Date: Feb 13, 2018

From: Algonquin Anishinabeg Nation Tribal Council (Wilf Ruland)

To: Lucia Abellan, Environmental Assessment Officer
Canadian Nuclear Safety Commission

By email: cnsc.ea-ee.ccsn@canada.ca

Subject line: NPD Closure Project

CEAA Reference number: 80121

Comments:

Dear Jessica,

Attached please find the report prepared for the Algonquin Anishinabeg Nation Tribal Council by myself.

I am a Professional Geoscientist retained by the AANTC to review the Draft Environmental Impact Statement (EIS) for the proposed NPD Closure Project. The AANTC are aware of the contents of my report, which was prepared on their behalf.

Sincerely,

Wilf Ruland (P. Geo.)

Initial Independent Review of Hydrogeological Issues
Pertaining to the Draft Environmental Impact Statement (EIS)
for the Proposed Decommissioning of the
Rolphton Nuclear Power Demonstration (NPD) Reactor

Prepared for:

the Algonquin Anishinabeg Nation Tribal Council

Prepared by Wilf Ruland (P. Geo.)

<Personal Information
Redacted>

February 13th, 2018

1) Introduction

I am a hydrogeologist, and I have worked as an environmental consultant for 32 years (2 years for a larger firm in Germany, and 30 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 also reviewed environmental assessments for numerous landfills, and more recently reviewed plans for the development of the proposed Deep Geologic Repository at the Bruce Nuclear Facility and the surface disposal facilities for low level nuclear waste in Port Hope and Port Granby Ontario. This experience is highly relevant to the issues being discussed in this matter.

I have been retained by the Algonquin Anishinabeg Nation Tribal Council to review (from a hydrogeological perspective) the documentation pertaining to the Draft Environmental Impact Statement (EIS) for the proposed Nuclear Power Demonstration (or NPD) Closure Project. The purpose of the NPD Closure Project is the safe decommissioning of the Rolphton NPD Reactor, using an "in-situ" decommissioning approach.

This in-situ approach if approved would involve the systematic demolition of all above grade structures which remain at the NPD Reactor site, size-reduction of the resulting pieces of the former structures, placement of the pieces into the below-grade portions of the reactor complex, followed by grouting of the below-grade areas, and capping with a concrete cap and an engineered impermeable cover. The goal is the long-term safe and secure disposal of the reactor complex through grout/concrete entombment.

This initial review of the Draft Environmental Impact Statement (Draft EIS) is not intended to provide my final comments regarding this matter, given that at this time the Draft EIS is simply a draft proposal - and as such 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 NPD Closure Project 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 NPD Reactor site and its surroundings including the local geology, hydrology and hydrogeology;
- the assessment of current NPD Reactor site impacts on the natural environment;
- the proposed site decommissioning design features aimed at 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 NPD Reactor Closure Project including site decommissioning, the 100 year Institutional Control (IC) phase, and the very long post-IC phase;
- the proposals for mitigation of any foreseeable impacts;
- the groundwater and surface water monitoring plans and contingency plans;
- the overall merits of the NPD Reactor Closure Project 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. I also toured the NPD Reactor site and met with CNL staff on January 11, 2018. During the tour and meeting we were able to discuss numerous questions which I had submitted prior to the meeting.

This review outlines my findings, conclusions and recommendations regarding the Draft EIS and my initial thoughts on potential short- and long-term groundwater and surface water impacts which could result from the proposed NPD Closure Project.

<u>2) Overview of the NPD Closure Project Proposal</u>

The NPD Closure Project Proposal proposal consists of the following key aspects which have been designed by CNL with the objective of safely and permanently entombing the reactor and associated structures in place:

- the reactor, associated systems and below-grade structures to be filled with grout to the extent practicable;
- the prior systematic removal and size-reduction of above-grade structures, which are then emplaced into below-grades spaces prior to the grouting;
- the grouted area covered with a thick concrete cap and low-permeability engineered liner;
- the “long-term” containment of the radioactive materials achieved through the concrete/grout entombment described above;
- site control and monitoring of the decommissioned NDP Reactor for 100 years after closure;
- after 100 years there is no intention to further monitor or in any way control the facility.

A much more detailed description of the NPD Closure Project proposal is provided in Canadian Nuclear Laboratories (CNL's) March 2016 Project Description Report.

I have reviewed the NPD Closure Project proposal which is the subject of the Draft EIS and numerous supporting documents in detail. Following my review I have questions and concerns remaining about several aspects of the proposal - these are outlined in the following sections of this review.

This review identifies problems with the draft Environmental Impact Statement (Draft EIS) including the descriptions of the process which led to the in-situ entombment option being selected, inadequate characterization of the bedrock hydrogeology which has in turn undermined the EIS's hydrogeological impact assessment, the lack of a surface water detention pond for the decommissioning period, the proposed termination of all site control and monitoring after 100 years, and the lack of detailed monitoring programs and contingency plans.

In my review I have also found disturbing evidence of a decades-long practice of dumping untreated water which is heavily contaminated with radionuclides as well as potentially hazardous non-radiological contaminants into the Ottawa River. I recommend that this practice should cease immediately.

The above issues and concerns 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) NPD Reactor Site Characterization

a) Introduction

A significant amount of hydrogeological investigation and characterization of the NPD site and its surroundings has been done by the proponent. Much of this work has been well done and is adequately presented in the Draft EIS, but there are also some very weak spots.

b) Site Topography and Drainage

The site topography is hilly, with an almost 50 meter drop across the 380 hectare NPD property from 160 meters above sea level (masl) at the Highway 17 entrance to 111 masl at the Ottawa River.

The topography of the immediate area of the NPD Reactor and associated structures has been heavily modified and is relatively flat and cleared of trees. This makes it very different from the natural environment which surrounds the NPD facility - which slopes steadily but unevenly toward the river and is heavily treed.

There are conflicting accounts regarding the ground surface elevation at the NPD Reactor Site - with the Draft EIS indicating on page 8-63 that the ground elevation is at about 125 masl. By comparison the 2017 Updated Groundwater Modelling Report indicates on page 2-3 that the ground elevation is at about 128 masl.

Surface water drainage from the NPD Reactor site area is downhill toward the Ottawa River. The river is to the northeast of the NPD site. Please note that I will follow the CNL convention of considering the river to be "north" of the site in this review - so that any descriptions in this review of the site which include directions will be made in reference to the river being "site north".

There are several wetlands on the NPD property, but these are all cross-gradient or uphill of the NPD site. There are no permanent streams on the property, due to the relatively high permeability of the thick sand/gravel soils which are found on-site (which allow rainfall to quickly infiltrate into the ground).

Any winter snowmelt or storm flows of surface water on the broader NPD property follow several ravines downhill toward the Ottawa River. In the immediate vicinity of the NPD Reactor site, surface water ditches carry storm water to ravines on the north-east and north-west sides of the facility.

There are also 2 tile drainage systems which capture infiltrating rainwater and shallow groundwater to varying extents and carry this water to the Ottawa River - these are discussed in more detail in the next section of this review.

c) Site Geology and Hydrogeology

The geology of the site is relatively straightforward. There are on the order of 10 meters of overburden consisting of thick layers of sand and mixed sand/gravel with (stones and boulders near the ground surface), which are underlain in places by silty and stony sand till. Beneath the overburden is fractured Precambrian gneiss bedrock.

The NPD reactor was constructed in an excavation which went deep into the bedrock. The 2017 Updated Groundwater Modelling Report indicates on page 2-3 that the elevation of the bottom of the reactor building is about 104 masl, 18 meters deeper than the bedrock elevation at the building of about 122 masl (and well below the Ottawa River's elevation of 111 masl).

The water table in the vicinity of the NPD Reactor site is situated near the base of the overburden (ie. near the bedrock surface) - however it can rise well into the overburden depending on time of year and location in the groundwater flow system. Annual water table fluctuations average about 1.3 meters.

Hydraulic conductivities are presented as being generally higher in the overburden than in the bedrock, however very little work seems to have been done to try to investigate and understand the bedrock groundwater flow system. The characterization of the bedrock groundwater flow system is the weakest part of the hydrogeological site characterization which was done for the Draft EIS.

The 2017 Updated Groundwater Modelling Report indicates on page 2-5 that a total of 45 wells have been installed over the years at the NPD site. Of this total, I could only find records of one location on the NPD site at which bedrock hydraulic conductivities were measured - the BH16-02 well nest, which includes 2 bedrock wells at one location.

The lack of bedrock hydraulics testing means that considerable uncertainty exists regarding the ability of the bedrock groundwater flow system to transmit significant amounts of groundwater. This is an important concern because bedrock groundwater flow (through fractures) can be much more rapid than groundwater flow through the overburden, and will provide much less of the attenuation or "filtration" processes which serve to impede the migration of contaminants in overburden materials.

A relatively low bedrock hydraulic conductivity of 3×10^{-8} meters per second (m/s) has been used in the groundwater model for the NPD site which is presented in the 2017 Updated Groundwater Modelling Report. An even lower hydraulic conductivity of 8.45×10^{-9} m/s has been used in the 2017 Resaturation Modelling Report. **I do not consider either of these hydraulic conductivity estimates to be based on an adequate assessment of bedrock hydrogeology.**

The bedrock hydraulic conductivity estimates listed above are not consistent with real-world observations of significant year-round flows observed in Tile Drain 1.

There are two tile drain systems at the NPD Reactor site - Tile Drain 1 and Tile Drain 2. The tile drains were installed for water management purposes, and were intended to capture infiltrating rainwater and shallow groundwater and carry this water to the Ottawa River.

Both tile drains were trenched into the surface of the bedrock. Tile Drain 1 captures groundwater from the (uphill) south side of the NPD facility, as well as the west side and the west half of the north side. Tile Drain 2 captures groundwater from the east side of the NPD facility, and from the east half of the north side.

Tile Drain 2 is a bit shallow and normally dry. Tile Drain 1 carries water year-round, considerably more than would be expected given the size of its assumed catchment area based on overburden water level contours. During construction, flows in Tile Drain 1 of 14 Liters per second (L/s) were observed. More recent estimates come in at around an average of about 11.2 L/s - with a range of 6.1 to 30 L/s.

The obvious explanation for the higher-than-expected flows in Tile Drain 1 is that much more than anticipated groundwater is coming from the bedrock groundwater flow system. This is consistent with the observation of flow through the winter months (during which shallower overburden-based flows would be expected to diminish to a trickle).

The bottom line is that while the overburden hydrogeology for the site has been well characterized and provides a solid foundation for the Closure Project impact assessment in the Draft EIS and its supporting documents, the same can not be said for the characterization of the bedrock hydrogeology.

I do not have any confidence in the estimates of bedrock hydraulic conductivity used in either of the reports which describe the modelling done for the Closure Project impact assessment - the 2017 Updated Groundwater Modelling Report and the 2017 Resaturation Modelling Report. I should note that the groundwater model's handling of flows in Tile Drain 1 is poor, likely due to the underestimation of bedrock hydraulic conductivity which was input into the model.

Further field investigations (including the drilling and testing of additional bedrock wells in at least 6 new locations) are urgently required in order to try to confirm or disprove the bedrock hydraulic conductivity estimates which have been used in the hydrogeological impact assessment of the NPD Closure Project.

d) Existing Contamination of Groundwater at the NPD Site

Current groundwater quality at the NPD Reactor site is summarized in a 2014 CNL Report entitled "Current Groundwater Quality at NPD". Some additional investigations have been carried out since that report was issued, with details provided in other documents. Following review of those reports I have concluded that to date the NPD Reactor site has not had any significant or lasting impacts on groundwater quality, except in the immediate vicinity of the reactor complex.

The reactor building is installed many meters below the groundwater table, such that groundwater flow through any leaks in the structure will be inward. This has precluded the possibility of radionuclides or other contaminants leaking out of the reactor building from the date of its construction to the present day. Please note that the situation will change significantly if the in-situ decommissioning project is approved, and this is discussed in following sections of this review. In the meantime, there is no appreciable groundwater contamination coming from the reactor building.

There are two landfills on the NPD property - both of which have been closed for decades. I have considerable experience and expertise in the assessment of landfill impacts on groundwater, and I have carefully reviewed the reports on the investigations of the 2 NPD site landfills.

While some very minor effects on groundwater quality have been observed downgradient of Landfill #1, I have no concerns about either of the landfills - neither is a source of significant groundwater contamination. I see no need for any remedial measures at either landfill.

There is an area of historic overburden groundwater impacts from a leaking underground fuel storage tank on the northwest side of the NPD complex. The tank has long since been removed and remediation of this area was successfully carried out. There is still some minor contamination of downgradient groundwater by petroleum hydrocarbons (PHCs). Groundwater from this area flows downhill through the overburden to the Ottawa River. The attenuation capacity of the overburden over the flow distance (of about 100 meters) is such that I do not expect measurable PHC levels in the groundwater discharging to the Ottawa River.

To summarize, I have concluded that the NPD Reactor site has not had any significant or lasting impacts on downgradient groundwater quality to date.

e) Existing Contamination of Surface Water from the NPD Site

There is no single overview document which discusses the NPD Reactor site's existing impacts on surface water, thus the following discussion is based on information which I have gleaned from review of a number of documents.

As described earlier, there are no downgradient wetlands near the NPD site and no surface streams - thus no possibility of stream or wetland impacts.

Surface ditches divert and carry clean stormwater away from the NPD site to ravines on the northwest and northeast sides of the facility. While I could not find any information to suggest that the diverted stormwater flows had ever been sampled, there is no reason to think that there would have been site impacts on such flows aside from the elevated tritium levels which are found around all nuclear facilities.

The tile drain system is intended to capture surface water and shallow groundwater from the immediate vicinity of the NPD Reactor complex. As such, it is much more likely to register water quality impacts than the stormwater ditches. I have reviewed the monitoring results for the Tile Drains carefully, and have concluded that little in the way of contamination is being carried to the Ottawa River via the drains.

The best indicator parameter for radiological impacts from the NPD site is tritium. Table 8.3-5 summarizes the tritium levels in the tile drain system from 1993 through 2015. Results for Manhole 2 (the downstream manhole in Tile Drain 1) show tritium levels which are generally in the range of 100s of Becquerels per Liter (Bq/L), compared to Ontario's Provincial Water Quality Objective (PWQO) for tritium of 7000 Bq/L.

Tritium levels in Tile Drain 2 are higher, averaging 12,000 Bq/L in 2014 and 2015. This is somewhat higher than the PWQO of 7,000 Bq/L, however flows in Tile Drain 2 are minimal and at times it is simply stagnant water which is being sampled. Gross beta test results have generally been below the detection limits for both tile drains for many years.

Both tile drains have been tested for non-radiological contaminants in 2014 and 2015. No results of concern are reported.

I conclude that the tile drains do not carry any appreciable contamination to the Ottawa River at present. This is likely to change if the proposed NPD Closure Project is approved, however that issue is discussed in more detail in subsequent sections of this review. In the meantime I have no concerns about the tile drains.

f) Dumping of Contaminated Water into the Ottawa River

Over the course of my review of the EIS, I have been concerned to learn of contaminated water handling practices at the NPD Reactor Site - which appear to have been ongoing for decades and continuing to the present day.

There has been a concerning practice of dumping batches of untreated contaminated water from the NPD facility into the Ottawa River. This practice is termed "surface water releases", and is discussed in Section 8.3.3 of the Draft EIS.

While this is issue is not central to the work which I have been contracted to do by my clients, it is of sufficient concern to me as a professional that I feel it is my responsibility to bring it to the attention of my clients, CNL, and the CNSC.

As described in the previous sections of this review, the leakage of water through the walls of the NPD Reactor complex is into the buildings from outside. Water also accumulates from condensation, and from various cleaning activities which may be performed from time to time. Water in the reactor complex picks up contamination and is accumulated in a complex series of drains and sumps which lead ever lower, and the contaminated water ultimately pools in the "Waste Area Sump" (or WAS) which is at/near the lowest point in the below-ground part of the complex.

Test results for the contaminated water which accumulated in the WAS in 2015 are provided in Tables 8.3-1 and 8.3-3 of the Draft EIS. I have summarized selected test results from these tables in **Table 1** on the next page of this review. **Table 1** presents the levels of various parameters in the WAS water (which is dumped untreated into the Ottawa River), together with the available regulatory guidelines for surface water quality (using the PWQO for tritium and PCBs) and CCME Environmental Quality Guidelines (for surface waters) for the other parameters.

Table 1

2015 Test Results for Contaminated Water Being Dumped into Ottawa River

Parameter	2015 Average Test Results	Regulatory Guideline	Exceedance Factor
		PWQOs	
tritium (Bq/L)	4.1×10^6	7×10^3	586 x
PCBs (ng/L)	5450	1	5450 x
		CCME EQG	
mercury	649 ng/L	26 ng/L	25 x
cadmium	43 ug/L	0.09 ug/L	478 x
copper	1320 ug/L	2 ug/L	660 x
lead	1720 ug/L	1 ug/L	1720 x
pyrene	800 ng/L	25 ng/L	32 x

Note:
Bq/L are Becquerels/Litre; ug/L are micrograms/Litre; ng/L are nanograms/Litre
25 x means that the test result was 25 times higher than the regulatory limit for surface water quality
PWQO are the Ontario Provincial Water Quality Objectives for surface water quality
CCME EQG are the CCME's Environmental Quality Guidelines for surface waters

As can be seen from Table 1 (on the previous page), **the regulatory guidelines for surface water quality were vastly exceeded in the contaminated water being dumped untreated into the Ottawa River from the NPD facility in 2015.**

For example, tritium levels in the contaminated water were 4.1 x 10^6 Bq/L compared to a regulatory guideline (in Ontario's PWQO) of 7 x 10^3 Bq/L - a factor of 586 times higher than the regulatory limit for tritium.

Levels of various heavy metals including (mercury, cadmium, copper and lead) were also tens to thousands of times higher than the regulatory guidelines, as were levels of potentially hazardous organic contaminants including PCBs and pyrene (a polynuclear aromatic hydrocarbon, or PAH).

The volume of water dumped (in 2 batches) in 2015 was 16 cubic meters or 16,000 Litres. Compared to the volume of water in the Ottawa River this is a small amount, and dilution in the river will have steadily diluted the contaminated water as it flowed downstream from the NPD site. I am nonetheless very disappointed to learn that this practice is occurring at a Canadian nuclear facility in the modern day.

I urge CNL to voluntarily discontinue this practice immediately, or alternatively for the CNSC to require CNL to discontinue this practice immediately.

I would also recommend to my clients that they request a full accounting and disclosure from CNL and/or CNSC about CNL's practices regarding liquid effluent releases from other facilities along the Ottawa River including the Chalk River Laboratories near Chalk River.

4) Evaluation of Project Alternatives

The evaluation of project alternatives is provided in Section 4.2 of the Draft EIS (entitled "Alternative Means of Carrying out the Project"), and includes four (4) options which were considered for the future of the NPD Reactor site:

- *continued storage with surveillance*
- *partial dismantling with removal*
- *full dismantling and removal*
- *in-situ decommissioning*

I do not consider the discussion or consideration of alternatives which is provided in the Draft EIS to be adequate or persuasive. For example, it is not clear what the impetus was for the current push to decommission the NPD Reactor. The facility has been in safe *storage with surveillance* mode for 30 years, with no significant groundwater or surface water impacts at the facility.

The most significant problem with the current *storage with surveillance* of the NPD Reactor complex is the decades-long practice of dumping of untreated contaminated water which accumulates in the facility into the Ottawa River (described in the previous section of this review). However the discontinuation of this practice which would come with the proposed *in-situ decommissioning* was not mentioned in the Draft EIS as an argument in favour of this option. Perhaps this is because the authors of the Draft EIS recognized that the practice could be discontinued at any time, and would not require site decommissioning in order to be accomplished.

The Draft EIS indicates that all 4 options are:
- technically feasible;
- able to meet regulatory requirements;
- economically feasible.

Tables 4.2.1, 4.2.2, and 4.2.3 in this section of the Draft EIS provide a visual overview of the relative advantages and disadvantages of the various alternative options. I do not find the tables to be persuasive, and in some cases I do not agree with the opinions being expressed through the tables.

For example, the potential risk to groundwater over the next 100 years from the *full dismantling and removal option* is indicated in Table 4.2.2 to be higher than the risk of leaving the NPD Reactor in place (imperfectly sealed with grout and concrete) through the *in-situ decommissioning* option. This doesn't seem to make a lot of sense.

Likewise the risk to surface water over the next 100 years from the *full dismantling and removal* option is indicated in Table 4.2.2 to be the same as the risk of leaving the NPD Reactor in place (imperfectly sealed with grout and concrete) through the *in-situ decommissioning* option. Again, this doesn't seem to make a lot of sense.

I recommend that this section of the Draft EIS needs to be expanded and rewritten to explain more clearly what the impetus is behind the current push to end the *storage with surveillance* status of the NPD Reactor facility, and to better present and articulate the relative advantages and disadvantages of the each of the 4 alternatives being proposed for the future of the NPD Reactor facility.

5) Proposed NPD Closure Design and Decommissioning Operations

The project description including the details of the proposed decommissioning site design and decommissioning operations are provided in Section 4 of the Draft EIS. Two Draft EIS supporting documents also provide more detailed information about the Closure Project design features and decommissioning operations.

Overview of Key Design/Operations Features

My understanding of the key features of the proposed NPD Closure Project design and decommissioning operations (which is based on the information provided in the Draft EIS) includes the following:

- systematic dismantlement and size-reduction of the above-grade structures;
- surface water management to minimize construction impacts and preclude flooding of the below-grade structures;
- emplacement of the dismantled and size-reduced above-grade structures into empty spaces in the below-grade structures;
- emplacement of stockpiled waste materials into the below-grade structures;
- assembly and operation of a grout batch-mixing plant, with the concrete grout being used to systematically fill all void spaces in the below-grade structures as completely as possible;
- the NPD drainage system to be grouted with the structure, with the outfall discharge pipes to be capped;
- after all below-grade grouting has been completed, a final reinforced concrete cap to be poured over top of the footprint of the in-situ decommissioned and grouted NPD Reactor facility;
- placement of a low-permeability engineered barrier (above the reinforced concrete cap), intended to minimize infiltration of rainfall into the concrete-capped and grouted structure;
- area to be graded with drainage ditching installed in order to divert clean surface water away from the entombed reactor;
- outside of the concrete-capped monolith all remnant building slabs, foundations and non-essential roadways to be “rubblized” in-situ and the area restored with native vegetation;
- the sole exception will be the NPD ventilation stack, which will be maintained to continue serving as habitat for the endangered chimney swift;
- all buried utilities to be capped/disconnected but left in place to minimize environmental disruption;
- above-grade electrical systems to be deactivated including removal of the back-up power diesel generator;
- area around concrete/grout monolith to be fenced to restrict access;
- inspections and monitoring (specific details as yet to be determined) for a 100-year Institutional Control period;
- lands surrounding the grouted area to be returned to AECL for determination of possible re-use(s) as appropriate given applicable soil and groundwater quality guidelines;
- removal of fencing after 100 years with no facility inspections, no monitoring and no maintenance thereafter.

The above description is based on conceptual descriptions of various design features and proposed decommissioning operations, with numerous crucial details yet to be worked out.

I was not able to find complete information (or reference to completed documents containing the information being sought) on numerous hydrogeology-related critical details pertaining to the NPD Closure Project proposal in the Draft EIS, including the following:

- information on whether groundwater is moving down the drain for the pressure relief duct, and if so what the water quality in that duct has been and is today;
- the specific details of the proposed groundwater and surface water monitoring programs for the 2-year decommissioning period and for the 100-year Institutional Control phase;
- a persuasive rationale which explains and justifies how the duration of the 100-year Institutional Control phase was selected;
- contingency plans which might be implemented in the event that critical assumptions (pertaining to groundwater and/or surface water impacts) which underpin the proposed NPD Closure Project assessment turn out to be incorrect;
- a detailed discussion of the water quality/quantity management issues needing to be considered in regard to the plans for retention of the ventilation stack;
- plans for the eventual fate of the stack (ie. whether it will be maintained or removed after a certain period, and what decision-making process will guide that decision);
- a surface water management plan for the project's 2-year decommissioning phase;
- design details of the batch plant's wash out pit, including plans for water management and environmental testing and protection measures;
- the proposed precise footprint, thickness, and other construction details for the reinforced concrete cap (designed to prevent intrusion into the concrete monolith);
- the design longevity and permeability of the engineered barrier (designed to minimize infiltration into the concrete monolith);
- specific details on any inspection/monitoring program intended to verify that the engineered barrier is performing as intended, and specific details regarding what if anything would trigger replacement of the engineered barrier;
- detail(s) and thickness(es) of any material(s) which will separate the concrete cap from the overlying engineered barrier;
- details of the proposed grading below and above the engineered barrier;
- proposed grading and planting and landscape management plans for the relatively flat and highly modified landscape surrounding the concrete monolith;
- final dimensions of the fenced-in area for the 100-year Institutional Control phase;
- whether there is any flexibility on what is to happen at the end of the 100-year Institutional Control phase (eg. whether there will be a detailed assessment of whether various estimates and projections made in 2018 have proved to be valid 100 years later, and whether there is a need for continued Institutional Control).

The Draft EIS can not be considered complete, because this information is currently not yet developed and/or missing from the document and/or not referenced in the document. The final EIS should be amended to either include this information, or to provide references to publicly available documents which provide this information.

6) Assessment of Potential Groundwater Quality Impacts

The assessment (and mitigation) of potential groundwater impacts associated with the proposed NPD Closure Project is provided in section 9.5 of the Draft EIS.

There are three periods of the NPD Closure Project which require consideration in this review:

- the Decommissioning Execution Phase (2019-2020)
- the Institutional Control Phase (2020-2120)
- the Post-Institutional Control Phase (after 2120)

a) Groundwater Impacts During the Decommissioning Execution Phase

There is no potential for groundwater impacts from the NPD Reactor Complex itself during this phase, because the facility is still dry with inward hydraulic gradients - precluding the possibility of outward leakage of radionuclides or other contaminants.

This means that the potential for groundwater impacts during the Decommissioning Execution Phase is not dissimilar to the potential for impacts at any major construction/demolition site, with the complication of some level of radionuclide contamination being present and needing to be accounted for and mitigated in order to prevent groundwater contamination.

I am confident in the ability of CNL and its contractors (operating under CNSC oversight) to make sure that groundwater around the facility does not become significantly contaminated during the Decommissioning Phase of the NPD Closure Project if they have detailed and well thought-out plans to guide them.

But the detailed plans for decommissioning (including for management/monitoring of the batch plant wash pit) have yet to be developed and presented or referenced, and so this part of the Draft EIS can not be considered complete. The final EIS needs to include plans which confirm that the potential for significant groundwater impacts during this phase of the proposed project is relatively low and able to be mitigated.

b) Groundwater Impacts During the Institutional Control Phase

The Institutional Control (or IC) Phase of the NPD Closure Project is proposed to go from the end of construction in 2020 for an period of 100 years, ending in 2120.

During the IC Phase the grouted NPD Reactor is expected to resaturate and begin leaching contaminants (both radionuclides and non-radiological contaminants) into the groundwater flow system. Once in the groundwater flow system these contaminants will be carried toward the nearby Ottawa River which is about 100 m steeply downhill from the reactor.

Groundwater moving downhill from the area of the reactor (carrying contaminants from the reactor) may either discharge to the ground surface in the form of springs and seeps or alternatively may discharge to the Ottawa River. Once the contaminant-bearing groundwater has discharged (either via surface springs or into the river) the contaminants become "available" with the potential for impacts on valued components (VCs) in the terrestrial and/or aquatic environment, and on people.

c) Modelling Factors Affecting Potential for Groundwater Impacts

There are numerous physical and chemical factors which will influence the rate at which contaminants from the grouted reactor become available in the natural environment.

Trying to develop the best possible understanding of how these factors will interact and to estimate when various contaminants will become available to environments hosting VCs (and in which quantities) is the key challenge for the hydrogeological impact assessment being presented and discussed in Section 9.5 of the Draft EIS.

The processes involved are complex, and computer modelling has been employed in support of the Draft EIS to try to develop key projections for the groundwater impact assessment. In particular two modelling exercises are critical for the impact assessment:

- the modelling of how rapidly the entombed reactor resaturates and starts leaking;
- the modelling of how quickly groundwater (and contaminants) are able to travel downhill from the entombed reactor toward the Ottawa River.

I will deal with each of these modelling exercises shortly. However I will state up front that in my opinion both models share a common and potentially fatal flaw - namely, that they are based on unsupported and in my view incorrect assumptions regarding the nature and hydraulic characteristics of the bedrock in the site study area around the reactor and downhill toward the Ottawa River.

d) Problematic Assumptions About the Bedrock

The bedrock has been assumed in the models to be a relatively homogeneous and unfractured medium with a very low hydraulic conductivity on the order of 3 x 10^{-8} meters per second (m/s) to 8.5 x 10^{-9} m/s.

Hydraulic conductivity is a measure of the ability of a geological material to transmit groundwater, and the models are assuming that the bedrock is unfractured and not able to transmit much groundwater at all. I believe this to be an incorrect assumption, which is based on inadequate information from field testing of the bedrock flow system and a failure to think about real world processes which may have affected the bedrock hydraulic conductivity.

As discussed earlier, bedrock hydraulic conductivity measurements were only made in one nest (of 2 monitoring wells at the same location) - and the results from this one location were then extrapolated and assumed to apply to the entire site study area. This is poor scientific procedure (extrapolating from a non-representatively small sample), which has led to poor results. I will explain the problem as best as I can.

As described earlier the NPD Reactor was constructed in an excavation which went deep into the tough Precambrian bedrock. The bedrock surface around the reactor is about 122 meters above sea level (masl), and the depth of excavation for the lowest part of the structure (in the area of the Waste Area Sump) is below 104 masl - so the excavation is about 18 meters into the bedrock. Images taken at the time of construction show impressively deep excavations on the NPD site (please see **Figure 1** and **Figure 2** at the end of this review).

I do not know exactly which methods or combinations of methods were employed to get this deep into the bedrock - I expect that it was a lot of blasting. It is clear that to dig down into and then excavate over 18 meters of tough Precambrian bedrock there will of necessity have been very considerable disturbance of that bedrock all around the outlines of the structures which subsequently comprised the reactor complex - as said, likely through blasting.

This area of disturbed bedrock will have had its hydraulic conductivity (ie. its ability to transmit groundwater) permanently increased in a very dramatic fashion through the blasting, leaving a "halo" of fractured/shattered bedrock in the immediate vicinity of the NPD Reactor. The hydraulic conductivity of this badly fractured/shattered bedrock will be many orders of magnitude (ie. many hundreds or thousands of times) higher than the undisturbed bedrock further away from the reactor complex.

There is only one nest of observation wells which has been drilled into the bedrock and had hydraulic conductivity measured - namely the BH16-02 well nest. (Please note that a well nest is simply a group of wells at the same location, but drilled/ screened to sample water from different depths).

This well nest was obviously not drilled into the halo of disturbed bedrock around the NPD structure but was instead drilled into an area of undisturbed bedrock nearby. Bedrock which has been fractured by blasting has hydraulic conductivity many times higher than the range observed at the BH16-02 well nest.

The problem with using the hydraulic conductivity measured in the BH16-02 well nest to represent the hydraulic conductivities in bedrock in the site study area, is that this very significantly underestimates the ability of the disturbed bedrock to transmit groundwater (and transport contaminants) in the site study area around the NPD structure and in the disturbed area between the NPD complex and the Ottawa river.

When these non-representative hydraulic conductivities from the BH16-02 location are input into the models used to estimate the time needed for the grouted NPD reactor to saturate and to estimate groundwater flow and contaminant transport rates, the result is model predictions which are not realistic and not conservative and which underestimate the critical parameters being modelled.

e) Model Estimates of Time for Building Saturation

The 2017 Resaturation Modelling Report provides description of a computer modelling exercise which was used to estimate the time it would take for the grouted entombed reactor to become saturated and started leaking contaminants into the surrounding groundwater flow system.

The bedrock hydraulic conductivity which was used in the resaturation model is similar to that used in the groundwater model, and is in my opinion far too low.

Possible evidence of more active bedrock groundwater flow is provided on page 2 of the report which indicates that weatherproofing applied to the walls and floor of the NPD structure "*did not install to expectations, subjected to accidental damage and displacement of asphalt emulsion by groundwater flows*". Page 12 of the report also indicates that during a site visit in May 2017 "*evidence of groundwater seepage through the walls was also observed*".

Even with the artificially low hydraulic conductivities which were used in the model, the finding of the modelling exercise (reported on page 20 of the report) is that "*the majority of flow into the building during the transient resaturation period occurs through the bedrock*".

The sensitivity of the model to bedrock hydraulic conductivity was not tested, but it follows that if the majority of the flow into the resaturating grouted NPD structure is through the bedrock then a higher bedrock hydraulic conductivity (which allows more water to flow toward and into the building) would facilitate inflows.

The model's prediction is that the time for resaturation would be 44 years, with water reaching the highly contaminated reactor vault (and starting to pick up contaminants) in 22 years. The model's predicted resaturation time is much faster (19 years) in the event that an earthquake cracks the walls of the NPD structure, with water reaching the reactor vault in just 1 year. I should note that in the event of an earthquake, actual resaturation times would be even quicker than predicted by the model because the bedrock's ability to transmit water is much higher than assumed in the model.

My position is that the model predictions of building resaturation times are longer than the actual times would be in real life, because of the artificially low bedrock hydraulic conductivity estimate which has been used in the model.

f) <u>Computer Modelling of Groundwater Flow System</u>
A relatively low bedrock hydraulic conductivity of 3 x 10^{-8} meters per second (m/s) has been used in the groundwater model for the NPD site which is presented in the 2017 Updated Groundwater Modelling Report. **I do not consider this hydraulic conductivity estimate to be accurate based on various lines of evidence, and based on the fact that an adequate assessment of bedrock hydrogeology has not been carried out by the proponent.**

The key hydraulic parameter for any geologic medium is its hydraulic conductivity (ie. its ability to transmit groundwater) - the higher the hydraulic conductivity, the better it is able to transmit groundwater (and transport contaminants).

As discussed previously, the site investigations which provide the foundation for the hydrogeological impact assessment in the Draft EIS did a poor job of characterizing the bedrock hydrogeology. Hydraulic conductivity in the bedrock was measured at only one location - the BH16-02 well nest - and the hydraulic conductivities found there were assumed to be identically applicable across the entire site study area.

This is poor scientific practice - hydraulic conductivity often varies by factors of 100 to 1000 in the same formation, sometimes more than that. For this reason, monitoring wells are typically drilled into key formations of interest at a number of different locations across a study area and then compared to try to determine an average value and to assess variability. This step was omitted at the NPD site, which is relying on data from only one location.

In my professional opinion it was not prudent or conservative to be relying on hydraulic conductivity data from only one location to try to estimate the bedrock hydraulic conductivity at this nuclear site - especially as the estimated hydraulic conductivity provides the foundation for computer modelling which is the basis of the assessment of groundwater impacts from the NPD Closure Project (which is presented in Section 9.5 or the Draft EIS).

The computer modelling has ended up being non-conservative - that is, it is predicting NPD Closure Project impacts which are less significant than they are likely to be in real life if the project proceeds.

In particular, the assumed low bedrock hydraulic conductivity used in the computer model forces the vast majority of groundwater flow from the NPD site upward and out of the bedrock, and into the sandy overburden fill (in the channels which were excavated into the top of the bedrock for the tile drains and the pipes for reactor cooling water). This sandy fill would provide much more attenuation (ie. "filtration" and dilution by a variety of physical and chemical processes) than would be the case if the groundwater were moving through fractures in the disturbed bedrock beneath the sandy fill.

Lines of evidence which suggest that the bedrock hydraulic conductivity is much higher than has been assumed in the Draft EIS documentation includes the following:

- the water table is typically found near the bedrock surface (if the bedrock had a very low hydraulic conductivity as the EIS suggests, then groundwater flow and the water table would be displaced up into the overburden);
- the bedrock has been observed to be fractured;
- as recounted earlier, it was observed that weatherproofing applied to the walls and floor of the NPD structure "*did not install to expectations, subjected to accidental damage and displacement of asphalt emulsion by groundwater flows*";
- as set out in several recent Draft EIS supporting documents, the groundwater flows in Tile Drain 1 average about 11.2 L/s, which is much higher than can be accommodated in the computer model if the low assumed bedrock hydraulic conductivity of 3×10^{-8} m/s is used;
- overburden groundwater contours indicate a very limited catchment for Tile Drain 1, which is not consistent with observed flows (strongly suggesting the tile drain is picking up bedrock groundwater);
- the 2017 Updated Groundwater Modelling Report discusses on page 2-10 that at the time of NPD construction a major bedrock shear zone about 100 meters wide was observed on the northwest side of the site, and that "*the shear zone is expected to represent a zone with a high density of major fractures*");
- it is worth noting that the only hydraulic conductivity measurements done for the NPD site investigation were done at the BH16-02 location, on the far (southeast) side of the NPD complex and well away from the shear zone.

g) Summary

The above discussion in this review is of the utmost importance, because in the real world much more of the groundwater at the NPD site is moving through the fractured bedrock and not through the overburden as has been suggested in the Draft EIS.

Groundwater will move more quickly through bedrock fractures and contaminants being carried by that groundwater will be subject to less attenuation (ie. filtration and dilution) than assumed before discharging to surface springs and/or the Ottawa River.

It is my professional opinion that the Draft EIS was released prematurely. Basic field investigation of the fractured bedrock has been rushed and is woefully inadequate - further field investigations (including the drilling, testing and sampling of additional bedrock monitoring wells at several new locations) are urgently required.

Once the field work has been completed, the data obtained should be used to update the computer modelling (currently presented in the 2017 Updated Groundwater Modelling Report and the 2017 Resaturation Modelling Report), and the updated model data can then be used to revisit and revise the effects assessments for Valued Components (VCs) in the aquatic and terrestrial ecosystems.

7) Draft EIS Assessment of Potential Surface Water Quality Impacts

The assessment (and mitigation) of potential surface water and aquatic environment impacts associated with the proposed NPD Closure Project are provided in sections 9.3 and 9.4 of the Draft EIS.

There are three periods of the NPD Closure Project which require consideration in this review:
- the Decommissioning Execution Phase (2019-2020)
- the Institutional Control Phase (2020-2120)
- the Post-Institutional Control Phase (after 2120)

a) Potential Surface Water Impacts During the Decommissioning Phase
There is no potential for surface water or aquatic environment impacts from the NPD Reactor Complex itself during this phase, because the facility is still dry with inward hydraulic gradients - precluding the possibility of outward leakage of radionuclides or other contaminants.

This means that the potential for surface water and aquatic environment impacts during the Decommissioning Execution Phase is similar to the potential for impacts at any major construction/demolition site, with the complication of some level of radionuclide contamination being present and needing to be accounted for and mitigated in order to prevent surface water and aquatic environment contamination.

There will be a variety of potential sources of surface water contamination during the Decommissioning Phase, including the following:
- erosion of contaminants from the materials stockpiles for the concrete batch plant;
- excavation and grading for the batch plant's wash out pit, and leakage from the pit;
- uptake into surface water of contaminants from areas where size-reduction work is being carried out, and from size-reduced stockpiles of materials;
- erosion of contaminants from stockpiles of materials for emplacement beneath and above the engineered barrier;
- surface water contamination due to leaks of fuels and oils from trucks and equipment;
- grading and shaping of the final landscape for the decommissioned NPD reactor.

b) Possible Mitigation Measures During the Decommissioning Phase
I could not find reference to a surface water management plan for the Decommissioning Phase in the Draft EIS, however a list of possible mitigation measures is provided on page 9-33 of the Draft EIS. Missing from that list is any mention of a surface water management pond (SWMP) for the NPD for the Decommissioning Phase of the project.

I recommend that careful consideration be given to the merits of constructing a surface water management pond (SWMP) prior to the commencement of decommissioning activities, and grading the construction/decommissioning site such that the site runoff is directed into the SWMP.

This is standard procedure for many progressive construction/demolition sites, and it has many benefits. Fines eroded from stockpiles and unvegetated surfaces have a chance to settle out in the still waters of the SWMP, and the SWMP can be used to "screen" the discharges from the construction/decommissioning site through sampling, with the water only being discharged once prior sampling has shown that it meets regulatory requirements for radionuclides and conventional contaminants.

Likewise, the use of a SWMP allows fines from the construction/decommissioning site to be screened. Sediments accumulating in the SWMP can be sampled periodically, and then removed and disposed of appropriately once their content of radionuclides and conventional contaminants has been determined.

The NPD site is at an isolated location, and I am concerned that there may otherwise be a tendency to simply allow surface water runoff from the work area to run downhill toward the Ottawa River. The site's history of dumping untreated contaminated water from the Waste Area Sump (WAS) into the Ottawa River provides a caution in this regard.

I am hoping that it goes without saying that water which accumulates in the WAS during the Decommissioning Phase should not be simply dumped into the Ottawa River. Measures should be implemented to allow the contaminated water to be collected and taken off-site for appropriate treatment.

It is worth noting that the volumes of contaminated water accumulating in the WAS will be much higher during the Decommissioning Phase than has been the case in the past, because as the NPD structure is demolished the first thing to be removed will be the roof of the facility. This will allow precipitation to have full access to the interior of the structures in the NPD complex, and to the contaminants which they contain.

c) Surface Water Impacts During the Institutional Control Phase

The Institutional Control (or IC) Phase of the NPD Closure Project is proposed to go from the end of construction in 2020 for a period of 100 years, ending in 2120.

During the IC Phase the grouted NPD Reactor is expected to resaturate and begin leaching contaminants (both radionuclides and non-radiological contaminants) into the groundwater flow system. Once they are in the groundwater flow system, these contaminants will be carried toward the nearby Ottawa River which is about 100 m steeply downhill from the reactor.

Groundwater moving downhill from the area of the reactor (and contaminants from the reactor) may either discharge to the ground surface in the form of springs and seeps or alternatively may discharge to the Ottawa River. Once the contaminant-bearing groundwater has discharged (either via surface springs or into the river) the contaminants become "available" and can have impacts on valued components (VCs) in the aquatic environment, and on people.

Because the pathway for contaminants to reach surface springs and/or the Ottawa River leads through the groundwater system, any weakness in the groundwater impact assessment gets carried over into the surface water and aquatic environment impact assessments. The problems with the groundwater site investigations and impact assessment were discussed previously - these problems have undermined the surface water and aquatic impact assessments, which in their current form will underestimate the potential risks to people and VCs in the aquatic environment.

The surface water and aquatic environment impact assessments should be redone once a proper investigation of the bedrock groundwater flow system has been completed, and once the results of that investigation have been processed and used to redo the groundwater modelling and resaturation modelling for the NPD Closure Project.

8) Monitoring and Contingency Plans

Given the significance and precedent-setting nature of the proposed NPD Reactor Closure Project, downgradient groundwater quality monitoring programs and downstream surface water quality monitoring programs would be key components of any approval of the proposal.

To the extent that it addresses these subjects, monitoring or follow-up programs are discussed in a conceptual manner in Section 12 of the Draft EIS. But the Draft EIS does not contain (or reference a document containing) the specific details of monitoring or follow up programs for groundwater quality or surface water quality. This is a deficiency, which should be corrected before the Draft EIS is finalized.

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

While the proponent may have good intentions, there is no assurance that this is case until the details of water quality monitoring programs are 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 by not making them available during the public review period for the Draft EIS.

The monitoring issues requiring further consideration/description in the Draft EIS from a hydrogeological perspective include the following:

a. detailed 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 significant adverse 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 NPD monitoring programs;
d. the duration of the proposed Institutional Control monitoring period (fixed at 100 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 the specific details of proposals for follow-up monitoring programs for downgradient groundwater quality or downstream surface water quality.

Components of groundwater and surface water monitoring programs which are generally missing from the Draft EIS include the following :

- a list of groundwater monitoring locations, and a map showing those locations;
- a list of surface water monitoring locations, and a map showing those locations;
- for each monitoring location, a list of indicator parameters which will be used to quickly help determine if contamination is occurring;
- for each monitoring location, a more lengthy list of routine monitoring parameters which will be used to confirm that the decommissioned NPD Reactor is not having unacceptable effects on groundwater, surface water, or the aquatic environment;
- trigger levels for each of the monitoring parameters (which if exceeded will trigger action by the proponent), and a full description of what actions will be triggered;
- conceptual outlines of contingency plan options which will be triggered if confirmed very 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 Draft EIS is finalized, the proposed monitoring programs should be made publicly available for review and comment.

The only commitment to downstream surface water quality monitoring is a vague commitment to upstream and downstream monitoring in the Ottawa River, with no details provided.

My understanding is that historically the nearest downstream surface water quality monitoring was done at the drinking water intake for the town of Deep River and at the nearby Chalk River laboratories - this is much too far away from the NPD site.

The most likely pathways for contaminated groundwater from the decommissioned reactor to reach the Ottawa River are via Tile Drain 1 and/or the Cooling Pipes Trench, and a closer surface water quality monitoring point should be established just downstream of these features.

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

The Draft EIS fails to provide triggers for the groundwater and surface water monitoring programs for the decommissioned NPD Reactor.

A monitoring program without triggers for action is one in which data are just routinely collected, with no actions taken even if issues arise. This is not desirable for a decommissioned nuclear reactor.

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 two examples of conceivable adverse monitoring scenarios:

- Groundwater quality monitoring downhill from the decommissioned NPD Reactor reveals rapidly rising tritium levels a few years into the Institutional Control Phase, indicating that the reactor has resaturated much more quickly than projected in the EIS and is going to be leaking contaminants at much higher levels than anticipated;

- A few years after the decommissioned NPD Reactor has resaturated, a surface spring develops downhill along the course of Tile Drain 1 and has high levels of tritium and a number of other contaminants known to be present in the reactor complex.

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

Moreover, as with the monitoring programs, these contingency responses should be made available to the public and to Aboriginal communities for review and comment.

c) Independent Review and Public Dissemination of NSDF Monitoring Results

Though the details have not been provided, the proponent has committed to a 100-year monitoring period during the Institutional Control Phase of the NPD Reactor Closure Project.

While I firmly believe that the proposed 100-year monitoring period duration is inadequate (as outlined below), the fact that the proponent has committed to a 100 year-long monitoring period for the decommissioned NPD Reactor 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 NPD Closure Project.

My experiences (in the context of a different project) in accessing results from existing Chalk River facility monitoring programs are 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 potential hydrogeological impacts of a proposed major development at that facility.

Missing from the Draft EIS is a meaningful commitment by the proponent to subject the NPD Closure Project monitoring program results to independent and proponent-funded review, and to make the full results of its monitoring programs readily available to the public and to Aboriginal communities for review.

In this regard, Section 12.4 of the Draft EIS (in its entirety) states the following:

> *"12.4 Information Management and Reporting*
> *The detailed follow up monitoring program will be developed to outline aspects of data management and reporting, including data collection, storage, standards and responsible roles. Data collected will meet the required guidelines for collection and quality assurance and control. CNL will store information generated from the detailed follow up monitoring program in a robust database for future analysis and reporting. Analysis of results from the monitoring and follow-up program will be reported and submitted to the relevant regulatory agencies, and the public and Aboriginal groups as required. Periodic review of selected EA follow-up monitoring results by independent researchers will also be assessed".*

The above sounds like a statement of what could be good intentions, but that is all. A careful review confirms that there is no actual commitment to providing the results of the follow-up monitoring program to either the public or to Aboriginal groups - only to doing so "*as required*".

There is likewise no commitment to actually having the results of the follow-up monitoring program reviewed by independent researchers, only that this "*will also be assessed*".

If there is anything to these possible commitments, then they need to firmed up and completed and circulated to the public and to Aboriginal communities as soon as possible - and certainly at a minimum 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. A commitment from the proponent to adaptively updating the groundwater and surface water quality monitoring programs in concert with technological advances is essential, but is currently missing from the Draft EIS.

Building into the NPD Closure Project's follow-up 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 and Aboriginal communities is an excellent way to ensure the programs remain relevant and up-to-date.

d) Questioning the Arbitrary 100-Year Post-Decommissioning Monitoring Phase

The Draft EIS seems to indicate that some form of groundwater quality monitoring will continue throughout the 100-year post-decommissioning Institutional Control (IC) Phase. Precise details are not available, although the commitment to do something with regard to inspections and monitoring can be gleaned from the document.

By comparison, the Draft EIS is crystal clear on the termination date for the IC Phase and the associated monitoring and inspections - exactly 100 years. If this timeframe appears to be arbitrary, that's because it is. The project team seems to have selected and then fixated upon this termination date for oversight and monitoring, even before the proposed NPD decommissioning project commences.

There is no sign of any willingness to extend the 100-year monitoring period in the event that monitoring during the 100-year Institutional Control Phase shows that unforeseen problems have developed. It is not clear why the commitment by the proponent to monitor the NPD is not open-ended, or at least of a longer duration.

The Draft EIS does not provide any rationale let alone a compelling argument in favour of the firm plan to terminate the proponent's obligations for monitoring the decommissioned NPD Reactor after only 100 years.

It would be more prudent and responsible for the proponent to commit to monitoring "as long as required" (and at a minimum for the desired period of at least 100 years), with no automatic termination at all. Instead, a "Check Point" report outlining the results of a full final site investigation including field studies plus a future-risk analysis should be required prior to any proposed termination of monitoring and institutional control, in order to confirm that it is safe to abandon the site. The Check Point report should be submitted for regulatory consideration, and circulated to the public and Aboriginal groups for review and comment beforehand.

9) Discussion

The proposed NPD Closure Project is a unique undertaking in the history of Canada's nuclear industry. If approved and successfully implemented, it would mark the first time a nuclear reactor has been final-decommissioned in this country. As a result, this is a very important and precedent-setting project which requires full attention and engagement from the public, Aboriginal groups, and the CNSC.

Given the precedent-setting nature of the project, it is unfortunate that the Draft EIS has the appearance of having been rushed to completion. In particular, the hydrogeological investigation and impact assessment has been woefully inadequate.

Hydrogeological information presented in the Draft EIS indicates to me that the most important geological formation at the site (in terms of understanding and mitigating the water-related potential project risks) is the fractured Precambrian bedrock. Given that this is the case, it is very difficult to understand why the bedrock seems to be the least-studied and most poorly understood of the geologic formations beneath the site.

Investigations of the bedrock hydraulics were only conducted at a single location (the BH16-02 well nest), with the results of the testing then extrapolated to the rest of the site study area. Although the bedrock is fractured, it was assumed (in the computer modelling done in support of the Draft EIS effects assessment) that there are no fractures and the bedrock behaves like an ideal, low-permeability porous medium.

These problems with the hydrogeological investigations of the bedrock have undermined the hydrogeological effects assessment, and in turn have carried forward to undermine the effects assessments for surface water and the aquatic environment. This project needs to be put on hold in order for this issue to receive the attention it requires. This would allow other deficiencies in the Draft EIS to also be addressed.

10) Conclusions

1) The purpose of the NPD Closure Project is the safe decommissioning of the Rolphton NPD Reactor, using an "in-situ" decommissioning approach.

2) A significant amount of hydrogeological investigation and characterization of the NPD site and its surroundings has been done by the proponent. Much of this work has been well done and is adequately presented in the Draft EIS, but there are also some very weak spots.

3) The site topography is hilly, with an almost 50 meter drop across the 380 hectare NPD property from 160 meters above sea level (masl) at the Highway 17 entrance to 111 masl at the Ottawa River. Groundwater flow and surface water drainage from the NPD Reactor site area is downhill toward the Ottawa River.

4) The geology of the site is relatively straightforward. There are on the order of 10 meters of overburden consisting of thick layers of sand and mixed sand/gravel with (stones and boulders near the ground surface), which are underlain in places by silty and stony sand till. Beneath the overburden is fractured Precambrian gneiss bedrock. The NPD reactor was constructed in an excavation which went deep into the tough Precambrian bedrock.

5a) Very little field work seems to have been done to investigate and understand the crucial bedrock groundwater flow system, and as a result the characterization of the bedrock groundwater flow system is the weakest part of the Draft EIS' hydrogeological site characterization. This issue is discussed in detail in **Section 3c)** and **Section 6d)** of this review.

5b) Investigations of the bedrock hydraulics were only conducted at a single location (the BH16-02 well nest), with the results of the testing then extrapolated to the rest of the site study area. Although the bedrock is fractured, it was assumed (in the computer modelling done in support of the Draft EIS effects assessment) that there are no fractures and that the bedrock behaves like an ideal, low-permeability porous medium.

5c) These problems with the hydrogeological investigations of the bedrock have undermined the hydrogeological effects assessment, and in turn have carried forward to undermine the effects assessments for surface water and the aquatic environment (as described in detail in **Sections 6 and 7** of this review). These problems represent a potentially fatal flaw in the Draft EIS.

6) The evaluation of project alternatives provided in the Draft EIS includes four options which were considered for the future of the NPD Reactor site: *continued storage with surveillance; partial dismantling with removal; full dismantling and removal; in-situ decommissioning*. As discussed in more detail in **Section 4** of this review, I do not consider the discussion or consideration of project alternatives which is provided in the Draft EIS to be adequate or persuasive.

7) As described in detail in **Section 5** of this review, the descriptions of the proposed decommissioning site design and decommissioning operations which are provided in the Draft EIS can not be considered adequate or complete at the present time. Further details are urgently required to be included before the Draft EIS is finalized.

8a) As set out in **Section 8** of this review, the Draft EIS fails to provide the specific details of proposals for follow-up (ie. monitoring) programs for downgradient groundwater quality or downstream surface water quality. There is no firm commitment to providing the results of the follow-up monitoring program to either the public or to Aboriginal groups. There is likewise no firm commitment to having the results of the follow-up monitoring program periodically reviewed by independent researchers over the proposed 100 year Institutional Control Period.

8b) A major concern with the proponent's failure to develop or present these details to date 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 scrutiny from the public and Aboriginal groups.

9) The Draft EIS does not provide any rationale let alone a compelling argument in favour of the firm plan to terminate the proponent's obligations for monitoring the decommissioned NPD Reactor after a predetermined period of only 100 years. It would be more prudent and responsible for the proponent to commit to monitoring "as long as required" (and at a minimum for the desired period of at least 100 years) - with no automatic termination at all, and a requirement to apply to terminate monitoring and institutional control with a detailed and publicly available report.

10) Over the course of my review of the EIS, I have been concerned to learn that there has been a practice of dumping batches of untreated contaminated water (with levels of tritium and a variety of non-radiological contaminants tens to thousands of times higher than regulatory guidelines for surface waters) from the NPD facility into the Ottawa River. This concerning practice appears to have been ongoing for decades and continuing to the present day, and is discussed in detail in **Section 3f)** of this review.

11) Recommendations

Recommendation 1)

a) Further field investigations (including the drilling and testing of additional bedrock wells in at least 6 new locations) are urgently required in order to try to confirm or disprove the bedrock hydraulic conductivity estimates which have been used to support the hydrogeological impact assessment of the NPD Closure Project.

b) Once the field work has been completed, the data obtained should be used to update the computer modelling (currently presented in the 2017 Updated Groundwater Modelling Report and the 2017 Resaturation Modelling Report). The updated model data can then be used to review and revise the hydrogeology and surface water impact assessments, and the effects assessments for Valued Components (VCs) in the aquatic and terrestrial ecosystems.

Recommendation 2)

Section 4.2 of the Draft EIS needs to be expanded and rewritten to explain more clearly what the impetus is behind the current push to end the *storage with surveillance* status of the NPD Reactor facility, and to better present and articulate the relative advantages and disadvantages of the each of the 4 alternatives being proposed for the future of the NPD Reactor facility.

Recommendation 3)

Page 14 of this review describes how it was not possible to find complete information (or reference to completed documents containing such information) on numerous hydrogeology-related critical details pertaining to the NPD Closure Project design and decommissioning operations in the Draft EIS. The final EIS should be amended to either include this information, or to provide references to publicly available documents which provide this information.

Recommendation 4)

The Draft EIS fails to provide the specific details of proposals for follow-up (ie. monitoring) programs for downgradient groundwater quality or downstream surface water quality. This deficiency needs to be corrected in the final EIS for this proposal.

Recommendation 4 - continued)

Components of groundwater and surface water monitoring programs which are generally missing from the Draft EIS include the following :

- a list of groundwater monitoring locations, and a map showing those locations;
- a list of surface water monitoring locations, and a map showing those locations;
- for each monitoring location, a list of indicator parameters which will be used to quickly help determine if contamination is occurring;
- for each monitoring location, a more lengthy list of routine monitoring parameters which will be used to confirm that the decommissioned NPD Reactor is not having unacceptable effects on groundwater, surface water, or the aquatic environment;
- trigger levels for each of the monitoring parameters (which if exceeded will trigger action by the proponent), and a full description of what actions will be triggered;
- conceptual outlines of contingency plan options which will be triggered if confirmed very adverse monitoring results are obtained.

Before the Draft EIS is finalized the above details need to be added, with the finalized monitoring programs made publicly available for review and comment.

Recommendation 5)

The final EIS should include a meaningful commitment from the proponent to subject the NPD Closure Project monitoring program results to independent and proponent-funded review, and to make the full results of its monitoring programs readily available to the public and Aboriginal groups for review.

Recommendation 6)

The Draft EIS proposes to terminate the proponent's obligations for monitoring the decommissioned NPD Reactor after only 100 years. It would be more prudent and responsible for the proponent to commit to monitoring "as long as required" (and at a minimum for the desired period of at least 100 years), with no automatic termination at all.

Instead, preparation of a "Check Point" report outlining the results of a full final site investigation (including field studies plus a future-risk analysis) should be required prior to any proposed termination of monitoring and institutional control - in order to confirm that it is safe to abandon the site. The Check Point report should be submitted for regulatory consideration, and circulated to the public and Aboriginal groups for review and comment beforehand.

Recommendation 7)

Careful consideration should be given to the merits of constructing a surface water management pond (SWMP) prior to the commencement of decommissioning activities, and grading the construction/decommissioning site such that the site runoff is directed into the SWMP.

Recommendation 8)

a) There has been a decades-long and concerning practice of dumping batches of untreated contaminated water from the NPD facility into the Ottawa River. This practice is termed "surface water releases", and is discussed in Section 8.3.3 of the Draft EIS. CNL should voluntarily discontinue this practice immediately, or alternatively the CNSC should require CNL to discontinue this practice immediately.

b) Contaminated water which accumulates in the WAS during the Decommissioning Phase should not be simply dumped into the Ottawa River. Measures should be implemented to allow the contaminated water to be collected and taken off-site for appropriate treatment.

c) I recommend to my clients that they should request a full accounting and disclosure from CNL and/or CNSC about CNL's practices regarding liquid effluent releases from other facilities along the Ottawa River including the Chalk River Laboratories.

Recommendation 9)

The EIS (with its supporting documentation) should not be accepted or approved in its current form.

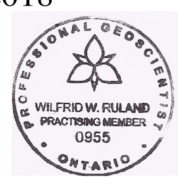
In its current form the Draft EIS is incomplete, inconsistent, and inadequate in terms of providing a proper or adequate assessment of the potential impacts of the proposed NPD Closure Project on down-gradient groundwater quality and downstream surface water quality.

12) 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 NPD Closure Project, and review or reference to other documents listed in the Reference List.

This Review has been prepared for the use of my clients, the Algonquin Anishinabeg Nation Tribal Council (AANTC).

Signed on the 13th day of February, 2018



<Personal Information Redacted>

Wilf Ruland (P.Geo.)

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Figure 1 - NPD Excavations into Precambrian Bedrock

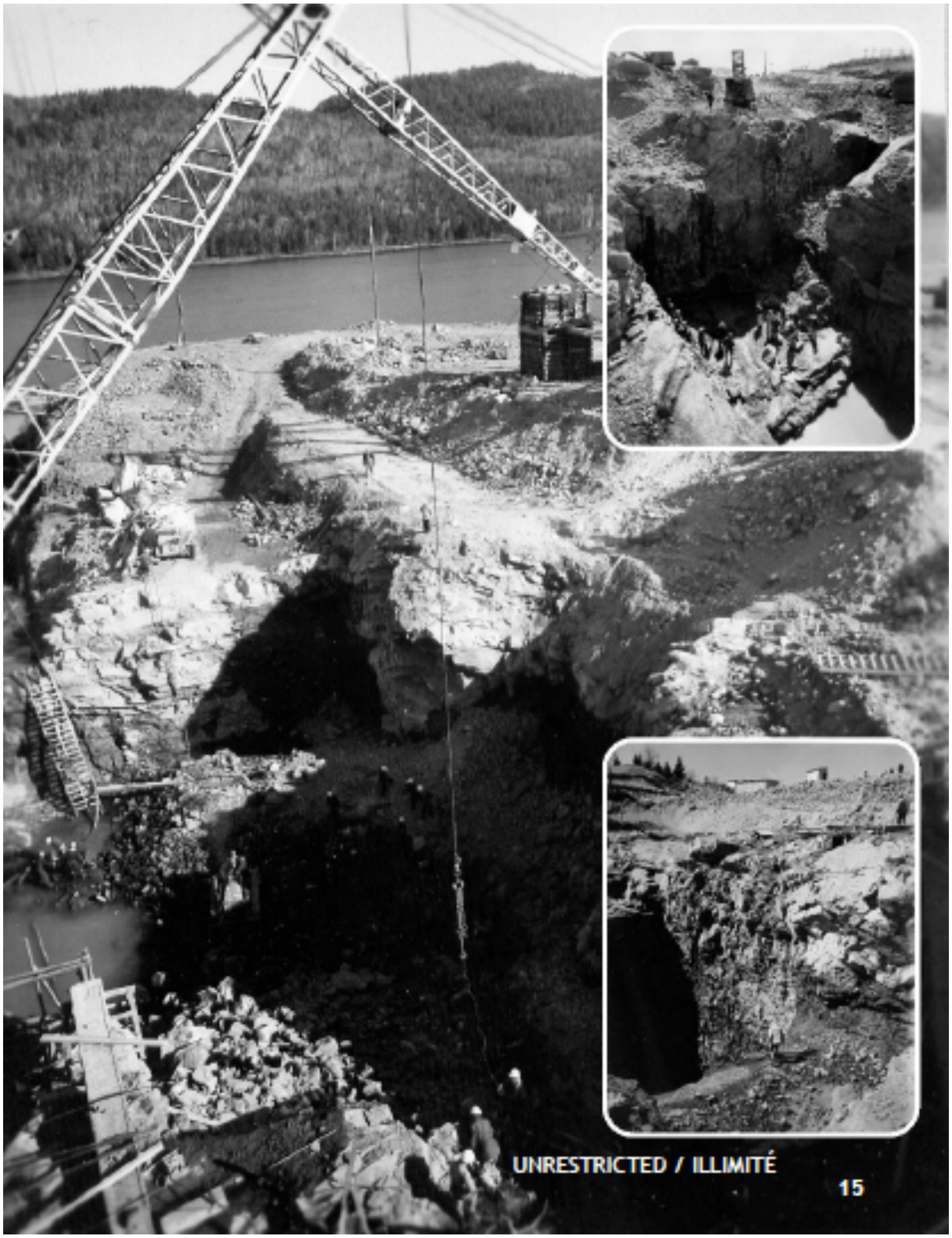

Figure 2 - NPD Bedrock Excavations for Reactor and Cooling Pipe Trench

Appendix 1

References

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