us of our nuclear liability from the Chalk River site.

**D. Monitoring Plan**

- Once CNL begins disposing wastes in the NSDF a robust monitoring protocol will be essential as a means to protect people and animals that are in contact with the wastes and with the effluent that will be polluted with radionuclides. The draft EIS is deficient when it comes to providing details for the required multi-faceted monitoring plan. Ottawa Riverkeeper is in favour of long-term monitoring at the disposal site. As long as humans inhabit this region the monitoring should continue. Clearly that will be an expensive, yet necessary component of this project that will require adaptive management and transparent public reporting. Long-lived radionuclides in the NSDF will be highly vulnerable to human intrusion throughout the post-closure period. We believe it is important to have a detailed plan for how the proponent will prevent human intrusion into the engineered containment mound.
- Furthermore, given the significant groundwater pollution existing today at the proposed site it will be important to have reliable baseline information to understand the changes that will occur once contaminated leachate is released into the nearby surface water that is directly connected to the Ottawa River.

**E. Timelines and Process**

- We have concerns that the proponent has a mandate to find a quick solution for nuclear waste disposal at Chalk River Nuclear Facilities.
- The timelines that were presented in AECL's 2014 Comprehensive Decommissioning Plan for Chalk River are very different and recommend a slower, more thorough approach that involves extensive public consultation. The discrepancies between the 2014 plan and the 2017 plan are curious. We believe finding a solution that protects our environment and instils public trust and confidence is most important.
- The recent and thorough review of the Canadian Environmental Assessment Act (CEAA) provides important recommendations for restoring public confidence in the environmental assessment process. The review panel recommended the establishment of an independent authority to conduct impact assessments on behalf of the federal government. They go further to recommend the authority act as a quasi-judicial tribunal empowered to undertake a full range of facilitation and dispute resolution processes.
- We believe the decision for creating Canada's first permanent nuclear disposal facility is a societal decision that requires a thorough understanding of the risks and also requires social acceptance of the project.

**Deficiencies of the EIS**

Without a doubt, the EIS is missing a great deal of critical information. Without the information we are asking for, it will be impossible to assess the full range and severity of impacts on our groundwater, surface water and aquatic ecosystems. This is a short summary of some of the critical information that is missing, for a complete and detailed review of the EIS deficiencies please see Appendices 1 & 2.

- There is no justification or evaluation regarding the decision to include intermediate level waste (ILW) in the disposal facility.
- There is insufficient information regarding the waste that will eventually be accepted for disposal into the NSDF. It is impossible to assess ecological risk without a complete understanding of the composition and amounts of the wastes that will be placed in the dump. More details about our concerns related to the Waste Acceptance Criteria (WAC) can be found in Appendix 2, page 5.
- There is no consideration given to the existing groundwater and surface water contamination at the site, yet is critical for assessing cumulative effects of the NSDF on Perch Lake, Perch Creek and the Ottawa River.
- The monitoring plan is severely deficient in details. There is no explicit timeline for monitoring and no budget. See Appendix 1 for more details.
- There are no details regarding how CNL will prevent tritium concentrations in Perch Creek from exceeding 7,000 Bq/L. The concentration of tritium in the wastewater effluent is predicted to be 9,100,000 Bq/L, orders of magnitude greater than regulatory limits. Since there is no way to remove tritium from the effluent it appears that the plan is to slowly release and dilute the tritium which of course is highly concerning.
- There is no assessment provided regarding the impacts of tritium on aquatic biota. More details in Appendix 2, pages 16-17.

- Although there are several pages in the EIS about the proposed wastewater treatment plant (WWTP) they are lacking details and references to provide confidence that the very complex treatment process will work. Treating liquid nuclear waste is extremely complex and a quick search of the literature is not reassuring. We would like to see examples of where these wastewater treatment technologies are being used, how effective they are and how difficult it is to operate a WWTP designed to remove radionuclides and hazardous waste. There are no details on risks/impacts associated with power outages. There are no details on a monitoring plan for the WWTP effluent.
- There is mention of a 300-year "post-closure control period", yet no details on what that would look like and why the 300 year time frame was chosen. It is unclear whether this period will involve monitoring of downstream surface water quality.
- There is insufficient information on how the proponent will reduce the risk of human or animal intrusion into the mound for the thousands of years the mound will remain radioactive and hazardous.
- There are discrepancies regarding species at risk inventories and no detailed plans for mitigation of endangered species such as the Blanding's Turtle. There is more detail in Appendix 2, page 8.
- An ecological risk assessment has not been conducted to estimate whether risks are acute or chronic, to estimate the severity of the effects to a variety of species, the number of organisms that are at risk and the time period over which we can expect the risks to continue. For example, what are the risks to migratory waterfowl that eat fish or amphibians from Perch Lake? Or the risk to the humans who eat the waterfowl who ate the fish who ate the frog?
- Cumulative impacts have not been adequately addressed. There is already significant groundwater pollution at the site and the EIS clearly states that contaminated leachate will be released into the nearby surface water that is directly connected to the Ottawa River. More details Appendix 2, pages 11-14.

**Recommendations:**

1. The EIS must include the critical information we have requested in order for commissioners to legitimately determine whether the project will have significant adverse impacts on the environment.
2. Alternate sites that are isolated from the Ottawa River should be carefully considered and assessed.
3. Alternate technologies that reduce contact of the radioactive waste with water/precipitation should be carefully considered and assessed.
4. Intermediate level waste should not be placed in an engineered containment mound or near surface disposal facility to maintain consistency with international standards derived to protect the environment. Given that ILW require considerably greater safeguards, we recommend the proponents design a disposal facility that will only accept low level waste (LLW).

5. An ecological risk assessment must be completed to adequately assess whether the proposed project will have significant impacts. The Ottawa River must be included in the study area for the assessment of impacts on the aquatic environment. More information regarding the aquatic food chain and food web dynamics will be necessary to conduct an ecological risk assessment.
6. Effluent discharge criteria should be established for the treated effluent being discharged from the Wastewater Treatment Plant. The plant should be designed to accommodate ample storage of leachate in the event of a power failure or in the event of poor treatment results.
7. The EA must consider the entire proposed lifecycle of this project and that is well beyond 50 years. Some waste will remain radioactive and pose a risk for thousands of years.
8. Nuclear waste should never be abandoned; any proposal to permanently dispose of nuclear waste must be accompanied by a robust and continuous monitoring plan. Detailed recommendations for monitoring are found in Appendix 1, section 10.
9. It should be recognized that the disposal of nuclear waste is not a scientific decision alone; it is a public health issue and a societal issue that warrants an independent review and appropriate consultation with all Canadians.

# Appendix 1

# Initial Independent Review of Hydrogeological Issues Pertaining to the draft Environmental Impact Statement for the Proposed Near Surface Disposal Facility (NSDF) at the Chalk River Nuclear Site

**Prepared for:**

**Ottawa Riverkeeper**

**and**

**the Algonquin Anishinabeg Nation Tribal Council**

**Prepared by Wilf Ruland (P. Geo.)**

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**July 31st, 2017**

## 1) Introduction

I am a hydrogeologist, and I have worked as an environmental consultant for 30 years (2 years for a larger firm in Germany, and 28 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 given 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 a number of environmental assessments (EAs) and Environmental Impact Statements (EISs) over the course of my career. I have reviewed environmental assessments for numerous landfills, and recently 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 and the Algonquin Anishinabeg Nation Tribal Council to review documentation pertaining to the proposed Near Surface Disposal Facility (NSDF) which is intended to provide disposal capacity for 1 million cubic meters of low level nuclear waste (LLW) including some intermediate level nuclear waste (ILW) at the Chalk River Laboratories (CRL) site.

This initial review of the draft Environmental Impact Statement (draft EIS) is not intended to provide my full comments regarding this matter, given that at this time the draft EIS is an incomplete and inadequate document which requires further work. Instead I am simply hoping with these initial comments to provide my professional opinion regarding the NSDF proposal and the work done on the draft EIS to date.

In this initial review I will provide 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 the radiological and other wastes;
- the assessment of potential groundwater quality and surface water quality impacts related to inorganic, organic, and radiological contaminants at all stages of the project including site preparation and construction, DGR operation, 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 draft 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.

This review outlines my findings, conclusions and recommendations regarding the draft EIS and the potential impacts on groundwater and surface water of the proposed NSDF.

## 2) Overview of the NSDF Proposal

The Near Surface Disposal Facility (NSDF) proposal consists of the following key aspects:

- the planned construction (on the grounds of the Chalk River Laboratories) of a permanent landfill for disposal of mainly low-level radioactive wastes (LLW), with a capacity of 1,000,000 m3 of such wastes;
- up to 1% of wastes (10,000 m3) are proposed to be intermediate level radioactive wastes (ILW);
- in cases where hazardous wastes are commingled with radioactive wastes, the site will accept hazardous wastes;
- the disposal of these wastes in the NSDF, over an operational period which will last for about 50 years;
- 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 monitoring of the DGR facility is for about 300 years after closure, after which there is no intention to further monitor the facility; and
- the containment of the low-level radioactive wastes for a minimum of 500 years.

A significant portion of the wastes proposed to be 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 waste disposal pits, contaminated soils and vegetation, contaminated and/or redundant buildings and structures, and wastes which are currently being stored at various locations.

This aspect of the NSDF proposal is welcome, as it would mark a significant improvement to the Chalk River facility and its environment to have all of these various "legacy wastes" disposed of in a properly designed and secure facility.

Unfortunately this positive aspect of the proposal is overshadowed by the ill-considered, poorly described, and inadequately assessed plan to dispose of up to 10,000 m3 of intermediate level radioactive wastes (ILW) in the NSDF. My grave concerns about this issue are provided in the following sections of this review.

This review also identifies problems with the draft environmental impact assessment (draft EIS) including the site characterization, various aspects of the NSDF design, the impact assessment, and the proposed monitoring programs and contingency plans. These problems are discussed in detail in the following sections of this review, and should be dealt with by the proponent before the draft EIS is finalized.

## 3) Concerns about the Site Characterization

Introduction

A significant amount of investigation and characterization of the NSDF site and its surroundings has been done by the proponent. Many aspects of this work have been well done and adequately presented in the draft EIS, providing a solid understanding of the hydrogeology of the site and its surroundings. Other aspects have not been done well at all, and critical necessary information is missing from the draft EIS.

Site Topography and Drainage

There is a significant bedrock ridge on the east side of the NSDF site with highest elevations of about 195 meters above sea level (masl), with the ground surface sloping 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 to the west and south, and any runoff from the site will make its way into the Perch Lake wetlands and/or into Perch Lake. Perch Lake is a shallow 45 hectare feature, which 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.

Site Geology and Hydrogeology

At the NSDF site, the overburden is thin (thickness is generally on the order of 2 meters) and 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 NSDF would migrate south and west in the shallow sand horizons and the upper fractured bedrock beneath the site. This is confirmed by the existing patterns 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 site for the proposed NSDF - with the landfill to take the form of an engineered containment mound (ECM).

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 designed for disposal of LLW. An 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 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. My review of the 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.

Existing Radioactive Contamination of Groundwater and Surface Water

The aspect of the NSDF site investigation and characterization which has been most poorly done in the draft EIS is the description of the existing groundwater (and surface water) contamination from historic activity and waste disposal practices at the Chalk River facility.

Accurate mapping of the extent of existing radioactive groundwater and surface water contamination should be - but has not been - provided in the draft EIS for key parameters such as:

- gross alpha activity,
- total beta activity,
- Strontium-90 beta activity, and
- tritium.

The draft EIS provides a brief discussion of radioactive contamination of groundwater (in Section 5.7.4.5) and surface water (in Section 5.7.4.6) - but does not provide mapping of the areal distribution of key contamination parameters including gross alpha, total beta, Sr-90, or tritium.

As a result there is no way to obtain a quantitative understanding of the extent of the existing radioactive groundwater and surface water contamination on the Chalk River property. This is a major deficiency in the draft EIS, which must be corrected.

It is important for this aspect of the EIS to be be augmented and improved, for several reasons:

1) The existing groundwater and surface water contamination will skew the background groundwater chemistry, and this needs to be accounted for in the impact assessment.

2) 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 NSDF.

3) The surface water and treated WWTP effluent from the NSDF will be flowing into surface water features which are already radiologically impacted by historic site activities and radioactive waste disposal, and for at least some parameters there will be little capacity for the environment to absorb further contaminant loading from the NSDF.

## 4) Evaluation of Project Alternatives

The evaluation of project alternatives is provided in Section 2 of the draft EIS, and includes evaluation of alternatives for:
- facility type;
- facility design;
- facility location;
- site selection;
- leachate treatment.

I have no real issue with the work done on evaluating and deciding between the alternatives presented in this section of the draft EIS.

A significant shortcoming of this section of the draft EIS is that it does not provide an evaluation of alternatives to the proposal to include 10,000 m3 of intermediate level radioactive waste (ILW) in the NSDF. This is a major oversight which should be corrected in the final EIS, in the event that the ILW plan is pursued.

## 5) Proposal to Include Intermediate Level Waste in the NSDF

In my professional opinion the plan to use the NSDF for the disposal of ILW is the single most worrisome aspect of the entire NSDF proposal. The draft EIS does not contain any evaluation or justification of the decision to include ILW in the wastes being proposed for disposal in the NSDF, and I find this bizarre.

Radiological wastes are classified by the level of their radioactivity, and ILW have higher levels of radioactivity than LLW - necessitating considerably greater safeguards in terms of managing and disposing of such wastes.

The IAEA Standards for Classification of Radioactive Waste can be found here:
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1419_web.pdf

The IAEA definition of Low Level Waste (LLW) includes reference that it needs to be contained for up to 300 years, and that **LLW is suitable for near-surface disposal**. The proposed Near Surface Disposal Facility (NSDF) would therefore be a suitable type of facility for disposal of LLW.

The IAEA definition of Intermediate Level Waste (ILW) includes reference that this is waste that contains long-lived radionuclides, and that **ILW needs to be provided with a greater degree of containment and isolation from the biosphere than is provided by near surface disposal**. Disposal in a facility at a depth of between a few tens and a few hundreds of metres is indicated for ILW. The proposed Near Surface Disposal Facility (NSDF) which consists of an engineered mound above the ground surface would therefore not be a suitable type of facility for disposal of LLW.

The only justification provided in the draft EIS for bringing ILW into the proposed NSDF is that the amount to be brought in is "small", and would be less than 1% of the total waste volume. This argument is without merit.

Firstly 10,000 m3 is not a "small" amount. It is the equivalent of several hundred dump truck loads of pure ILW. Moreover, no rationale has been provided to explain why the "small" amount can not simply be kept in storage at the Chalk River facility until a suitable ILW disposal option has been developed.

I should note that the draft EIS does not include a listing of the types and quantities and radioactivity and half-lives of ILW which are proposed to go into the NSDF. Apparently there have been some assurances on the part of the proponent that only shorter-lived ILW compounds would be accepted - but such assurances are meaningless in the absence of a detailed itemized listing of precisely which ILW are proposed to be accepted, as well as their half-lives, levels of radioactivity, and chemical toxicity.

As a professional with decades of experience in dealing with issues pertaining to management of municipal wastes, industrial wastes, hazardous wastes, and nuclear wastes I can not find in the draft EIS any justification for the proposal to be bringing ILW into a LLW landfill which has not been designed to receive and contain such wastes.

The ILW proposal can be likened to a waste hauler proposing to dump hundreds of truckloads of hazardous wastes into a municipal landfill which has not be designed to receive and contain such wastes. This is not done and is not allowed in Ontario.

All the NSDF will provide is containment of the wastes it contains for a few hundred years. After that the cover and base liner will be failing and leachate will begin leaking from the NSDF into the surrounding groundwater flow systems. If the wastes in the proposed NSDF are LLW, then this will be less problematic because their radioactivity will largely be spent. This is not the case for ILW.

The decision to allow ILW into the proposed NSDF came late in the process which led to the development of the draft EIS. It is not clear to me whether the proposal to include ILW in the NSDF was made known during the public consultation process and the aboriginal consultation process. If the proposed presence of ILW was not made known, then this is a fatal flaw in these consultation processes - all of which will need to be redone to properly inform the public and aboriginal community of the increased hazards associated with the revised NSDF proposal.

My recommendation to my clients and to others reading this review is to challenge the entire NSDF application if the plan to accept ILW is not removed from the proposal. My professional recommendation to the CNSC is to refuse the application if the plan to accept ILW is not removed from the proposal.

## 6) 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 draft EIS.

Overview of Key Design/Operations Features

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

- a theoretical 500 year design life for the facility;
- operating life during which wastes will be accepted of 50 years (2020 to 2070);
- 90% of the wastes to come from the Chalk River facility and its surroundings, with the rest to come from off-site sources;
- 1,000,000 m3 of radiological wastes, of which 99% would be LLW and 1% would be ILW;
- a waste to cover soil ratio of 4:1;
- 34 hectare waste footprint, with a maximum waste thickness of 18 meters;
- a double liner system for the base of the engineered containment mound or ECM (see Figure 3.5. 2-1), designed to contain the landfill's leachate;
- liner to be at least 1.5 meters above the maximum water table;

- the double liner system to include a geosynthetic clay liner and HDPE geomembrane in the primary liner, and a HDPE geomembrane and 0.75 m of compacted clay (with hydraulic conductivity of $<10^{-7}$ cm/s) in the secondary layer;
- a leachate collection system above the primary liner, designed to collect the leachate and remove it from the ECM;
- a maximum permitted depth of 300 mm for leachate accumulation on the primary liner;
- a new dedicated wastewater treatment plant (WWTP), designed to treat the leachate which is collected from the ECM through the operating life of the NSDF and beyond;
- WWTP to use the "best available treatment, economically available" (BATEA);
- anticipated average annual leachate flows at full development of 6,556 m3/year.

I was not able to find information on the following details of the NSDF proposal:
- the spacing of leachate collection lines;
- the proposed depth of excavation into the ground (if any), and whether any of the wastes in the ECM will actually be below-ground;
- the source of the "treatment targets" for the WWTP, and explanation of those targets which are set higher than Ontario's Provincial Water Quality Objectives (PWQO).

The final EIS should be amended to include this information.

Overall, the design of the site generally seems appropriate for a facility intended to contain LLW, but I recommend the compacted clay portion of the base liner should be increased to 1 m thickness to provide increased assurance of effectiveness in preventing significant leakage from the LLW for the 500 hundred year design period.

The issue of the impermeable ECM cover and the implications of that cover for the long-term impacts of the NSDF on its surroundings also needs to be more thoughtfully considered by the proponent than has been the case to date.

Final Cover, Closure, and Long-Term Post-Closure Monitoring

One of my main concerns about the site design pertains to the final cover of the site. Page 3-19 of the draft EIS indicates that the HDPE liner in the cover is expected to perform as an effective hydraulic and diffusion barrier for the 500-year design life of the proposed engineered containment mound (ECM).

The site design is based upon the final cover retaining its effectiveness and repelling water for many centuries, with the WWTP planned to be decommissioned by or before the year 2100. After that time there will be no leachate collection. If the final cover begins leaking after closure, then leachate will build up inside and eventually start leaking out of the proposed ECM. This will lead to radiological groundwater and/or surface water contamination issues downgradient and downstream of the site.

Alternatively if the final cover performs as planned and lasts for centuries, then the LLW will no longer pose much of a threat based on their radioactivity - however the wastes in the proposed ECM are also a threat simply based on the chemistry of the leachate which they will produce.

As set out in Sections 3 and 5 of the draft EIS, a potent list of waste substances are expected to be contained in the LLW deposited in the ECM including:
- heavy metals such as cadmium, cobalt, and mercury;
- petroleum hydrocarbons and solvents;
- PAHs;
- insecticides, herbicides, and pesticides;
- unnamed other hazardous wastes (if these are mixed with radioactive wastes).

The current design of the site will minimize the amount of leachate generation for hundreds of years, by capping the site with an impermeable cover. With much less rain getting in and much less leachate being generated, the wastes inside the ECM will retain much of their "potency" compared to a conventional landfill in which the chemicals are more rapidly "leached out" (due to the effects of rainfall infiltrating the cover and dissolving chemicals from the wastes).

Once the cover does finally degrade and the landfill begins to saturate and leak, these still potent wastes can cause significant groundwater and/or surface water contamination - centuries after closure of the NSDF.

Of particular concern is that no surface water monitoring aapears to be proposed after the WWTP is decommissioned, and no groundwater monitoring (or any other monitoring) is planned after 2400. In effect, there will be no monitoring when the impacts from the ECM on its surroundings can be expected to be at their greatest.

The proponent's goal seems to be stop monitoring as of an arbitrary date, whereas given the unique site design and the issues arising from it the goal should be to keep monitoring for as long as possible and dealing with any issues which arise.

This problematic issue needs to be properly addressed in the final EIS.

## <u>7) Wastewater Treatment and Impacts of Effluent on Surface Waters</u>

Given the redundancies in the base liner design, I believe that the vast majority of the NSDF leachate will be contained and prevented from leaking out of the facility for many hundreds of years. This is a good thing, but only if the wastewater treatment plant which is part of the proposal is a state-of-the-art facility with effluent criteria which are protective of the natural environment.

WWTP Treatment Targets vs. Effluent Discharge Criteria

There are numerous statements in the draft EIS that the NSDF's WWTP treatment targets are based on the *"CRL Acceptability Criteria for Routine and Non-Routine Discharge of Liquids to Stormwaters"*, but this document can not be found on-line and is not included in the reference list provided in the draft EIS. If the document exists then it should be provided forthwith for review.

In the meantime, I have not been able to find clearly defined WWTP effluent quality criteria anywhere in the draft EIS. This oversight should be corrected, and the effluent quality criteria which are presented should then be the basis for the final EIS's hydrogeological and surface water quality impact assessments.

If the "treatment targets" listed in Tables 3.5.3-1 and 3.5.3-2 are intended to represent the effluent quality criteria for the NSDF's WWTP, then this should be clearly stated.

It should be noted that there are significant problems with the treatment targets in Table 3.5.3-1 and Table 3.5.3-2, including the following:

- there are no treatment targets for benzene, toluene, ethylbenzene and xylenes, even though these chemicals can be expected to be present in the leachate given that the NSDF will be accepting wastes containing petroleum contamination;
- there are no targets for numerous PAHs including naphthalene;
- the targets for the 2 PAHs listed (chrysene and fluoranthene) are higher than their PWQO limits;
- there is no treatment target for tritium, and Table 3.5.3-1 indicates it is untreatable;
- Table 3.5.3-1 also indicates that "*tritium releases will be managed such that tritium concentrations in Perch Creek do not exceed 7,000 Bq/L. This will be accomplished by providing additional containment for high tritium concentration wastes.*"

Tritium Impacts on Downstream Surface Waters

Tritium in particular could be a very significant problem in WWTP effluent, given that tritium levels would be very high in many of the proposed ECM's incoming wastes - and this would translate into very high tritium levels in the ECM's leachate. As indicated above, the WWTP is unable to provide any treatment of tritium so whatever concentrations of tritium are found in the influent to the WWTP will roughly correspond to the tritium levels in the effluent.

As also discussed previously, there has not been adequate disclosure regarding existing levels of radiological contamination in the East Swamp wetland and downstream surface waters which will be receiving effluent from the WWTP. However based on the information which can be gleaned from the draft EIS, I am seeing that quite high tritium levels are already found in the wetland and downstream surface water features including Perch Lake and Perch Creek.

Following in **Table 1** are the average tritium levels which are currently found at various points downgradient and downstream of the discharge point for the WWTP effluent, based on the relatively sparse information provided in the draft EIS.

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**Table 1:**

**Current Average Tritium Levels Downstream/Downgradient of NSDF**

| **Monitoring Locations** (see Fig. 1 on next page) | **Tritium Levels** | **Reference** |
|---|---|---|
| Current Tritium Levels on Undeveloped NSDF site | <64 to 155 Bq/L | p. 5-481 |
| Tritium Levels in Groundwater in East Swamp | no disclosure provided in draft EIS | |
| East Swamp Weir (ESW) | 359 Bq/L | Table 5.7.4-8 |
| Perch Lake Inlet (PL2) | 2,438 Bq/L | Table 5.7.4-8 |
| Perch Lake Outlet (PLO) | 3,879 Bq/L | Table 5.7.4-8 |
| Perch Creek - Weir (PCW) | 3,374 Bq/L | Table 5.7.4-8 |

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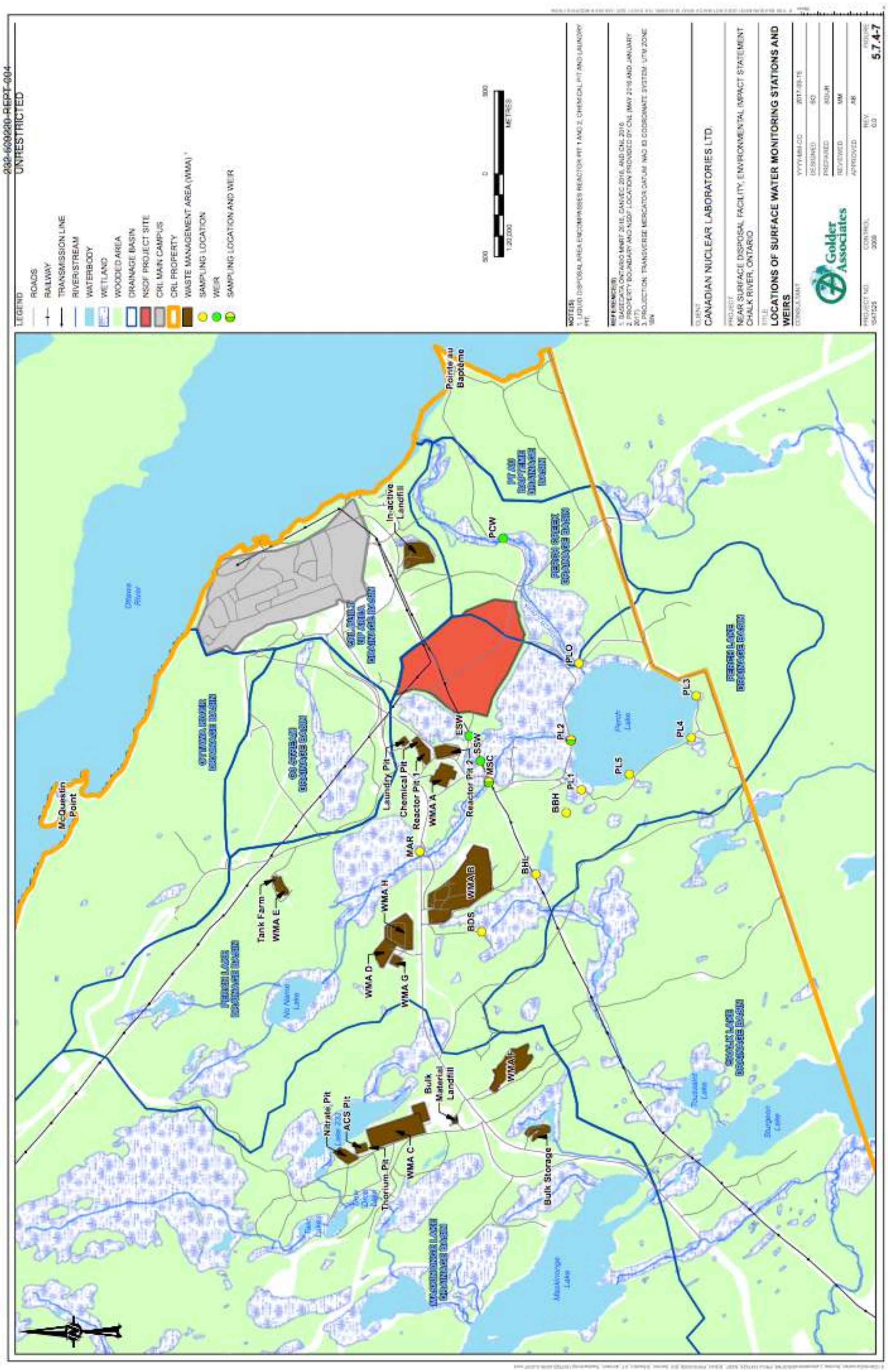
High tritium levels are already present in Perch Lake and Perch Creek, as shown in Table 5.7.4-8, which shows average tritium levels in these surface waters of several thousand Bq/L. This means that there is only a limited capacity for addition tritium loading if the draft EIS commitment to an upper limit in Perch Creek of 7,000 Bq/L (which is based on the PWQO for tritium) is to be respected.

# Figure 1 - Chalk River Surface Water Monitoring Stations



Instead of just providing average levels, seasonal high and low tritium levels should have been presented in the draft EIS. My sense is that there will be times (perhaps during drier summer base flow periods) when the creek is already at or near the 7,000 Bq/L limit for tritium, implying that the addition of tritium-laced WWTP effluent will push the creek over the limit.

Summary

From the description of the treatment processes which are indicated to be part of the NSDF's WWTP, it can be anticipated that considerable treatment would be provided.

But in my experience what matters in the end are the effluent quality criteria which the proponent commits to - and I have not been able to find any commitments to any particular WWTP effluent quality at this time. The lack of firm effluent quality targets hampers the draft EIS - because the uncertainty about effluent quality makes it difficult to assess impacts of the treated effluent on downstream surface water features. Considerable further work is needed on this aspect of the draft EIS.

Tritium is shaping up to be a critical contaminant in the WWTP effluent and in the downstream surface water system, with more information needed in the final EIS.

## 8) Groundwater and Surface Water Quality Impact Assessments

A meaningful groundwater quality impact assessment has not been presented in the draft EIS, nor has a meaningful surface water quality impact assessment.

Such assessments would have included the followings steps:

- providing mapping showing existing levels of radiological contamination throughout the East Swamp wetland;
- identifying the location at which the treated effluent from the WWTP is to be introduced into the East Swamp wetland;
- conducting calculations and/or modelling (based on firm effluent quality criteria which the proponent has committed to, and detailed analysis of already existing levels of contamination in the wetland) in order to assess the cumulative groundwater quality impacts of the treated effluent on the wetland;
- performing further calculations and/or modelling to assess how discharge of the impacted groundwater from the East Swamp wetland into the downstream surface water system will impact surface water quality in Perch Lake and Perch Creek;
- comparison of predicted levels in Perch Creek to the PWQO;
- if any parameters are predicted to exceed the PWQO in Perch Creek, then impacts on the Ottawa River would need to be considered.

Such an assessment needs to be carried out and included in the final EIS.

This will be especially important for tritium, which is already present at elevated levels throughout the Perch Lake and Perch Creek watershed, due to historic environmental contamination by the Chalk River facility and a variety of legacy waste disposal sites in the watershed.

A poor semblance of a surface water quality impact assessment is provided in Section 5.7.6 of the draft EIS, however the analysis provided is incomplete and inadequate.

Shortcomings of the surface water quality impact analysis in Section 5.7.6 of the draft EIS include the following:

- existing levels of contamination in the Perch Creek watershed were not considered (please note that **Table 1** of this review shows that existing contamination levels of several thousand Bq/L of tritium are already present in the watershed);
- the potential for increased contaminant flows into the watershed from existing groundwater plumes and contaminated dump site locations were not considered;
- inputs into the watershed from current and future operations at the Chalk River facility were not considered;
- inputs from airborne emissions into the watershed were not considered.

All that was done in Section 5.7.6 of the draft EIS was that inputs from the WWTP effluent into the East Swamp Stream were calculated and presented.

As can be seen from the average tritium data in **Table 1** of this review, the East Swamp Stream already contains tritium levels of about 350 Bq/L as measured at the East Swamp Stream Weir (ESW) location. There are other existing potent tritium sources in the Perch Lake watershed which combine to drive tritium levels in Perch Lake up to about 3,900 Bq/L at the lake's outlet to Perch Creek.

As indicated earlier, the draft EIS fails to disclose seasonal data - but it is my sense that on a seasonal basis the waters of Perch Creek are already pushing the upper limit of 7,000 Bq/L which the proponent has committed to. To this pre-existing tritium contamination, the draft EIS indicates (in Table 5.7.6-2) that the proposed NSDF's WWTP effluent will be adding an average 140,000 Bq/L in its ongoing discharges to the watershed!

The proponent is clearly banking on massive dilution in the Perch Creek watershed to bring tritium levels in the WWTP effluent (projected at 140,000 Bq/L) down to the 7,000 Bq/L commitment for an upper tritium level in Perch Creek. I am not confident that the hoped for dilution will actually be provided given the extensive contamination and significant other inputs which obviously present in the Perch Lake and Perch Creek watersheds.

In summary, the draft EIS does not provide a proper or adequate surface water quality impact assessment (or groundwater quality impact assessment).

## 9) Commitment to Hold Back WWTP Effluent

In numerous statements the draft EIS provides the commitment by the proponent that WWTP effluent will be tested on a regular basis, with the treated effluent being "held back" if it fails this testing.

For example page 5-438 of the draft EIS states that:

> *"Treated effluent will be sampled and confirmed that it meets treatment targets before release to East Swamp Wetland."*

This is a welcome commitment, but the details of how this is to work in practice have not been provided in the draft EIS. It is clear that three components will be required:

- effluent discharge criteria, which if not met would require leachate to be held back;
- a robust and on-going effluent monitoring program;
- an effluent storage facility with ample capacity, such that effluent can be held back as long as is necessary in the case of adverse test results.

As discussed previously, effluent discharge criteria have not been provided in the draft EIS. As will be discussed below, an effluent monitoring program has also not been presented in the draft EIS. Regarding WWTP effluent storage, the following description has been provided in the draft EIS:

> *"Treated effluent from the final pH adjustment tanks is conveyed by gravity to the final effluent storage tanks, each sized for 8 hours of hydraulic detention time at the design flow rate of 11.36 $m^3$/hour. The final effluent storage tanks provide storage of final effluent for sampling prior to discharge."*

From the above description it is clear that not much effluent hold-back capacity has been provided in the current WWTP design.

Overall the lack of effluent discharge criteria, the lack of an effluent monitoring program, and the inadequate treated effluent holding capacity combine to make the draft EIS commitment "*that treated effluent will be sampled and confirmed that it meets treatment targets before release*" rather meaningless at present.

This aspect of the WWTP design is critical in terms of the assurance provided, and it should be ensured that the final EIS is revised to ensure that all pieces are in place to make this commitment robust and meaningful.

As indicated in a previous section of this review, the liner design is such that the vast majority of leachate from this site will be contained and collected and sent to the WWTP for treatment. This means that the vast majority of any leachate impacts will be due to issues arising at the WWTP - making the leachate hold-back commitment a critical piece of the overall site design.

The optimal way for such a hold-back system to work would be to have at least four triggers for the WWTP effluent to be held back:

a) if the SWMP discharge water quality fails to meet a specified level of conductivity during ongoing, continuous monitoring;

b) if the effluent fails to meet specified radioactivity targets during ongoing, continuous monitoring;

c) if if the effluent fails to meet specified tritium targets during ongoing, continuous monitoring;

d) if the effluent quality fails to meet detailed effluent discharge criteria during a scheduled regular testing event.

Continuous monitoring of the WWTP effluent for key parameters can be used to trigger a "closing of the gate" if precautionary limits are exceeded. Closing the gate will then allow more detailed testing to be done to ascertain the reason(s) for the change in water quality.

<u>a) Continuous Conductivity Monitoring</u>

Electrical conductivity is an excellent surrogate parameter to use as a broad measure of water quality impairment - in essence, the higher the levels of chemical contamination in the WWTP effluent, the higher the conductivity will be. If conductivity exceeds a certain level, then this provides a broad indication that something has happened to affect the water quality in the effluent.

<u>b) Continuous Monitoring for Radioactivity</u>

The whole point of the NSDF is to protect the natural environment from the radioactivity contained in the wastes (and the effluent) from the facility. Continuously monitoring radioactivity in the WWTP effluent (gross alpha, total beta and gamma) would provide the best possible method of accomplishing this goal.

<u>c) Continuous Tritium Monitoring</u>

Tritium is looking like it would be the critical contaminant in the downstream surface water flow system. As such a detailed effluent monitoring program involving continuous measurements of tritium levels is indicated.

The proponent has indicated that one goal in managing the NSDF is to keep Perch Creek tritium levels below 7,000 Bq/L and calculations can be done to determine which tritium emission level is compatible with this goal. Spikes in tritium above this level would trigger a review of waste deposition and/or acceptance criteria.

d) Regular Broadscan Surface Water Quality Monitoring

Finally, there needs to be a regular and much more detailed program of testing of the WWTP effluent to determine concentrations of the numerous specific parameters which are anticipated to be in the ECM's leachate. The results from these tests can then be used to ensure WWTP effluent strength is kept within safe limits, to assess the success of the wastewater treatment processes, and to test calculations and/or model predictions about long-term emissions from the NSDF.

It should be noted that what happens next if the WWTP effluent has been held back (because of adverse water quality test results) has not been specified in the draft EIS.

In some cases, modifications and improvements to treatment methods could improve effluent quality such that it meets criteria and can be discharged. In other cases, it may not be possible to effectively treat the effluent with the processes and facilities on hand - in which case improvements to the WWTP will need to be made and/or waste acceptability criteria will need to be modified.

In all cases, adequate storage capability is required in order to make this commitment meaningful.

## 10) Monitoring and Contingency Plans

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

The draft EIS does not contain details of monitoring or follow up programs for testing of WWTP effluent quality, groundwater quality or surface water quality. This is a severe deficiency, which should be corrected before the draft EIS is finalized.

In the meantime, the lack of any details or any real commitment on the part of the proponent to any particular monitoring program raises grave concerns.

While the proponent may have good intentions, there is no assurance that this is case if the details of water quality monitoring programs are not provided. Instead what arises is the concern that the proponent is seeking to minimize monitoring requirements and/or avoid public scrutiny of their plans for monitoring.

The monitoring issues requiring further consideration/description in the EIS include the following:

a. robust WWTP effluent, groundwater and surface water quality monitoring programs need to be developed;
b. there is no provision in the draft EIS outlining how the proponent will respond in the event of adverse effluent or water quality monitoring results, or what monitoring results might trigger a response;
c. independent review (including public access to all monitoring information) is needed for the NSDF monitoring programs;
d. the duration of the proposed post-closure monitoring period (300 years) seems arbitrary and too short, and there is no commitment to updating and improving the monitoring programs over time.

These issues are discussed in more detail below.

a) Development of Robust Monitoring Programs

The draft EIS fails to provide proposals for monitoring programs for WWTP effluent quality, downgradient groundwater quality, or downstream surface water quality. These omissions are inexcusable given that the list of wastes to be accepted into ECM for disposal contains ILW and LLW, hazardous wastes, petroleum contamination, insecticides, herbicides and pesticides.

Leachate from the ECM will contain varying amounts of these chemicals, and any failures of the ECM liner and/or WWTP could result in contaminants being discharged to downgradient groundwater and/or downstream surface water.

Robust and effective monitoring programs for WWTP effluent quality, groundwater quality and surface water quality are all needed.

Components of monitoring programs which are generally missing from the draft EIS include the following:

- a list of monitoring locations, and a map showing those locations;
- a list of indicator parameters which will be used to determine if contamination is occurring;
- trigger levels for each of the monitoring parameters, which if exceeded will trigger action by the proponent;
- conceptual outlines of contingency plans which will be triggered if confirmed adverse monitoring results are obtained.

A major concern with the proponent's failure to develop or present these components is the fact that if they are developed after the environmental assessment process has concluded, then the proponent will effectively have avoided subjecting these details to independent and public scrutiny. Before the EIS is finalized, the proposed monitoring program should be made publicly available for review and comment.

b) Lack of Triggers or Contingency Responses to Adverse Monitoring Results

The draft EIS fails to provide triggers for the necessary WWTP effluent, groundwater and surface water monitoring programs for the NSDF.

A monitoring program without triggers for action is one in which data are mindlessly collected, with no actions taken even if issues arise. This is not desirable for a disposal facility for nuclear wastes.

The draft EIS also fails to provide descriptions of what sorts of contingency responses might be triggered, in the event of adverse monitoring results.

Following are some examples of conceivable adverse monitoring scenarios:

- Leachate quality monitoring in the secondary leachate collection system during the operations phase of the project detects the breakthrough of high levels of radiological, inorganic and organic contamination, indicating massive failure of the primary base liner.

- Downgradient groundwater monitoring in the East Swamp during the operations period detects unexpectedly high amounts of benzene and other petroleum hydrocarbons at several monitoring wells. Petroleum hydrocarbon contamination is also revealed to be present at high levels in the treated WWTP effluent.

- Downstream monitoring in Perch Creek in the post-closure period (in 2120, long after the WWTP has been decommissioned) reveals rapidly increasing levels of tritium, whose most likely source is the DGR facility.

- Post-closure monitoring of the ECM indicates that there has been differential settlement of the wastes in the ECM, and that this has led to failure of the landfill cover.

Conceptual descriptions of contingency responses to these and other conceivable monitoring results should be provided by the proponent.

Moreover, as with the monitoring programs, these contingency responses should be subject to broad public scrutiny.

c) Independent Review and Public Dissemination of NSDF Monitoring Results

Though no details have been provided the proponent 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 300-year post-closure monitoring period.

While I firmly believe that the 300-year monitoring period duration is inadequate (as outlined below), 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.

My experience in accessing results from existing Chalk River facility monitoring programs proved instructive in this regard. Despite my best efforts it proved impossible to obtain an integrated, clear and explicit overview of current groundwater and surface water contamination at Chalk River, even though such an overview was important to improving my understanding of the site hydrogeology and surface water flows.

Missing from the draft EIS is a meaningful commitment by the proponent to subject the NSDF monitoring program results to independent and proponent-funded review, and to make the full results of its monitoring programs readily available to the public for review.

In this regard, Section 10.3 of the draft EIS (in its entirety) 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 on issues and opportunities related to the NSDF Project, including the monitoring and follow-up program, with Aboriginal peoples and communities of interest as part of the Public Information Plan and Aboriginal Engagement Plan. Canadian Nuclear Laboratories will continually evaluate both the process and the outcome of the ongoing engagement and communication activities to address and manage issues as they arise."*

The above is akin to a statement of good intentions, but not much more. The "*Public Information Plan*" and "*Aboriginal Engagement Plan*" do not appear to exist, or if they do exist then they are not included in the draft EIS's reference list and are also not accessible on-line at this time.

As with many other plans cited in the draft EIS, it is my strong impression that at this point there is "a plan to have a plan" - but that the plans being cited in the draft EIS (the "*Public Information Plan*" and "*Aboriginal Engagement Plan*") do not exist.

These omissions should be corrected with plans in question completed and circulated to the public and the aboriginal community before the draft EIS is finalized.

The ongoing development of environmental monitoring technologies over the long term also needs to be planned and accounted for. For example, sampling a series of boreholes may well be considered quaintly antiquated within the monitoring period of this proposed facility. A commitment from the proponent 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 independent and proponent-funded review, and to make the full monitoring program results readily available to the public is an excellent way to ensure the programs remain relevant and up-to-date.

d) 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 much less rain getting in and much less 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 draft EIS indicates that downgradient groundwater quality monitoring will continue throughout the 300-year "post-closure institutional control period". I was not able find any commitment to downstream surface water quality monitoring in the 300-year post-closure institutional control period, and this oversight should be corrected before the draft EIS is finalized.

The proposed duration of monitoring for a period of 300-year post-closure institutional control is arbitrary, and seems far too short given that the ECM will represent a potent 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 somewhat diminished and will still pose a real threat.

Moreover, if the proposed NSDF does in fact receive intermediate level radioactive wastes (ILW) then the proposal to cut off monitoring after an arbitrarily set 300-year deadline becomes recklessly absurd.

It is not clear why the commitment by the proponent to monitor the NSDF is not open-ended, or at least of a longer duration.

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, many if not most of the most plausible failure scenarios would require a considerably longer period of time for 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 landfills are measured in centuries, and so are the monitoring commitments for these facilities.

The draft EIS does not contain any estimate of the ECM's contaminating lifespan. This oversight should be corrected in the final EIS.

To date the proponent has not provided any rationale let alone a compelling argument in favour of their proposal to terminate their obligations for monitoring the NSDF after only 300 years. It would be prudent and responsible for the proponent to commit to monitoring "as long as possible", and at a minimum for a period of at least 1000 years.

If the proponent wishes to terminate the monitoring program at an earlier date, then calculations of the chemical contaminating lifespan of the ECM should be provided in the final EIS - with the duration of monitoring tied to the estimated contaminating lifespan.

## 11) Discussion

The NSDF proposal has the potential for marking a positive step forward in terms of properly and responsibly managing low level radioactive wastes at the Chalk River facility.

Although the draft EIS is not forthcoming about the details, it appears that there is a very considerable amount of contaminated material distributed around the Chalk River facility and its surroundings - including radiologically contaminated soils and vegetation, radioactive wastes and dump sites, commingled hazardous wastes and radioactive wastes, and a variety of surplus/derelict buildings and structures which are radiologically contaminated.

The engineered containment mound (ECM) which is the centrepiece of the NSDF proposal offers the prospect of providing one well-designed and secure location for all of these historical of “legacy” wastes to be disposed of. As such, the emplacement of those legacy wastes in the ECM would represent a significant improvement to the environment of the Chalk River facility and its surroundings.

Moreover, the ECM is intended to provide a secure disposal site for low level radioactive wastes which result from CNL operations over the next 50 years.

Unfortunately the NSDF proposal has been marred by an ill-considered, poorly described, and inadequately assessed plan to dispose of up to 10,000 m3 of intermediate level radioactive wastes (ILW) in the NSDF. This aspect of the proposal should be dropped before the draft EIS is finalized. If it is not dropped, then the NSDF proposal becomes unapprovable - and should be strongly opposed. The further discussion of the proposal below is based on the assumption that no ILW wastes will be accepted.

Even without the ILW the draft EIS in its current form is incomplete, inconsistent in places, and inadequate - and not at all approvable. For example, the vast majority of the radioactive leachate which will be generated within the ECM is to be collected and treated at a wastewater treatment plant (WWTP). Critical to the assessment of the groundwater and surface water quality impacts of the WWTP (and the ECM) will be effluent discharge criteria which are applied to the WWTP effluent. Effluent criteria are not presented in the draft EIS, and as a result there has not been a meaningful assessment of the impacts of the NSDF at this time.

Another example is provided by the references throughout the draft EIS to plans which do not yet appear to exist (ie. they do not appear on the draft EIS’s reference list and can not be found on-line), and yet which are cited and relied upon in the draft EIS as providing a solid foundation for the purported viability of the NSDF proposal.

The list of such plans which pertain to groundwater and/or surface water issues includes the following:

- the Blasting Plan
- the Environmental Protection Plan
- the Surface Water Management Plan
- the ECM Final Grading and Drainage Plan
- the Operations and Maintenance Plan
- the Groundwater Monitoring Program
- the Post-Closure Care Plan
- the Public Information Plan
- the Aboriginal Engagement Plan

Clearly considerable further work is needed to finalize the draft EIS.

## 12) Conclusions

1) The Near Surface Disposal Facility (NSDF) proposal consists of the planned construction (on the grounds of the Chalk River Laboratories) of an engineered containment mound (ECM) landfill for disposal of mainly low-level radioactive wastes (LLW), with a capacity of 1,000,000 m3 of such wastes.

2) A significant portion of the wastes proposed to be disposed of in the ECM is to come from the remediation of "legacy wastes" which are found scattered around the Chalk River facility and its surroundings, including waste disposal pits, contaminated soils and vegetation, contaminated and/or redundant buildings and structures, and wastes which are currently being stored at various locations.

This aspect of the NSDF proposal is welcome, as it would mark a significant improvement to the Chalk River facility and its environment to have all of these various "legacy wastes" disposed of in a properly designed and secure facility.

3) The NSDF proposal was revised to include an ill-considered, poorly described, and inadequately assessed plan to dispose of up to 10,000 m3 of intermediate level radioactive wastes (ILW) in the ECM.

More detailed discussion of this issue is provided in **Section 5** of this review. I can not find in the draft EIS any justification for the proposal to be bringing ILW into a LLW landfill which has not been designed to receive and contain such wastes. There was no evaluation of possible alternatives to this proposal provided in the draft EIS.

It is not clear if the proposal to include ILW in the NSDF was made known throughout the public consultation process and the aboriginal consultation process. If the proposed presence of ILW was not made known, then this would represent a fatal flaw in these consultation processes - all of which would need to be redone to properly inform the public and aboriginal community of the increased hazards associated with the revised NSDF proposal.

5a) The proposed design of the ECM is described and discussed in **Section 6** of this review. Overall the design of the site generally seems appropriate for a facility intended to contain LLW, but I am concerned that the 0.75 meter thick compacted clay portion of the base liner is not of sufficient thickness.

5b) The impermeable cover which has been proposed for the ECM is not compatible with the plans to stop treatment of the leachate prior to 2100. Failure of the cover will likely occur long after that, at which time the chemical contamination in the landfilled wastes will have the potential to be mobilized by infiltrating rainwater - leading to water quality impacts.

6) As is outlined in **Section 7** of this review, I have not been able to find clearly defined WWTP effluent quality criteria anywhere in the draft EIS. This oversight should be corrected, and the effluent quality criteria which are presented should then be the basis for the final EIS's hydrogeological and surface water quality impact assessments.

7) **Section 8** of this review provides my concerns about the fact that the draft EIS does not provide a proper or adequate assessment of the potential impacts of the NSDF proposal on downgradient groundwater quality and downstream surface water quality.

8) As discussed in **Section 7 and Section 8** of this review, tritium is shaping up to be one of the critical contaminants for this proposal. The evaluation of potential tritium impacts of the NSDF proposal on downgradient groundwater quality and downstream surface water quality has been incomplete and inadequate.

9) As outlined in **Section 9**, the draft EIS contains a welcome commitment to hold back the treated effluent from the facility until prior testing has confirmed it is safe for discharge, but the details of how this is to work in practice have not been provided in the draft EIS. It is clear that three components will be required (none of which are in place at present):

- effluent discharge criteria, which if not met would require leachate to be held back;
- a robust and on-going effluent monitoring program;
- an effluent storage facility with ample capacity, such that effluent can be held back as long as is necessary in the case of adverse test results.

10) **Section 10** describes how the draft EIS does not contain details of monitoring or follow up programs for testing of WWTP effluent quality, groundwater quality or surface water quality. This is a severe deficiency, which should be corrected before the draft EIS is finalized. The few details which have been provided raise significant concerns, which need to be addressed by the proponent (as discussed in some detail in **Section 10**).

## 13) Recommendations

**Recommendation 1)**

**The EIS (with its supporting documentation) should not be approved in its current form. In its current form the draft EIS is incomplete, inconsistent, and inadequate in terms of providing a proper or adequate assessment of the potential impacts of the NSDF proposal on downgradient groundwater quality and downstream surface water quality.**

**Recommendation 2)**

**Accurate mapping of the extent of existing radioactive soil, groundwater and surface water contamination in the Perch Lake and Perch Creek watershed should be provided in the final EIS for key parameters such as:**

- **gross alpha activity,**
- **total beta activity,**
- **Strontium-90 beta activity, and**
- **tritium.**

**Recommendation 3)**

**a) My professional recommendation to my clients and to others reading this review is to challenge the entire NSDF application if the plan to accept ILW is not removed from the proposal.**

**b) My professional recommendation to the CNSC is to refuse the application if the plan to accept ILW is not removed from the proposal.**

**Recommendation 4)**

**I recommend that the compacted clay portion of the base liner should be increased to 1 m thickness to provide increased assurance of effectiveness in preventing significant leakage from the LLW for the 500 hundred year design period.**

**Recommendation 5)**

**The steps required in order to conduct a meaningful groundwater quality impact assessment have not been followed in the draft EIS, nor has a meaningful surface water quality impact assessment conducted.**

**A proper assessment of the potential impacts of the NSDF proposal on downgradient groundwater quality and downstream surface water quality should be conducted in accordance with the direction provided in Section 8 (at the bottom of page 14) of this review.**

**<u>Recommendation 6)</u>**

**The final EIS needs to include clearly defined WWTP effluent quality criteria, which the proponent has committed to meeting. Those effluent quality criteria should then be the basis for the final EIS's groundwater quality and surface water quality impact assessments.**

**<u>Recommendation 7)</u>**

**a) The proponent has made the commitment that *"treated effluent will be sampled and confirmed that it meets treatment targets before release to East Swamp Wetland."* The final EIS should ensure that the revised NSDF proposal includes the 3 components required to meet this commitment, namely:**

- **effluent discharge criteria, which if not met would require leachate to be held back;**
- **a robust and on-going WWTP effluent monitoring program;**
- **an effluent storage facility with ample capacity, such that effluent can be held back as long as is necessary in the case of adverse test results.**

**b) Section 9 of this review provides detailed recommendations regarding an effluent monitoring program for the WWTP - these should be adopted into the final EIS.**

**<u>Recommendation 8)</u>**

**The draft EIS does not contain details of monitoring or follow up programs for testing of WWTP effluent quality, groundwater quality or surface water quality. This is a severe deficiency, which should be corrected before the draft EIS is finalized. Recommendations regarding the missing details are provided in Sections 10a, 10b), and 10d) of this review.**

**<u>Recommendation 9</u>**

**The final EIS should include a commitment by the proponent to subject the NSDF monitoring program results to independent and proponent-funded review, and to make the full results of the monitoring programs readily available to the public for review.**

**<u>Recommendation 10)</u>**

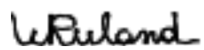
**The proponent should be required to address the issues raised and to implement the recommendations provided in this review, taking them into account when finalizing the draft EIS. This includes addressing the inconsistencies and omissions listed in the Errata in Appendix 2 of this review.**

## 14) 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 draft 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 and the Algonquin Anishinabeg Nation Tribal Council.

Signed on the 31st of July, 2017

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# Appendix 1

## References

References which were considered in the course of preparing this review included the following:


Chapman, L.J. and Putnam, D.F. 1984. The Physiography of Southern Ontario, 3rd Edition.

Domenico, P.A. and Schwartz, F.W. 1998. Physical and Chemical Hydrogeology.

Freeze, R.A. and Cherry, J.A. 1979. Groundwater.

Golder Associates, March 2017. Draft Environmental Impact Statement, Near Surface Disposal Facility, Deep River, Renfrew County, Ontario.

International Atomic Energy Agency, 2009. Classification of Radioactive Waste, General Safety Guide. IAEA Safety Standards Series No. GSG-1,

Ontario Geologic Survey, 1992. Geology of Ontario.

Ontario Regulation 169/03: Ontario Drinking Water Quality Standards. Updated January 2017.

Ontario Ministry of the Environment (MOE). May1998. Landfill Standards.

Ontario Ministry of the Environment (MOE). 1994, updated 1998. Water Management: Policies, Guidelines, Provincial Water Quality Objectives.

# <u>Appendix 2 - Errata</u>

There are a number of troubling inconsistencies and omissions in the draft EIS which need to be corrected before the final EIS is issued. These inconsistencies (all of which need to be clarified and corrected) and omissions (all of which need to be addressed) include the following:

<u>Duration of Operation of the WWTP</u>

Page 2-52 indicates that the WWTP will be operated "<u>several years</u>" following closure of the ECM in 2070.

By comparison, page 3-5 indicates the WWTP would be operated until 2100 - period of <u>30 years</u>.

<u>Interim Cover Thickness for the ECM</u>

There are inconsistent statements in the draft EIS regarding the interim cover thickness for the ECM.

The last full paragraph on page 3-18 states that: *"The filled cells will first be covered with interim soil layer **<u>0.5 m</u>** thick to limit contact with stormwater."*

The second full paragraph on page 3-50 states that: *"Interim cover consists of a **<u>0.3 m</u>** layer of clean soil (if soil is used as the cover material). Interim cover soil will be a relatively tight-grained soil to promote runoff and reduce infiltration into the waste material."*

<u>Mowing of the Final-Covered ECM</u>

There are inconsistent statements on page 3-69 of the draft EIS regarding the need to mow the final-covered ECM.

The second full paragraph states that: *"The vegetation will be limited to grass species that are maintenance free and drought resistant. Mowing of the grass is <u>not</u> necessary."*

The third full paragraph states that: *"Vegetation will be established and maintained by watering, fertilizing, weeding, <u>mowing</u>.. and performing other operations as required to establish healthy, viable grassy vegetation."*

Treatment Targets for the WWTP

There are numerous statements in the draft EIS that the WWTP treatment targets are based on the *"CRL Acceptability Criteria for Routine and Non-Routine Discharge of Liquids to Stormwaters"*, but this document can not be found on-line and is not included in the reference list provided in the draft EIS. If the document exists then it should be provided forthwith.

Failure Scenario - typographic error.

Page 5-212 of the draft EIS in describing a potential failure scenario for the NSDF states the following (which doesn't make sense):

> *"Upon cover failure, untreated leachate discharges into Perch Creek along its northern stream bank (between Perch Lake and Perch Creek Weir approximately 1.5 km from Ottawa River) at a daily average flow rate of 120 $m^3$/d (43,200 $m^3$/yr). The total waste volume will require approximately 25 years to fully discharge into Perch Creek."*

Various Nonexistent(?) Plans Cited in Draft EIS

There are references throughout the draft EIS to plans which do not yet appear to exist (ie. they do not appear on the draft EIS's reference list and can not be found on-line), and yet which are cited and presented and relied upon in the draft EIS as providing a solid foundation for the purported viability of the NSDF proposal.

The list of such plans which pertain to leachate management/treatment, groundwater and/or surface water issues includes the following:

- the Blasting Plan
- the Environmental Protection Plan
- the Surface Water Management Plan
- the ECM Final Grading and Drainage Plan
- the Operations and Maintenance Plan
- the Groundwater Monitoring Program
- the Post-Closure Care Plan
- the Public Information Plan
- the Aboriginal Engagement Plan

# Appendix 2

**APPENDIX 2**

# Written Comments on the Environmental Impact Statement for the Near Surface Disposal Facility Related to Information on Potential Impacts on the Aquatic Environment

Produced for Ottawa Riverkeeper
Ole Hendrickson, Ph.D. (Ecology)
July 18, 2017

## Executive Summary

This report, prepared for Ottawa Riverkeeper, provides comments related to potential impacts on the aquatic environment of the proposed Near Surface Disposal Facility (NSDF) Project at the Chalk River Laboratories of Atomic Energy of Canada, Limited. A subsequent phase of this work will provide additional information on the aquatic toxicology aspects of wastes that may be placed in the NSDF.

In general, the draft environmental impact statement (EIS) provides very limited information on the wastes that the project proponent, Canadian Nuclear Laboratories (CNL), would put in the NSDF. This makes it difficult to assess the project's impact on the aquatic environment. CNL has omitted critically important details from the EIS, such as the half-lives of the radionuclides and amounts of heavy metals and toxic organic chemicals that it intends to place in the facility. This represents a very serious deficiency in the EIS. Unless this deficiency is corrected, and far greater details are provided in a final EIS, the conclusion is inescapable that the project is likely to cause significant adverse environmental effects that cannot be justified in the circumstances.

This report examines potential impacts of the NSDF project related to the following topics:

- Exclusion of the Ottawa River from the Regional Study Area for the aquatic environment;
- Description of the food chain and food web dynamics as a habitat component as this relates to fish populations, and detailed fish habitat mapping;
- Aquatic species at risk;
- Contaminant levels in aquatic and semi-aquatic mammals (e.g., Moose and Beaver);
- Cumulative effects of the project in conjunction with existing levels of radiation and toxic chemical pollution in the East Swamp and South Swamp;
- Cumulative effects in conjunction with remediation of contaminated sites;
- Impacts of radiation on genetic integrity of aquatic organisms;
- Effects of tritium on aquatic organisms;
- Peak flows and low flows;
- Construction phase impacts on the aquatic environment; and
- Water quality and overflows related to berms and surface water management ponds.

Conclusions and recommendations related to these topics follow, with a focus on information deficiencies in the draft EIS:

**1. The Ottawa River should be identified as a "Valued Component" in the EIS**. An assessment of potential impacts of the proposed facility on Ottawa River aquatic biota should be done. Potential impacts of the NSDF on Lake Sturgeon, American Eel, and other valued fish species found in the Ottawa River should be assessed.

**2. Information should be provided about the aquatic food chain and food web dynamics as related to fish populations, and details of fish habitats.** This information should be applied to estimates of radiological contamination in valued species such as Northern Pike.

**3. Discrepancies between CNL's aquatic species at risk monitoring results and information in the EIS, and gaps in currently available species at risk information, should be addressed.**

**4. Existing data on radiological contamination in Moose and Beaver should be included in the EIS.** These existing data, and a full assessment of predicted impacts of the proposed facility on these species, should be made available to local indigenous groups and the public.

**5. Impacts of the project on wetlands immediately adjacent to the proposed site of the NSDF should be included in the EIS.** Data on current levels and total inventories of radiological contaminants in the wetlands should be presented. Impacts of activities such as removal of contaminated wetland vegetation and disposal in the NSDF, or discharge of additional radionuclides and other toxic contaminants to the wetlands, should be assessed.

**6. Cumulative impacts of the project should be assessed pursuant to section 19 of the *Canadian Environmental Assessment Act, 2012*.** The EIS fails to address decommissioning and site remediation, the key physical activities associated with the NSDF Project. Section 19 of CEAA 2012 says that "The environmental assessment of a designated project must take into account… any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out."

**7. Genetic effects of exposures to radionuclides should be assessed for aquatic organisms.** The proponent should review the scientific literature describing effects of low-level radiation on the genetic integrity of aquatic organisms, with special attention to mussel species, including those living in Perch Lake and portions of the Ottawa River adjacent to the Perch Creek outlet.

**8. Impacts of tritium on aquatic biota should be assessed.** Noting that potential releases of tritium from the proposed NSDF are very large, the EIS should assess the potential for these releases to impact aquatic organisms, particularly during developmental stages. Specific attention should be given to impacts of organically bound tritium, which has the potential to accumulate in aquatic food chains.

**9. Impacts of large precipitation events on erosion and surface water quality changes, and on aquatic organisms, should be assessed.** Increasing flooding and major storms, predicted under climate change scenarios, could accelerate contaminant releases from the NSDF, with deleterious impacts on aquatic organisms in Perch Lake, Perch Creek and the Ottawa River.

**10. Impacts of tree clearing on hydrology and sediment transfer should be considered in the aquatic environment section of the EIS.** No mitigation measures to deal with potential adverse impacts of tree clearing on the aquatic environment are proposed in the EIS.

**11. Potential impacts associated with construction of the surface water management ponds should be addressed.** These ponds would be adjacent to the wetlands bordering on the west and south portions of the project area. If pond construction were to coincide with a major precipitation event, it could create large sediment loads and alter movement of existing contaminant plumes from nearby waste management areas.

**12. Consideration should be given to management of water flows associated with a major storm event immediately after bottom liner installation.** Such an event would have the potential to result in significant erosion and sediment deposition in the area outside the NSDF project area boundary. It could also compromise the integrity of the bottom liner itself and lead to its prompt failure and impacts on groundwater quality and aquatic biota.

**13. Additional information on construction of the base of the mound should be provided,** including excavation and blasting for installation of the base liners, the installation process for the base liners; and precautions to avoid wrinkling or puncturing of the geomembrane elements of the base of the mound.

**14. Risks to the aquatic environment associated with leaching of radioactive and hazardous substances from the berms, and overflows from the surface water management ponds should be assessed.** Estimates are needed of contaminant concentrations in the surface water management ponds, and quantities of contaminants exiting these ponds in overflow waters for varying amounts and intensities of precipitation.

**15. Risks that the surface water management ponds could become contaminated at levels sufficient to cause harm to organisms such as migratory waterfowl should be assessed.**

**History of the Chalk River Laboratories: Long-lived radionuclides**

At an April 1944 meeting in Washington, D.C. of the Combined Policy Committee that oversaw the World War II atomic bomb effort (the “Manhattan Project”), representatives of the U.S., the U.K. and Canada agreed that Canada should build a heavy water reactor to produce plutonium from uranium for nuclear weapons (Sims 1981). Chalk River was chosen as the site for this nuclear facility. Construction of the National Research Experimental (NRX) reactor began that year and continued after the war ended in September 1945. When it came into operation in

July 1947 the NRX was the world's most powerful reactor. It was used to supply plutonium for U.S. atomic bombs for the next 30 years.

Splitting uranium atoms in a nuclear reactor (fission) produces a wide range of new artificial isotopes. "Spent" fuel is over a million times more radioactive than fuel prior to its insertion and irradiation in a reactor. Spent fuel contains large amounts of "fission product" waste such as strontium-90 and cesium-137 that generates intense heat and radiation. It also includes significant amounts of artificial radioactive elements such as americium, curium, neptunium and plutonium that are heavier than uranium and that are created by neutron bombardment of reactor fuel. Some isotopes of these artificial elements have very long half-lives.

Early research at the Chalk River Laboratories included reprocessing of spent fuel: dissolving the "unburned fuel" (i.e., uranium) and "new fuel" (i.e., plutonium) in strong acid, followed by chemical separation of the fuel from the fission product waste produced in the reactor (Hatfield 1960). Facilities at Chalk River to remove and concentrate the fission product waste (prior to storage) experienced serious accidents. In December 1950, an explosion at the ammonium nitrate pilot plant used to concentrate fission product waste killed a worker and contaminated the surrounding environment.

In December 1952, the NRX reactor itself experienced the world's first serious reactor accident, involving fuel melting and a hydrogen explosion. The NRX accident generated large quantities of radioactive waste. The highly contaminated original NRX reactor core was removed, towed uphill, and buried in the sand at Waste Management Area A. A large quantity of highly radioactive liquid waste was poured into unlined trenches at this same location. Radioactive waste was also later dumped in unlined trenches at Waste Management Area B, and two reactor cores are buried there as well (AECL 2014).

These early waste disposal practices at Chalk River generated numerous radioactive waste plumes migrating in uncontrolled fashion, contaminating wetlands, groundwater, surface water bodies, and streams draining into the Ottawa River. The main radioactive contaminants in these plumes are tritium (hydrogen-3) and strontium-90 (AECL 2014), but other radionuclides are also present. Enhanced cobalt-60 migration has been observed beyond 50 meters from the burial trenches, associated with natural dissolved organics from neighboring swamps (Serne et al. 2002). Trace amounts of cesium-137 and plutonium have also migrated faster than expected from Waste Management Area A (Robertson et al. 1989).

Perhaps because the U.S. already has licensed facilities for permanent disposal of nuclear reactor waste, whereas Canada does not, U.S. bodies have been more active than those in Canada in making information publicly available on behavior of individual radionuclides found in reactor waste. The U.S. Nuclear Regulatory Commission has identified four "sensitive" radionuclides that "require site-specific considerations to ensure that performance objectives for long-term environmental protection are met": technetium-99, carbon-14, iodine-129, and tritium. A U.S. Department of Energy review examines environmental aspects of the disposal of these four radionuclides, plus eleven others that it also considers "important to low-level radioactive waste management" (U.S. DOE 1996). These 15 radionuclides are listed in Table 1.

Table 1. Radionuclides important to management of low level radioactive waste

| Radionuclide | Chemical symbol | Half-life (years) | "Sensitive" according to U.S. NUREG | "Important" according to U.S. DOE | "Significant" according to NSDF WAC |
|---|---|---|---|---|---|
| americium-241 | Am-241 | 432 | no | yes | yes |
| carbon-14 | C-14 | 5.7 thousand | yes | yes | yes |
| cesium-137 | Cs-137 | 30.1 | no | yes | no |
| chlorine-36 | Cl-36 | 301 thousand | no | no | yes |
| cobalt-60 | Co-60 | 5.27 | no | yes | no |
| curium-242 | Cm-242 | 0.41 | no | yes | no* |
| hydrogen-3 | H-3 | 12.3 | yes | yes | no |
| iodine-129 | I-129 | 15.7 million | yes | yes | yes |
| neptunium-237 | Np-237 | 2.1 million | no | yes | no |
| nickel-59 | Ni-59 | 76 thousand | no | yes | no |
| nickel-63 | Ni-63 | 101 | no | yes | no |
| niobium-94 | Nb-94 | 20.3 thousand | no | yes | yes |
| plutonium-239 | Pu-239 | 24 thousand | no | no | yes |
| plutonium-241 | Pu-241 | 14.3 | no | yes | no |
| radium-226 | Ra-226 | 1.6 thousand | no | no | yes |
| strontium-90 | Sr-90 | 28.9 | no | yes | no |
| technetium-99 | Tc-99 | 216 thousand | yes | yes | yes |
| thorium-230 | Th-230 | 75.4 thousand | no | no | yes* |
| uranium-234 | U-234 | 246 thousand | no | no | yes |
| uranium-238 | U-238 | 4.5 billion | no | yes | yes |

*Not included in the "Bounding NSDF Project Waste Radionuclide Inventory"

**<u>Insufficient information about the waste proposed to be put in the NSDF</u>**

The EIS for the Near Surface Disposal Facility contains virtually no discussion of environmental hazards associated with individual radionuclides that may be put in the facility. It provides only a "Bounding NSDF Project Waste Radionuclide Inventory" (Table 5.7.6-1, p. 5-513). CNL's "Waste Acceptance Criteria" (WAC) document defines eleven radionuclides as "significant" in the context of long-term environmental performance of the proposed NSDF facility, referring to "Safety Criteria" that have not been released to the public (CNL 2017). No information is provided to explain why these particular radionuclides have been defined as "significant".

The "Significant Radionuclides" identified in the NSDF Waste Acceptance Criteria (Table 1) differ from the radionuclides identified by U.S. bodies as important to low-level radioactive management. Tritium (hydrogen-3), which is considered "sensitive" by the U.S. Nuclear Regulatory Commission, is not considered "significant" by Canadian Nuclear Laboratories in the context of the performance of the NSDF. This may explain why CNL proposes to release waste water containing very high tritium levels from the NSDF, and proposes no measures to limit worker tritium exposures. However, this in no way justifies ignoring the environmental and health risks associated with tritium releases and exposures (for more information on tritium see section entitled "Lack of information on effects of tritium on aquatic organisms").

Cesium-137 and strontium-90, two major fission products present in very high total amounts in the Bounding NSDF Project Waste Radionuclide Inventory, are not identified as "significant" in the NSDF WAC. According to the U.S. DOE (1996), the common chemical compounds of cesium-137 are "water soluble and will readily move with groundwater unless preferentially retained in the soils," and strontium-90 "is very soluble and is transported readily with precipitation and groundwater deep into soils." Thorium-230, identified as "significant" in the NSDF WAC, is not even listed in the Bounding NSDF Project Waste Radionuclide Inventory. The omission of neptunium-237 from the list of "significant" radionuclides in the NSDF WAC is problematic given its very long half-life; the quantity, radiotoxicity, and mobility of its daughter products, which include isotopes of radium and radon; and its high solubility and tendency to remain in the groundwater rather than being adsorbed by the soil (U.S. DOE 1996).

The NSDF EIS also provides virtually no information on the constituents of the "mixed waste" that might be placed in the NSDF EIS. Table 5.3.2-5 lists a wide range of non-radioactive "contaminants of potential concern", including arsenic, cadmium, lead, PCBs, and dioxin. Other portions of the EIS indicate that the NSDF "mixed waste" could have significant amounts of mercury and asbestos. The EIS does not identify the sources of these contaminants, nor total amounts that might be included in the NSDF. Table 5.4.2-7 indicates that discharges of mercury and cadmium from the waste water treatment plant could exceed "treatment targets" for these heavy metals. The Waste Acceptance Criteria do not propose any upper bounds for the organic or inorganic components of the mixed waste that would be included in the NSDF. Both the EIS and WAC documents merely state that CNL will follow the Province of Ontario's "Land Disposal Regulations" with regard to disposal of hazardous waste. No consideration is given to possible synergistic effects of exposures to radioactive and non-radioactive contaminants.

**<u>Exclusion of the Ottawa River from the Regional Study Area for the aquatic environment</u>**

The proposed Near Surface Disposal Facility would be roughly 1 km from the Ottawa River. The potential for the NSDF to have adverse environmental impacts on an extensive downstream area of the Ottawa River owing to releases of radionuclides and toxic substances such as mercury, arsenic, lead, PCBs and dioxin is of great concern to members of the public. Table 5.5.1-1 on page 5-234 notes that "Effects to fish from potential for contamination in the Ottawa River from the NSDF Project" was an "Area of interest raised during engagement activities."

Table 5.5.1-1 on page 5-234 claims that, in response to this public interest, "The spatial boundaries of the assessment were selected to include consideration of potential effects to the Ottawa River." However, this claim is directly contradicted by a statement made on page 5-236 in the section of the EIS on "Valued Components" [and on pages 5-163 and 5-193]:

> "Although the Ottawa River in the vicinity of the mouth of Perch Creek is included in the RSA, the river beyond this location lies outside the boundary of the assessment."

No rationale or justification is provided for the decision not to consider the Ottawa River as a "Valued Component", and for the lack of consideration of impacts of the NSDF on the Ottawa River in the Aquatic Environment section of the EIS. Also, despite the claim that the EIS contains information about species found the Ottawa River "in the vicinity of the mouth of Perch Creek," the EIS lacks information about key species found there such as Lake Sturgeon (*Acipenser fulvescens*), American Eel (*Anguilla rostrata*) and freshwater mussels.

The Ottawa River and its biota are clearly major areas of interest for the public. The Ottawa River itself should be identified as a "Valued Component" in the EIS. A full assessment of potential impacts of the proposed facility on Ottawa River aquatic biota should be done before a determination is made of the significance of potential adverse environmental effects associated with the proposed facility.

**<u>Lack of information on the aquatic food chain and food web dynamics as related to fish populations, and on details of fish habitats</u>**

Appendix B of CNSC REGDOC-2.9.1*, Environmental Principles, Assessments and Protection Measures*, "Characterization of the Baseline Environment for an Environmental Assessment under CEAA 2012," describes the information that should be used by an applicant to characterize the baseline environment at a project site. Section B3, Aquatic Environment, says:

> "The applicant or licensee should include a description of the food chain and food web dynamics as a habitat component as this relates to fish populations, and potential effects resulting from the facility or activity..." (CNSC 2016)

The EIS does not include such a description of the food chain and food web dynamics in the Perch Creek Basin. This information is required to estimate radiological contamination of fish species by cesium-137, strontium-90, and other radionuclides that would be disposed of in the proposed facility and that would be discharged to the environment during the operation and post-closure phases (see section 5.7.6 of the EIS, Residual Effects Analysis). For example, insufficient information is provided to determine if models used in the EIS properly estimate cesium-137 levels in fish species such as Northern Pike (*Esox lucius*) that occur at the project site and that occupy higher trophic levels in the food chain.

Table 5.7.4-15 of the EIS, "Radioactivity (Bq/kg fresh weight) in Fish Sampled from the Ottawa River," shows that cesium-137 levels in fish sampled from the Ottawa River downstream from the Perch Creek outlet are currently much higher than in fish sampled upstream. This underscores the need for additional information about potential impacts of the NSDF on radiological contamination of fish. Tuovinen et al. (2013) state that:

"… it is well known that accumulation of Cs is higher in organisms that are at higher levels in the food chain. Our finding of higher $^{137}Cs$ levels and CR [concentration ratio] values in piscivorous species (pike and perch) than in the other species is consistent with numerous other studies showing that $^{137}Cs$ activity concentrations increase with increasing trophic level in aquatic ecosystems … and strengthens the need to use different transfer functions for piscivores and non-piscivores."

Another major deficiency in the Aquatic Environment section of the EIS relates to fish habitat. CNSC (2016) says that:

"The applicant or licensee should provide detailed habitat mapping that demonstrates habitat usage by fish within the study areas. This information should include depth profiles, substrate mapping, water temperature profiles, and a description of known and potential habitat usage (such as spawning, nursery, rearing, feeding and migratory) by fish that occur in the study areas."

Although the EIS notes that "Fish and fish habitat are recognized as important components of the aquatic environment that may be affected by the NSDF Project," none of this detailed information is provided. The EIS contains no reference whatever to spawning habitats.

Another deficiency in the EIS is inadequate information on the models and assumptions used to estimate radiation doses to humans from consumption of contaminated fish. As noted earlier, the potential for the NSDF to contaminate fish in the Ottawa River is a major public concern.

**Inadequate consideration of aquatic species at risk**

CNL's *2015 Species at Risk Annual Report* describes monitoring efforts for five at-risk species in 2015. Two of these are turtle species -- Blanding's Turtle (*Emydoidea blandingii*) and Snapping Turtle (*Chelydra serpentina*) – known to occur in the Perch Lake/Perch Creek wetlands adjacent to the proposed NSDF site (CNL 2015a).

Two other at-risk turtle species - the Northern Map Turtle (*Graptemys geographica*) and the Eastern Musk Turtle (*Sternotherus odoratus*) are present at CRL, but it is not made clear in the EIS if these two species occur in the immediate vicinity of the proposed NSDF site. As noted in the *2015 Species at Risk Annual Report*, these highly aquatic turtle species rarely leave the water except during the nesting season and are relatively difficult to detect and monitor.

Additional studies of the possible occurrence of these two at-risk turtle species in the Perch Lake/Perch Creek area are needed before the significance of potential adverse environmental effects associated with the proposed facility can be fully assessed.

Another aquatic species at risk known to occur on the Chalk River Laboratories property is the Western Chorus Frog (*Pseudacris tristeriata*). CNL's *Biodiversity Review for the Near Surface Disposal Facility Project* indicates that Western Chorus Frog was not heard during a spring 2016 survey involving automated recordings (CNL 2016a). However, these recordings were not made in the portion of the property where this species is known to occur. The EIS should discuss whether the absence of evidence of the species may have been because the sound recording technology was unable to detect its call. Additional work is required to confirm that this species does not occur in the immediate vicinity of the proposed site, and to determine if the proposed site includes suitable habitats that might be occupied by this species in the future.

The EIS fails to consider how highly valued fish species at risk such as the Lake Sturgeon and the American Eel could be impacted by construction activities at the proposed site or by radioactive leachate release to Perch Creek and the Ottawa River during the operation and post-closure phases. The EIS (p. 5-234) says,

> "Species, such as Lake Sturgeon (*Acipenser fulvescens*), American Eel (*Anguilla rostrata*), River Redhorse (*Moxostoma carinatum*), and Northern Brook Lamprey (*Ichthyomyzon fossor*), which occur in the Ottawa River and are species of conservation concern… are not identified as specific VCs [valued components] in the aquatic biodiversity assessment because their species distributions and preferred habitats lie outside the Regional Study Area (i.e., downstream of any expected measurable changes to surface water quality; RSA)."

CNL's *2015 Species at Risk Annual Report* directly contradicts this statement. The *Repor*t clearly indicates that the Lake Sturgeon (*Acipenser fulvescens*) and the American Eel (*Anguilla rostrata*) are at-risk fish species found at the CRL site (CNL 2015a). The *Report* contains a specific assessment of Lake Sturgeon, mature individuals of which are occasionally killed in the water intake for the NRU reactor at CRL. The *Report* states that "the section of the Ottawa River where CRL sits, called Allumette Lake, has a relatively healthy population" of Lake Sturgeon and adds that "Younger, smaller fish are more often found in more shallow regions while larger fish inhabit the deepest depth strata" (CNL 2015a).

Furthermore, Figure 2 ("Distribution of Lake Sturgeon") in Sowden and Power (1981) shows that one of the sites where Lake Sturgeon was collected in their study lies between the mouth of Perch Creek and Pointe au Baptême, well within even the very limited "Regional Study Area" for the NSDF EIS (shown as a dashed purple line on the map on page 5-237 of the EIS).

Optimal spawning habitats for Lake Sturgeon are "clean rock or cobble in flowing streams and rivers" (Bruch and Binkowski 2002). Lake Sturgeon could enter Perch Creek for spawning. As noted earlier, the EIS wholly neglects spawning habitats. Potential impacts of the NSDF on this species and other valued fish species found in the Ottawa River should be addressed so that a determination can be made of the potential significance of adverse environmental effects associated with the proposed facility.

**<u>Lack of information on contaminant levels in large aquatic and semi-aquatic mammals</u>**

Section 5.7.2 of the EIS on "Valued Components" provides information on "receptor taxa" that "have a relatively high potential for exposure to potentially impacted media, play a key role in the food web, and represent a variety of habits and trophic levels." Criteria listed on page 5-441 of the EIS for selecting species as "valued components" include being:

- reflective of the main exposure pathways, feeding habits, habitats, etc. on the site, and particularly those associated with the highest exposures;
- known to reside on the site, and therefore, are potentially exposed to environmental effects from the NSDF;
- representative of their trophic level, resulting in representation for all trophic levels and therefore, all exposure pathways; or
- of special socio-economic importance or value (e.g., due to their economic value or cultural importance).

Moose (*Alces americanus*), Beaver (*Castor canadensis*), Muskrat (*Ondatra zibethicus*) and other fur-bearing mammals immediately come to mind in this context. These species are of immense socio-economic and cultural importance in the upper Ottawa Valley, to indigenous and non-indigenous peoples alike. They would be expected to occur on the proposed site of the NSDF.

Given the high dependence of these large mammal species on aquatic habitats, they would be among those species most highly exposed to radiological contamination from the proposed facility, and from the existing leaking waste management areas adjacent to the project site.

The EIS should identify these large aquatic or semi-aquatic mammals in Table 5.7.2-1 as "Valued Components and Indicator Species for Ecological Health Assessment." The EIS should assess their potential to contain contaminants of concern such as tritium, strontium-90 and cesium-137. Radiological contaminants may bio-accumulate in the food chain and be present in large amounts in these species, given their food preferences. Beavers eat the highly-contaminated alders in the Perch Creek basin. Moose eat aquatic vegetation in this area. Muskrats eat highly contaminated freshwater mussels. These species are also eaten by humans, who could be exposed to serious radiological risks.

Measurements have been made in past of radionuclides in Moose killed on the CRL property. Data showing high levels of radiological contamination have been reported in the media. Such data would be useful in validating model predictions of radiological contamination from the NSDF. The EIS (p. 5-497) contains only an opaque reference to these data:

> "Historically, elevated levels of radioactivity have been measured in large game animals from within 25 km of the CRL property (e.g., approximately 1,100 Bq/L tritium in large game animal flesh sample in 2001). This is related to historical contamination of the CRL WMAs.... Fences installed in 2004 to prevent game animal access to areas with surface contamination have led to a reduction in radioactivity in local game animals."

During the post-closure phase of the NSDF, large aquatic and semi-aquatic mammal species would appear to have free access to the wetlands surrounding the proposed facility. Large semi-aquatic mammal species should be identified as "Valued Components" in the EIS – at minimum, Moose and Beaver. Existing data on radiological contamination in Moose and Beaver should be included in the EIS. These existing data, together with a full assessment of predicted impacts of the proposed facility on these species, should be made available to the public, including local indigenous groups.

**Cumulative effects of the project in conjunction with existing levels of radiation and toxic chemical pollution in the East Swamp and South Swamp**

In five places within the EIS it is stated that "Radiological contamination in the East Swamp wetland is relevant to the NSDF Project, as this area is immediately west of the NSDF Project site." In three places within the EIS it is stated that "Doses to non-human biota exposed to the aquatic habitat of East Swamp Stream were calculated to provide a bounding estimate of potential exposure."

The EIS should provide more details on these predicted doses and their implications for ecological health. In particular, the EIS should assess the cumulative impacts of additional radioactive discharges from the NSDF (e.g., from the waste water treatment plant and the surface water management ponds) in the context of existing radiological doses in the East Swamp and South Swamp wetlands near the proposed facility.

The EIS states (page 5-524):

> "Results indicate that the predicted doses to all indicator species are below the dose benchmark values. Doses to Bald Eagle, the most exposed species, account for 24 µGy/hr, or 24% of the benchmark value. This dose is primarily due to the waterborne emissions pathway (i.e., consumption of contaminated fish is 14 µGy/h) and direct exposure to external gamma radiation from the emplaced waste (assumed to be 10 µGy/hr). It is noted that non-human biota exposed to the aquatic habitat of East Swamp Stream are included in these dose calculations."

However, according to a CNL report entitled *Radiological Contamination in the East Swamp,* "The East Swamp is one of three wetlands on the CRL site where radiation doses to aquatic biota exceed radiological dose benchmarks for protection of biota" (CNL 2015b). This document states that "Radiation doses to snails, the most sensitive aquatic receptor in East Swamp Stream, were calculated to be 458 uGy.hr$^{-1}$, slightly exceeding the 400 uGy.hr$^{-1}$ benchmark for protection of biota."

By using the Bald Eagle (*Haliaeetus leucocephalus*as) an "indicator species" with far less radiation exposure than snails, the EIS does not acknowledge the full implications for ecological health of the existing radiological contamination in the East Swamp. The EIS does not adequately describe the adverse environmental effects created by the current radiological contamination in the immediate vicinity of the study area. Without a full description of the environmental effects of existing radioactive discharges in the Perch Creek basin, the EIS cannot fully assess the cumulative adverse environmental effects of the proposed NSDF.

According to CNL (2015b), "PCB (Total) and Tetrachlorodibenzofuran (TCDF Total) concentrations in East Swamp Stream Sediments exceed benchmarks for protection of biota by factor of 18 and 24 respectively." The EIS makes no reference to TCDF as a "contaminant of potential concern" in the waste currently found at the Chalk River Laboratories. The source and extent of PCB and TCDF contamination should be indicated in the EIS.

A footnote on page 3-12 of the EIS states that "Mixed waste having total PCB concentration of up to 50 ppm may be accepted by the NSDF." Given that total PCB concentrations in East Swamp Stream sediments already exceed benchmarks for protection of biota by a factor of 18, adding more PCBs to the proposed NSDF landfill in the East Swamp Stream watershed could create additional significant adverse environmental effects that should be taken into account in the assessment of this facility.

The South Swamp is also very close to the NSDF site and releases pollutants to Perch Lake. It has even higher levels of radiological contamination than the East Swamp. It receives leaking contaminants from Waste Management Area A and Reactor Pit 2. According to CNL (2015c),

> "The dose rate to snails from exposure to surface water measured at South Swamp Weir with 642 $Bq.L^{-1}$ total beta activity was calculated to be 704 $uGy.hr^{-1}$ [2]. The dose slightly exceeds the ecological benchmark of 400 $uGy.hr^{-1}$ for protection of aquatic biota indicating there is some potential for ecological effects to result."

Furthermore, according to CNL (2015c), wetland vegetation in the South Swamp is exposed to excessive radiation:

> "The dose to alders within the most contaminated area of the wetland, having measured beta activity in tree tissue of 1140 $Bq.gfw^{-1}$, was 292 $uGy.hr^{-1}$, slightly exceeding the benchmark of 100 $uGy.hr^{-1}$ for terrestrial biota."

CNL (2015c) further calculates that vegetation (mostly Speckled Alder, *Alnus rugosa*) and organic soils in the South Swamp contain large amounts of beta radiation:

> "If we decay-correct all of the inventory estimates to 2011 (in effect portraying the situation that would exist if there were no further $^{90}Sr$ contributions to the swamp between the time of the survey and 2011) the inventories in 2001, 2007 and 2011 would be 855, 549 and 923 GBq respectively. The largest contributor to the inventory has been the $^{90}Sr$ plume from WMA A."

Extensive environmental monitoring work has been done in the South Swamp, including ongoing water quality sampling at the South Swamp Weir. The EIS should provide data from the South Swamp Weir (e.g., in Table 5.7.4-8: Radioactivity (Bq/L) in Surface Waters near the NSDF Project Site), given that this sampling location yields the highest levels of radiological contamination in the regional study area.

**Cumulative effects of the project in conjunction with remediation of contaminated sites**

The description of "Type 3 – Non-soil-like Waste" on page 3-7 of the EIS includes the following:

> "Type 3 waste includes waste that can be excavated and handled as a bulk material, but do not have the physical characteristics of soil and soil-like materials... Examples include contaminated vegetation such as trees."

This suggests that the NSDF project could include removal of contaminated vegetation (such as the Alder shrubs in the East Swamp and South Swamp wetlands) and disposal of it in the mound. Apart from this off-hand reference to contaminated vegetation as Type 3 waste, the EIS does not discuss the volume of contaminated vegetation or its impact within the mound.

Putting significant quantities of organic "waste" in the form of contaminated vegetation in a radioactive waste mound would create problems that are not addressed in the EIS, such as:

- generation of large amounts of landfill gases, including methane, with a potential for an explosion and fire;
- differential settlement and mound instability (vegetation is much lighter than soil and cannot easily be compacted); and
- production of large quantities of leachate.

The first two problems could lead could lead to loss of integrity of the mound cover following closure of the NSDF facility, and prompt initiation of the "Bathtub Scenario", described on page 5-515 of the EIS as follows:

> **"Bathtub Effect Overflow Scenario:** If the base liner remains intact, then the infiltrating water will continue to be constrained by the ECM liner and berms. Water will enter the ECM at a rate determined by the degree of failure of the cover and percolate through the waste. Within confines of the berms the ECM will become fully saturated and leachate will discharge to surface at the lowest point of the berm. Depending on the rate of discharge the escaping leachate will infiltrate to the local groundwater flow system and may also flow overland to Perch Creek."

The EIS says that "A passive landfill gas (LFG) venting system will be constructed contemporaneously with installation of the ECM final cover system… designed to mitigate buildup of excessive gas pressure under the low-permeability barrier components of the final cover that could, if it were to occur, result in damage/disruption of the cover system." The EIS provides no information on the design or predicted effectiveness of this passive landfill gas venting system.

Nor does the EIS address the issue of how to deal with differential settlement associated with placement of large quantities of contaminated vegetation in a mound-type facility. Failure to address these issues increases the probability that a rapid breakdown of the mound cover and loss of capacity of the NSDF to contain wastes could occur following closure.

Perhaps even more troubling is the failure of the EIS to address potential environmental impacts associated with removal of contaminated wetland vegetation and soils near the project site. Section 2.3 of the EIS ("Purpose of the Project") clearly states that "CNL intends… to remediate various WMAs [Waste Management Areas] at the CRL property." Page 3-8 of the EIS indicates a total volume of "Type 1 – Soil and Soil-like Waste" of 370,000 $m^3$, comprising fully 37% of the total wastes in the proposed facility.

The EIS provides no details on the areas where contaminated vegetation and soils would be removed. It does not describe the areas proposed to be remediated, or identify which of these areas are currently occupied by native biota (which could include species at risk). The EIS is therefore silent on the impacts on biology and hydrology in the areas to be remediated. The complete absence of detail on what could be the largest physical activity associated with the NSDF project is an extremely serious deficiency.

As site remediation is clearly a major purpose of the NSDF Project, the EIS should fully describe the physical activities that would be undertaken in this regard. It should identify all areas proposed for remediation and describe their current ecological condition, including the possible presence of species at risk. In particular, the EIS should provide existing data on levels and total inventories of radiological contaminants now present in the East Swamp and South Swamp wetlands near the proposed project site. This information should be used in the EIS to assess cumulative impacts of the proposed project, including ecological impacts of remediation activities on existing contaminated areas, and the potential for the project to create additional radiological contamination of nearby wetlands and water bodies such as Perch Lake, Perch Creek, and the Ottawa River.

The EIS is vague about how the remediation of the waste management areas (WMAs) would be carried out in terms of timing and priorities. The EIS itself lacks a description of the leaking waste plumes from the WMAs, although Figure 6.2 (*"Physical and Natural Features of the Two Candidate Sites for the NSDF")* in CNL (2016b) does contain a map showing these plumes, which is reproduced below as Figure 1. This figure shows the contaminant plumes from WMA A and B, both of which are intercepted by streams discharging into Perch Lake. Additional details on these plumes and the WMAs are contained in the *Comprehensive Preliminary Decommissioning Plan* (AECL 2014) for the Chalk River Laboratories. This document, unfortunately, is not accessible on line. Its substantive contents are completely ignored in the EIS. It should be made accessible to the public by the proponent and used as a primary reference for the NSDF project. Other documents referenced in the EIS should also be made publicly accessible.

The most problematic wastes in the WMAs are likely to be "intermediate-level", with high amounts of long-lived radionuclides, unsuitable for placement in a near surface disposal facility. Despite the lack of information in the EIS on the contents of the WMAs, and how WMA remediation activities would be carried out, logic suggests that priority should be given to the sources of the leaking plumes (i.e. the materials in the WMAs), and not the plumes themselves. If contaminated vegetation and soils are removed, but the sources of contamination remain, new contaminant plumes will form. Time, money and effort will be wasted.

Impacts of the proposed construction and operation of the NSDF should be assessed in tandem with impacts of current and proposed decommissioning and remediation activities at the Chalk River Laboratories. In essence, a cumulative impact assessment is needed. Without such a cumulative impact assessment, the EIS does not meet the requirement in section 19 of the *Canadian Environmental Assessment Act, 2012*, that

> "The environmental assessment of a designated project must take into account… any cumulative environmental effects that are likely to result from the designated project in combination with other physical activities that have been or will be carried out."

**Lack of consideration of Impacts of radiation on genetic integrity of aquatic organisms**

As noted in an earlier section, the significance of radiation exposures to aquatic organisms has been assessed in the EIS using a so-called "deterministic" threshold of 400 µGy/h for "potential effect on non-human biota." This approach is seriously flawed. The unit Gray (Gy) is a measure of absorbed dose in Joules/kg and does not in itself describe the biological effects of different types of radiation. The Gray gives an average value determined in a large mass, whereas actual biological effects are related to energy deposition at the level of individual cells or DNA molecules.

In particular, average levels of energy deposition measured in Grays do not account for chromosomal or DNA damage, particularly to eggs, larvae and juvenile stages of aquatic organisms. The EIS is completely silent on potential genetic effects of radiation exposures.

Many peer-reviewed research studies provide overwhelming evidence of genetic consequences of exposure to radiation. One major source of this evidence has been exposures of natural populations following the April 1986 Chernobyl disaster. These studies span a range of exposure levels. A 2015 meta-analysis of 45 published studies covering 30 species confirmed dose-dependent effects of ionizing radiation on mutation rates, with plants showing a larger effect than animals (Møller and Mousseau 2015). This study's authors conclude that their findings indicate an "impact of radioactive contamination on individual fitness in current and future generations, with potentially significant population-level consequences, even beyond the area contaminated with radioactive material."

A 400 µGy/h exposure level is of limited value in assessing the significance of radiation exposures to aquatic organisms. There is no evidence whatever that this level can be considered as a “threshold” for biological effects. Potentially harmful biological effects can occur at exposure levels far lower than the 400 µGy/h value (AlAmri et al. 2012).

Table 5.7.7-1 (“Uncertainties in the Ecological Health Assessment”) in the EIS implicitly acknowledges this problem. This table refers to a much lower “screening level” for harmful effects of 10 µGy/h, and indicates that “If this level is exceeded, then a more detailed evaluation is required.” Table 5.7.6-6 (“Doses to Non-human Biota during the Operations Phase”) calculates that radiation levels during the operations phase of the NSDF would either meet or exceed this 10 µGy/h screening level for <u>all</u> species examined, often by a wide margin (e.g., in the case of fish species such as Northern Pike, *Esox lucius*). In order to fully examine the significance of adverse environmental effects associated with the NSDF project, the EIS should include a “more detailed examination” of the exceedances shown in Table 5.7.7-1.

Bivalves, including freshwater mussels, are frequently used as model organisms to assess genetic impacts of low-level radiation. Freshwater mussels are abundant in the Ottawa River near the Perch Creek outlet, and occur in Perch Lake itself (e.g., Kim et al. 2016). Freshwater mussels in Perch Lake are exposed to elevated strontium-90 and tritium concentrations. The EIS should review scientific findings on effects of low-level radiation exposures on mussels. It should also describe the occurrence of, and research on, freshwater mussels in Perch Lake immediately adjacent to the proposed NSDF site.

Information should be included in the EIS on potential genetic impacts on aquatic organisms from exposures to radionuclides, taking into account predicted levels in leachate from the proposed NSDF. The absence of references to the scientific literature on impacts of radiation exposures on mussel species, including those living in Perch Lake and portions of the Ottawa River, is a deficiency that should be corrected in order to perform a full assessment of the significance of potential adverse environmental effects associated with the proposed facility.

**<u>Lack of information on effects of tritium on aquatic organisms</u>**

Releases of tritium (the radioactive isotope of hydrogen) from the proposed NSDF are of particular concern, because the waste water treatment facility would have no capacity to remove this radiological contaminant from discharges to the East Swamp Stream. According to Table 5.7.6-2 in the EIS (“Maximum Concentrations of Radionuclides in the Treated Effluent and East Swamp Stream“), predicted tritium levels in treated effluent would be extremely high (140,000 Bq/L). It says that this would result in a concentration in the East Swamp Stream of 12,000 Bq/L of tritium, estimated “by applying a dilution factor of 12.5, which was calculated based on the flow rate of 72,000 $m^3$/y in the East Swamp stream and the WWTP effluent flow rate of 6,556 $m^3$/y. “

This would represent a very large increase in tritium concentrations in the East Swamp Stream, which are currently in the range of 300-400 Bq/L, and would have a significant impact on tritium concentrations in Perch Lake, which are currently in the range of 3000-4000 Bq/L.

A footnote to Table 5.8.6-2 (“Bounding NSDF Project Waste Radionuclide Inventory to be Placed in the Engineered Containment Mound“), states that “Maximum tritium inventory placed within the ECM is estimated at $4.8\times10^{15}$ Bq; however, waste streams with high tritium content will be placed in special packaging or decay-stored so that no more than $3.9\times10^{13}$ Bq will be available for leaching prior to the ECM closure.” This would represent more than a 100-fold reduction in tritium available for leaching. Information is required in the EIS to demonstrate the feasibility of decay-storing or packaging tritium-containing wastes to achieve such a significant reduction in quantities available for leaching.

The EIS indicates that tritium concentrations at the Perch Creek Weir, about 1 km upstream from the Ottawa River, are already very high, in the range of 3000-4000 Bq/L, over a thousand times higher than natural background levels in surface water. Figure 5.7.4-13 in the EIS shows tritium concentrations for Northern Pike (*Esox lucius*) sampled in 2013 at the CRL site on the order of 1000-1500 Bq/L in water contents and also in organically bound forms. Figure 5.7.4-14 shows similar tritium concentrations in clams. These concentrations are roughly a thousand times higher than normal levels in aquatic organisms. These data were for Northern Pike sampled in Chalk Lake, which is not connected to Perch Lake (although it is connected to the Ottawa River). The EIS should report tritium levels in Northern Pike in Perch Lake, and in other larger fish species found in Perch Lake such as Yellow Perch (*Perca flavescens*), Brown Bullhead (*Ictalurus nebulosus*) and Pumpkinseed (*Lepomis gibbosus*). If tritium data are not available for fish in Perch Lake, this information deficiency should be filled.

The EIS suggests that the tritium concentrations in Northern Pike found in Chalk Lake are not of concern from the perspective of the health of this species:

> “Based on a water content of 75% by mass… and an internal dose conversion coefficient of $1.38\times10^{-4}$ micrograys per day per Becquerel’s per kilogram (µGy/d)/(Bq/kg)… the concentrations of tritium in fish and clams are significantly less than concentrations that would result in doses exceeding the benchmark of 400 µGy/h for aquatic biota.”

As noted in the previous section, reliance on a “benchmark” of 400 µGy/h for assessing impacts on aquatic biota is seriously flawed. The EIS should review and assess the scientific evidence that much lower doses of tritium can have adverse impacts on aquatic organisms, particularly during developmental stages.

Furthermore, the EIS does not reflect recent findings that biological effects of elevated levels of organically bound tritium are not properly taken into account by current regulatory standards, and that tritium can accumulate in food chains. One recent study (Jaeschke and Bradshaw 2013) states that:

> “The persistence, potential for biomagnification and the increased toxicity of organic tritium increases the potential impact on the environment following a release of HTO; current legislation does not adequately take into account the nature of organic forms of tritium and therefore may be underestimating accumulation and toxic effect of tritium

> in the environment. Such information is necessary to accurately assess the distribution of tritium following routine releases, and to adequately protect the environment and humans."

Additional recent tritium studies, including some by researchers working at the Chalk River Laboratories, raise similar concerns. Given the very large potential tritium releases from the proposed NSDF, the EIS should include a more balanced and comprehensive review of the potential adverse environmental impacts of this radionuclide.

**Lack of information on peak flows and low flows**

The EIS refers in several places to "peak flows from the 100 year event" but lacks numerical data for these peak flows. Why was the "Timmins Storm" chosen as the "regional storm event for the area"? What rainfall amounts occurred during that storm, and over what time period?

The Ottawa River experienced a major flooding event during the late April – early May 2017 period. Did precipitation amounts during that period exceed the Timmins Storm? "Slow-moving" storms are becoming increasingly common. Has this phenomenon, and the longer resultant periods of heavy precipitation, been taken into account in facility design?

CNL (2016c) provides only average annual flow rates for Perch Creek, with no data on peak flows. It is therefore of very limited value for assessing the significance of potential adverse environmental effects associated with the proposed facility. This EIS itself also lacks peak flow information for Perch Creek. This makes it impossible to assess total quantities of leachate, contaminants and sediment loads that could be delivered to the Ottawa River during spring snow melt or periods of high precipitation.

Additional information is needed to fully assess potential impacts of large precipitation events, erosion and surface water quality changes (including increased sediment loads) on aquatic organisms in Perch Lake, Perch Creek and the Ottawa River.

Similarly, the EIS lacks adequate information on low flows. This information is of importance for estimating maximum concentrations of contaminants in the East Swamp Stream owing to waste water treatment plant discharges. Tritium concentrations, for example, could be much higher than the estimated 12,000 Bq/L in the East Swamp Stream if waste water with high tritium contents were to be discharged during low-flow periods. Low flow data should be used to estimate potential maximum concentrations of contaminants in the East Swamp Stream.

**Inadequate consideration of construction phase impacts on the aquatic environment**

As noted on page 5-208 and four other places in the EIS, "surface water drainage through the Project site during construction of the ECM may transport blasting residuals and metals directly into downstream waterbodies, affecting surface water quality." A more in-depth analysis of potential adverse impacts during the construction phase, and mitigation measures, is needed.

Tree clearing, excavation, and blasting activities would take place before berms, storm water ponds, and facilities for waste water treatment and collection would be in place. Tree clearing alone on the large scale proposed for the NSDF (34 hectares) could have significant potential to lead to large-scale erosion and sedimentation during periods of heavy precipitation.

Tree clearing is not addressed in the aquatic environment section of the EIS. No mitigation measures are proposed to deal with adverse impacts of tree clearing on aquatic biota.

Construction of the surface water management ponds would also have potential to create disturbances of wetlands adjacent to the project site. The surface water management ponds would be in close proximity to the wetlands bordering on the west and south portions of the project area. Surface water management pond construction could create large sediment loads were it to coincide with a major precipitation event. It could also alter movement of existing contaminant plumes from Waste Management Area A and the two Reactor Pits. These possibilities, and appropriate mitigation measures, should be taken into account in the EIS.

The uneven and sloping terrain at the project site is clearly not ideal for a landfill type facility. As noted in Golder Associates (2016),

> "The generally shallow bedrock and the irregular bedrock topography invariably characteristic of Precambrian crystalline rock requires the NSDF cells to be predominantly built up rather than excavated into the overburden soils. Therefore a significant amount of grading will be required for the NSDF construction."

This need to "build up" the base of the facility and to do a "significant amount of grading" means that large quantities of erodible material vulnerable to major storm events would be present during the construction and operation phases.

The EIS should describe the sequencing of bottom liner installation vis-à-vis creation of berms, surface water management ponds and waste water collection facilities for the facility. Installation of a bottom liner on the sloping terrain of the proposed NSDF site could channel large amounts of incoming precipitation to the low point within the proposed area of the mound. The EIS does not consider to how to deal with large amounts of water that could be produced by a heavy precipitation event during the period immediately after bottom liner installation. Such an event would have the potential to result in significant erosion and sediment deposition in the area outside the NSDF project area boundary. It could also compromise the integrity of the bottom liner itself and lead to its prompt failure and future impacts on groundwater quality.

The EIS indicates that during construction, erosion and sediment control measures "will be in place to mitigate the effects of sediment transport," (i.e., "erosion control blankets" on steep slopes, "check dams in ditches and swales," and "the three proposed surface water management ponds"). However, sufficient information to judge the adequacy of these mitigation measures is lacking. Additional required information includes the following:

- a diagram showing the topographic configuration of the base of the mound;
- a diagram showing areas where it is proposed to do blasting;
- Information on how the base of the mound would be leveled to allow installation of the base liners;
- a detailed description of installation process for the base liners; and
- the precautions that would be taken to avoid wrinkling or puncturing of the geomembrane elements of the base of the mound during installation.

**Inadequate consideration of water contamination from radioactive berms and surface water management pond (SWMP) overflows**

Page 3-47 of the EIS, in a paragraph describing "Type 1 Waste - Soil and Soil-Like Waste," says

> "This material may also be used as berm material for berm containment areas used to contain Type 3, 4, and 5 wastes."

This means that the perimeter of the proposed facility would itself be composed of radioactive waste. The EIS does not indicate that the berms would be covered by an impermeable liner; indeed, it suggests they would be used as access roads. Leachate from the radioactive waste used to construct the berms would not enter the leachate collection system or be treated in the waste water plant. Precipitation leaching through the "Type 1" waste used to construct the berms could flow directly into the surface water management ponds (SWMPs) and surrounding wetlands.

Section 3.7.1 of the EIS ("Surface Water Management Ponds") makes no reference to pond liners or other impermeable barriers in the SWMPs, suggesting that SWMP contaminants would migrate freely into ground water. The EIS does not indicate that contents of the SMWPs would be pumped to the waste water plant for treatment.

The EIS indicates that the SWMPs would be designed to mitigate erosion and intercept sediment during construction, and to limit surface water and sediment discharge during operations. However, no mention is made of water quality parameters such as radionuclides, heavy metal, and toxic organic chemicals in the SWMPs – only sediment loads. Failure to contain leachate from the berms would likely result in major contamination of the SWMPs.

At three points in the EIS (pages 3-58, 9-2 and 9-14) it is stated that "The PMP [probable maximum precipitation] flow will exceed the surface water management ponds attenuation capacity, but is adequately conveyed by inlet and emergency outlet structures adjacent to the surface water management ponds." This indicates that pond overflows will definitely occur.

If SWMPs were to be seriously contaminated by radionuclides, sediments, and non-radioactive hazardous compounds, their projected overflows and groundwater discharges into the surrounding environment would have significant adverse effects on aquatic organisms. The EIS proposes that water quality in the SWMPs would be monitored only twice a year. This sampling frequency seems insufficient to detect and mitigate potential adverse impacts of SWMP overflows.

Page 3-57 of the EIS suggests that the SWMPs would be deliberately used to discharge radioactive and other toxic contaminants into the surrounding wetlands, and that the wetlands would form part of the waste disposal system created by the NSDF project:

> "The target surface water quality objective is provided by MOECC in their *Stormwater Management Planning and Design Manual…* which reports a 60% total suspended solids (TSS) removal that provides a basic water quality treatment for discharge to the receiving wetland. The **choice of basic treatment** over normal or enhanced levels of treatment (70% and 80% TSS removal, respectively) **was influenced by the receiver being a contaminated wetland and not a watercourse**. The wetland also has a sediment trapping function that will provide additional treatment to ultimately enhance level of treatment for Perch Lake and Perch Creek (the ultimate receiving waters)." [emphasis added]

This suggests that the East Swamp, one of many contaminated sites at the Chalk River Laboratories, would be further contaminated by uncontrolled discharges of radioactive and toxic wastes.

In general, additional information is required in the EIS to better assess the risks to the aquatic environment from the NSDF surface water management ponds. This includes:

- predicted contaminant concentrations in SWMP #1, SWMP #2, and SWMP #3 (including tritium);
- predicted concentrations and masses of contaminants exiting the SWMPs in overflow waters and groundwater under varying amounts and intensities of precipitation;
- an explanation of how surface water runoff from active cells (which would be sent to the WWTP) would be separated from runoff from inactive cells (which would be sent to the SWMPs); and
- locations and flow paths of the "emergency outlet structures adjacent to the surface water management ponds".

Finally, it should be noted that the surface water management ponds would represent newly created habitat, available for colonization by vegetation, and freely accessible to migratory birds, amphibians, turtles, and other biota. The EIS should consider ecological succession in these ponds, and their likely fate during the post-closure phase. The EIS should address the possibility that the SWMPs would become contaminated with hazardous materials at levels sufficient to cause harm to the biota using them. Risks to plants and animals that would use the SWMPs as habitat should be assessed.

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